Measurement Protocol

Version 2

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SOIL ASSOCIATION EXCHANGE

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Contents

Introduction

At Soil Association Exchange we unlock science and data to help all farms to do more for the environment, whilst improving their long term resilience.

We believe that by equipping farmers with the information they need to understand their impact on the environment – as well as helping them realise the financial incentives available – we can, together, be part of the solution to the climate and nature crises we face. Because with all the facts at their fingertips, farmers can make the best decision for the environment, whilst also building resilient, profitable businesses for generations to come.

Whether regenerative or conventional, biodynamic or pasture-fed; we know every farmer has chosen the approach that suits their circumstances. We're passionate about producing nutritious food in harmony with climate and nature, but we're not out to certify whether a farmer adheres to any one particular practice. Rather, we provide each farmer with the rigorous outcome data they need to make informed decisions about the future of their land and local environment.

In September 2022, we at Soil Association Exchange released our inaugural Measurement Protocol V1. This is a document that describes how we measure a farm's impact on the environment.

That first version was implemented across 2022/23, helping more than 500 farmers understand their farm's impact - and helping the team at Exchange see where our methodology worked well, and where it needed improvement.

Measuring Mother Nature is a complicated business, and each year the scientific community gains fresh understanding of the natural world. As such, we have always committed to reviewing our Measurement Protocol, to ensure we're aligning with the best possible science, industry standards and technical advancements.

This document – the second iteration of our Measurement Protocol - is the result of six months' work reviewing hundreds of academic papers, canvassing the opinions of the scientific community, industry consultations and, most importantly, extensive conversations with farmers themselves.

Summary of changes:

This is a summary of the core changes and additions made to this protocol since Version 1. Within the document, each section expands on this detail, and a more in depth table can be found in the appendix.

Metric	How we collect data	Comparison to V1.
Soil Organic Matter	Sampling	Changed
Soil Organic Carbon Stocks	Sampling	New metric
Soil Structure: Bulk Density	Sampling	Changed
Soil Structure: VESS	Sampling	Changed
Total Nitrogen and C:N Balance	Sampling	New metric
Earthworms	Sampling	Changed
Soil Cover %	Farmer Survey	New metric
pH	Sampling	Changed
Contextual Soil Information	Third-party Data	New Metric
Water Storage	Third-party Data/Farmer Survey	Changed
Nitrogen Balance	Farmer Survey	Changed
Phosphate Balance	Farmer Survey	New Metric
Potash Balance	Farmer Survey	New Metric
Water Resource Availability	Third-party Data	Changed
Groundwater Status	Third-party Data	Changed
Water Usage Actions	Farmer Survey	Changed
Contextual Water Information	Third-party Data	New Metric
Crop and Livestock Diversity	Farmer Survey	Changed
Habitat Management	Farmer Survey	Changed
Biodiversity Connectivity Features	Farmer Survey/Third-party Data	Changed
Space for Nature	Third-party Data/Farmer Survey	Changed
Bird Species Abundance	Sampling	Changed
Arable, Hedgerow, Field Margins and Grassland Flora	Sampling	Changed
Hedgerow Structure	Sampling	Changed
Contextual Biodiversity Information	Third-party Data	New Metric
Carbon Balance	Farmer Survey/Third-party Data	Changed
GHG Emissions	Farmer Survey/Third-party Data	Changed
Carbon Stored in Woodland and Forest: Stocks	Third-party Data	Changed
Carbon Stored in Woodland and Forest: Sequestration	Third-party Data	Changed
Carbon Stored in Hedgerows: Stocks	Third-party Data	Changed
Carbon Stored in Hedgerows: Sequestration	Third-party Data	Changed
Carbon Stored in Soils: Stocks	Farmer Survey/Third-party Data	Changed
Carbon Stored in Soils: Sequestration	Third-party Data	Changed
Antibiotic Usage	Farmer Survey	Changed
Welfare Outcomes	Farmer Survey	Changed
Food Production	Farmer Survey	New Metric
Land Access	Farmer Survey/Third-party Data	Changed
Community Engagement	Farmer Survey	New Metric
Contextual People and Society Information	Third-party Data	New Metric


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So how do we go about measuring a farm's impact on the environment? With so many metrics to choose from, the answer could be complex. To keep our methodology focused, we ask five key questions of each potential metric:

1. **Financial benefit**
   Will meeting this metric help the farmer access a financial reward?
2. **Clarity**
   Is the farmer able to understand the metric and identify the changes they could make to improve it?
3. **Efficiency**
   Is the value of this metric to the farmer commensurate to the time and money they'll spend gathering the data?
4. **Scientific Rigor & Accuracy**
   Is there a sufficient body of scientific literature to support the metric; does it withstand challenge?
5. **Industry Alignment**
   Does the metric align with existing key legislation, policies, regulations and standards?

This document will outline each of the key metrics we measure at Exchange, detailing why we measure them, how we measure them and how we score them. We also note any other industry standards they meet, highlight the financial incentives they unlock and flag any changes to our methodology since Version 1 of the Protocol.

We hope this makes for a useful reference document as you make decisions about your business. If you have any suggestions as to how we can improve, please do get in touch: we'll soon start work on Version 3.

With thanks

The review of the Exchange Measurement Protocol has been led by Dr. Abigail Barker. The Exchange team would like to thank for her support, guidance and dedication to the project.

Abigail is a highly experienced natural capital advisor with in-depth knowledge of nature-based solutions, carbon and related public and private markets. In 2018, she co-founded Natural Capital Research Ltd (Nat Cap Research) becoming CEO and growing the company from just two employees to a highly successful organisation with a global client base across multiple sectors.

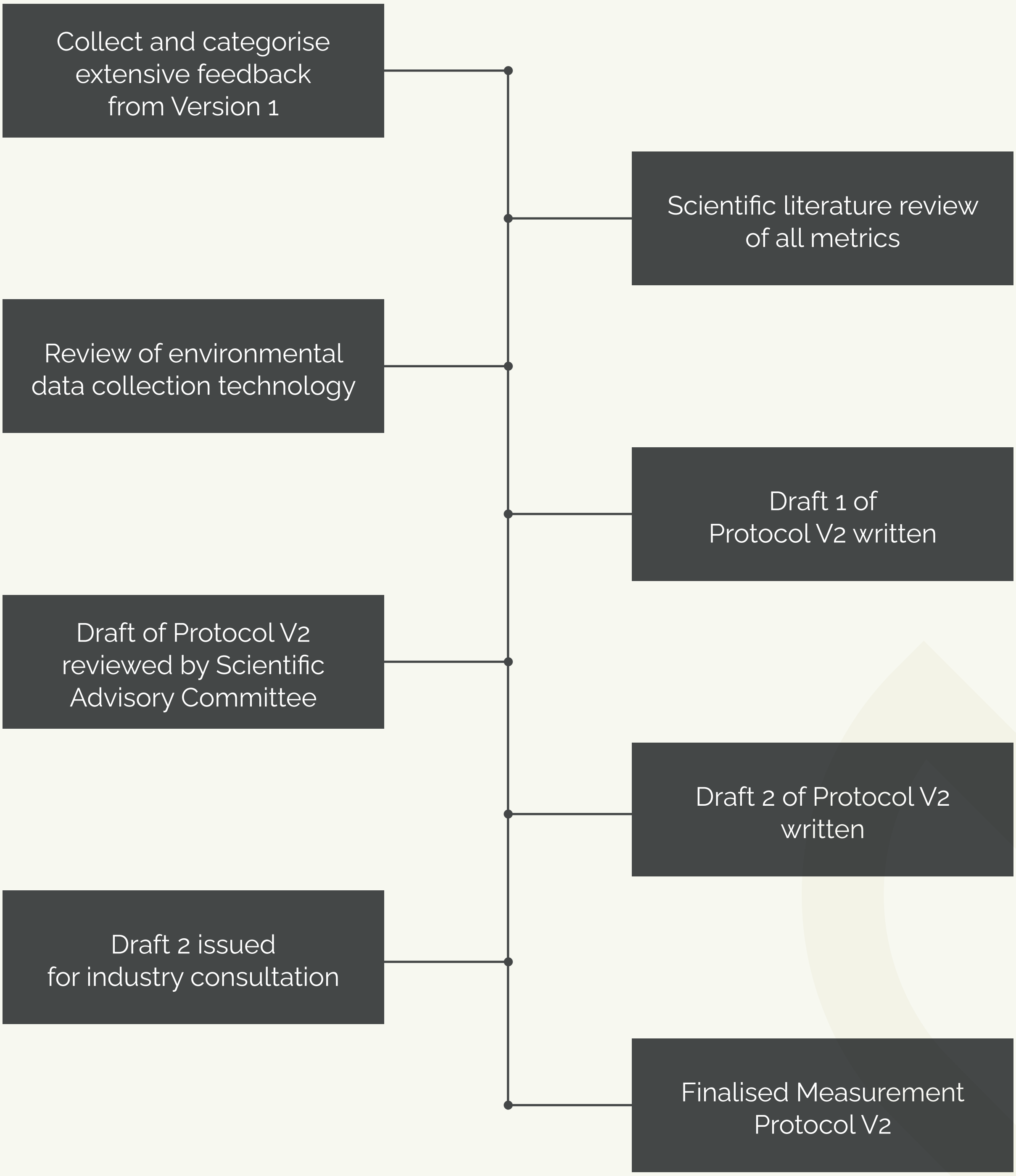
Abigail is an expert in all fields relating to natural capital, including ESG, nature and carbon-positive solutions, carbon markets, biodiversity net gain and ELMS.

Abigail spent over 10 years at the Royal Botanic Gardens, Kew, where she was the Head of Science, responsible for Biodiversity Informatics and Spatial Analysis.

Abigail has a PhD in spatial and statistical modelling of heathland ecosystems and has over 20 years' hands-on experience of big data, socio-demographic and spatial analysis and modelling.

Process

This Protocol is the result of a six-month development process, including extensive reviews of the research and inputs from both our Exchange Scientific Advisory Committee and the wider industry.



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abp · Agricarbon · AMC The Agricultural Mortgage Corporation · Arla · Bank of Scotland

Cibus · Co-op · Foodbuy · Lloyds Bank · M&S

Nando's · National Trust · Nestlé · Riverford Organic Farmers · Sustainable Soils Alliance

UK Centre for Ecology & Hydrology · Wiltshire Wildlife Trust · WWF · 3keel

A Note On Benchmarking and Scoring

In Version 1 we simplified the raw data obtained for each metric into an easy-to-understand and standardised score for the farm based on industry standards or expert opinion. In designing version 2, we spoke to over 500 farmers and they told us they would benefit from expanding this scoring system with benchmarking their metrics against other farms.

We always provide the raw data of each metric and we then benchmark that alongside other Exchange farms to understand that farms performance against their peers. Depending on the metric, they can filter based on common factors like enterprise type, location or average rainfall. 'Scoring' is only ever a tool to help farmers and other stakeholders understand how they might make changes to their farm - not a score that might punish or reward them. Exchange emphasises the requirement to interpret the score.

We're always looking for ways to improve our accuracy. In Version 2 of our Protocol, we now include two different ways to receive a score:

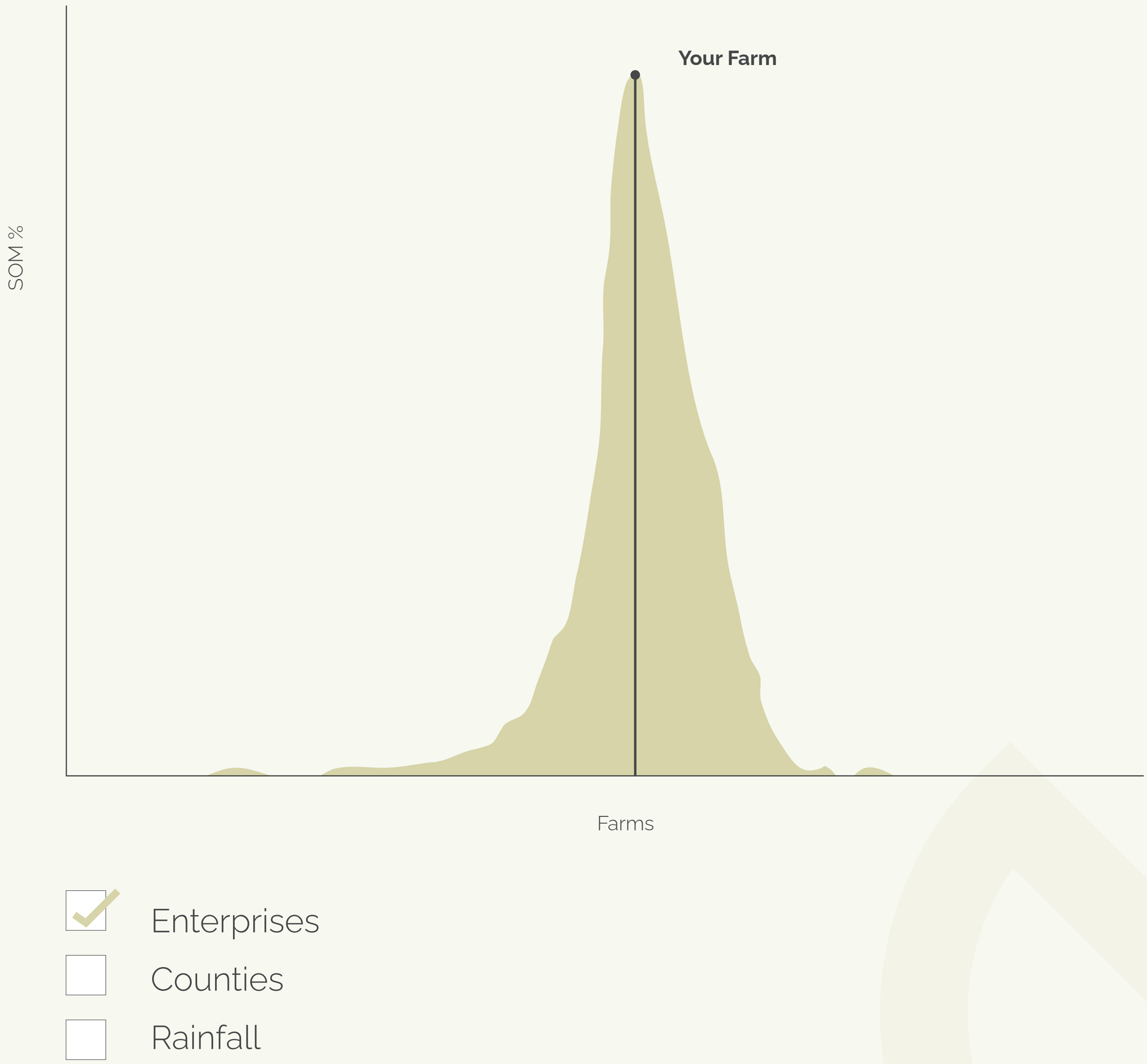
Industry standards – these are benchmarks drawn from scientific papers or industry guidelines. These benchmarks are often widely accepted in the industry but might not always feel like the most useful comparison for a farm with different variables (such as soil type or farm enterprise).

Exchange scores – these scores are calculated using a percentile based approach based on the Exchange Benchmarking, effectively giving a farm a position against other farms in our database. This scoring process is not scientifically peer reviewed but Exchange's unprecedented dataset allows for an empirical, real farm data, approach to scoring and comparison. It is also important to acknowledge that the Exchange scoring is dynamic based on their position amongst other Exchange farms - it will change as more Exchange farms complete the process. In time, Exchange will be able to contribute to creating and improving the industry standards.
We hope the new benchmarking and scoring process will lead to better interpretation of farm data and more farmer/ community engagement

Under each metric, you'll see the raw data collected, a graph that benchmarks your metric with other farms, selection criteria to filter your benchmarking graph based on farm factors (i.e. enterprise or location) and industry standards if they exist. The farm will then be given a score for that metric based on either the industry standard or their position amongst other Exchange farmers.

How we show benchmarks

Peer-to-peer Benchmarking
Toggle based on common factors like geography or rainfall and also see your data plotted vs other common industry standards.



Healthy Soils

Introduction to Soils

It all starts with the soil. Healthy soil is at the heart of a thriving farm, influencing everything from crop efficiency and herd health to water resilience, pest control and much, much more. Nothing is more important to a farm business, but optimising your soil is far from simple. How best to approach it? Which measure to use?

When it comes to assessing soil health, there are many useful metrics available, though none alone is perfect. That's why this year, our approach has been to use a suite of metrics which together provide a full picture of soil health. Not only can they help farmers understand their most vital asset, but they each align with key policy initiatives from the UK government, the UKCEH and the FAO's 2020 Protocol.[1]

Soil Organic Matter

Why we measure it?

Soil Organic Matter (SOM) makes up just 2– 10% of most soils' mass,[2] but it plays an important role in many physical, chemical and biological processes. Not only does it influence soil structure, aeration, soil water-holding capacity and cation exchange capacity, but it forms complexes with metal ions and acts as a source and store of nutrients (nitrogen and phosphorus) .

How we measure it?

We take samples in-field at a preferred depth of 30cm, as per the IPCC recommendation (see sampling and zonation for more details). The samples are reported with depth (if not 30cm). We sample and analyse the soil in a laboratory using the DUMAS combustion technique.

The DUMAS dry combustion method measures total and inorganic carbon with pre-acid treatment.[3] Samples are treated with acid to eliminate any carbonates (inorganic carbon) and then analysed for total carbon by a DUMAS combustion analyser. Samples are combusted in an oxygen-rich atmosphere at around 1000°C and the amount of carbon dioxide is then detected and quantified. We assume that all carbon measured in the sample after acidification is organic carbon.[4]

For more on soil samples, please see our Soil Zonation and Sampling Section at page 96.

How we score it?

There is no industry standard for soil organic matter, because all published standards use the Loss on Ignition lab methodology (rather than DUMAS) to calculate SOM.

Exchange Benchmarks allow farmers to compare themselves against all farms and farms with similar:

- Rainfall ranges (average/year in mm)
- Soil texture (British Geological Survey mapping)
- Landcover classes (UKHAB categorisation)

Soil Organic Carbon Stocks

Why we measure it?

Soil Organic Carbon (SOC) improves a soil's biological, chemical, and physical properties, its water-holding capacity and its structural stability. It's also a major contributor to overall soil health, agriculture, climate change, and food solutions.

Soils represent the largest terrestrial carbon sink on Earth, containing more carbon than is stored in terrestrial vegetation and the atmosphere combined.[5] Quantifying SOC is challenging, due to the spatial variability inherent in agricultural soils[6]. However, it's estimated that UK soil contains about 10 billion tonnes of carbon, roughly equal to 80 years of annual greenhouse gas emissions.

Although the relative amounts vary over the range of different soil types, carbon is found in two main forms in soils. First, soil organic carbon (SOC), made up of living and dead components of organisms, including fine plant roots, fungi, microbes and decomposing plants and animal residues; this comprises about 60% of the total carbon in UK soils. Second, Soil Inorganic Carbon (SIC) made up of minerals such as chalk. SIC is generally more stable than SOC, making up the remaining 40% of total carbon in UK soil.[7] In our methodology, both SOC and SIC are measured and reported, but only SOC is scored.

How we measure it?

We take samples in-field at a preferred depth of 30cm, as per the IPCC recommendation (see sampling and zonation for more details). The samples are reported with depth (if not 30cm) and stone content to obtain accurate Soil Organic Carbon stock from the laboratory, since soils with coarse fragment volumes of >2% will impact results.[8] Samples are then sent to the laboratory for analysis and Soil Organic Carbon stock per hectare is reported (t/ha).

We use the DUMAS-dry combustion method to measure Soil Organic Carbon. A pre-acid (mild) treatment is applied to remove any carbonates - thus accounting for inorganic carbon in the sample. The laboratory calculate carbon stocks as follows: Organic Carbon Stock = (SOC (mg/l) x Density (kg/l) x Depth (cm)) x (100 - Stones (%)) / 100

To calculate Co2e capture (CO2e/ha) we multiply Organic Carbon Stock by 3.67 (mole mass CO2/ mole mass C).[9] This can be extrapolated up to the farm level by multiplying it by the total hectares in that specific zone (i.e. with similar soil characteristics) and repeating this for the different zones (as categorised by the Exchange Zonation process).

How we score it?

The industry standard for Soil Organic Carbon Stock is taken from Woodland Carbon Code 2011 and Bradley et al., 2005 - Table 617. The WCC (Woodland Carbon Code) give a midpoint figure - we have extrapolated from this to create a range for the Exchange scoring.

The Exchange Benchmarks allow farmers to compare themselves against all farms and farms with similar:

- Rainfall ranges (average/year in mm)
- Soil texture (British Geological Survey mapping)
- Landcover classes (UKHAB categorisation)

The thresholds for scoring are based on the average soil carbon density (tCO2e/ha) for four main land use types across the UK at 0 - 30 cm depth (adapted from WCC 2011 and Bradley et al., 2005 - See Table 1 below. Taken from WCC – assessment of soil carbon prior to project planting (carbon baseline), 2011

The thresholds for scoring are based on the average soil carbon density (tCO2e/ha) for four main land use types across the UK at 0 - 30 cm depth.

Average soil carbon density (tCO2e/ha)

Table 1

	Semi-natural	Pasture	Cropping (arable)	Woodland
England	440	293	257	367
Scotland	587	587	440	623
Wales	403	330	257	440

Table 2

	Avg figures from Bradley et al, 2005	Exchange Scoring				
	Average soil carbon density (tCO2e/ha)	1	2	3	4	5
Semi-natural						
England	440	<374	418-374	418-462	462-506	>506
Scotland	587	<498.95	557.65-498.95	557.65-616.35	616.35-675.05	>675.05
Wales	403	<342.55	382.85-342.55	382.85-423.15	423.15-463.45	>463.45
Pasture						
England	293	<249.05	278.35-249.05	278.35-307.65	307.65-336.95	>336.95
Scotland	587	<498.95	557.65-498.95	557.65-616.35	616.35-675.05	>675.05
Wales	330	<280.5	313.5-280.5	313.5-346.5	346.5-379.5	>379.5
Cropping /arable						
England	257	<218.45	244.15-218.45	244.15-269.85	269.85-295.55	>295.55
Scotland	440	<374	418-374	418-462	462-506	>506
Wales	257	<218.45	244.15-218.45	244.15-269.85	269.85-295.55	>295.55
Woodland						
England	367	<311.95	348.65-311.95	348.65-385.35	385.35-422.05	>422.05
Scotland	623	<529.55	591.85-529.55	591.85-654.15	654.15-716.45	>716.45
Wales	440	<374	418-374	418-462	462-506	>506

Soil Structure: Bulk Density

Why we measure it?

The Bulk Density (BD) of soil is a key factor correlated with soil compaction, soil texture and many physical, chemical and biological properties of soil[10]; for example, the soil's water infiltration rate, gaseous exchange, root penetration and soil faunal activity.[11]

Bulk Density will be affected by practices like vehicle traffic, tillage, manure application and so on. Any changes in Bulk Density can therefore help to infer whether management changes have caused any soil degradation.

How we measure it?

Soil core samples are taken to a depth of 30cm (where possible) as per IPCC guidance.

In the lab, they are combined and weighed (after drying overnight at <30°C). Bulk Density is then calculated as the dry weight of soil divided by its volume, and is expressed as kg/L of soil.

To calculate a Bulk Density value for the whole farm, we weight the results per zone area (similar soil characteristics) and extrapolate to the wider farm.

How we score it?

The industry standard for Bulk Density is from AHDB.[12] This paper proposes scores ranging from 1 to 3 based on SOM (%), and a Bulk Density threshold for either tilled land (arable and ley) or untilled land (permanent pasture and rough grazing).

We expanded this score range to 1 to 5 by creating subcategories for scores 1 and 3.

The Exchange Benchmarks allow farmers to compare themselves against all farms and farms with similar:

- Rainfall ranges (average/year in mm)
- Soil texture (British Geological Survey mapping)
- Landcover classes (UKHAB categorisation)

Table 3

SOM (%)	Arable				
	1	**2**	**3**	**4**	**5**
<2	>1.68	1.61-1.68	1.45-1.6	1.28-1.44	<1.28
2-3	>1.58	1.51-1.58	1.36-1.5	1.20-1.35	<1.20
3-4	>1.47	1.41-1.47	1.27-1.4	1.12-1.26	<1.12
4-5	>1.37	1.31-1.37	1.18-1.30	1.04-1.17	<1.04
5-6	>1.39	1.31-1.39	1.14-1.30	0.96-1.13	<0.96
6-8	>1.26	1.21-1.26	1.09-1.20	0.96-1.08	<0.96
>8	>1.05	1.01-1.05	0.91-1.0	0.80-0.90	<0.80
Grassland					
<2	>1.58	1.51-1.58	1.36-1.5	1.2-1.35	<1.20
2-3	>1.47	1.41-1.47	1.27-1.4	1.12-1.26	<1.12
3-4	>1.49	1.41-1.49	1.23-1.4	1.04-1.22	<1.04
5-6	>1.26	1.21-1.26	1.09-1.2	0.96-1.08	<0.96
6-8	>1.28	1.21-1.28	1.05-1.2	0.88-1.04	<0.88
>8	>1.05	1.01-1.05	0.91-1.0	0.80-0.90	<0.80

Soil Structure: VESS

Why we measure it?

Soil Structure regulates the flow of air and water into the soil – both of which are essential for plant growth, root penetration, drainage and to reduce soil erosion and surface run-off.

Evaluating Soil Structure complements the measurement of bulk density.

How we measure it?

We use a process taken from the Scottish Rural College: a Visual Evaluation of Soil Structure (VESS).[13]

First, a 20cm x 20cm x 20cm section of earth is removed from a field. The sample then undergoes a visual evaluation to understand its structure, quality, aggregate size and appearance of crumb.[14]

Inevitably, a VESS test can only provide semi-quantitative data and is subjective to the assessor. However, it's also a quick and powerful tool to evaluate Soil Structure – and a chance for the farmer to be directly involved.

To calculate the average VESS value for the farm, we average the observations.

How we score it?

The industry standard for VESS uses the scoring system from the VESS assessment itself. (Though we've reversed the grading to align with our other Exchange scores, where 1 is poor and 5 is good.)

VESS scoring will not impact your overall Exchange score.

The Exchange Benchmarks allow farmers to compare themselves against all farms and farms with similar:

- Rainfall ranges (average/year in mm)
- Soil texture (British Geological Survey mapping)
- Landcover classes (UKHAB categorisation)

Table 4

Assessment	Status[11]	Result*
Very compact (aggregates are compact, difficult to pull apart and platy)	Poor, needs management action	1
Compact (effort needed to break down aggregates)	Poor, needs management action	2
Firm (most aggregates break down)	Moderate	3
Intact (aggregates easily break apart)	Good	4
Crumbly (aggregates readily crumble with fingers)	Good	5

*The SRUC guidelines for VESS scoring is inverted for Red, Amber, Green and can be used to aid interpretation of VESS scoring.

Total Nitrogen and C:N Balance

Why we measure it?

Closely associated with soil organic matter, nitrogen is the main driver of plant growth. It is mobile in the environment and present in many different compounds, some of which are available for uptake by plants. Among macronutrients, nitrogen is also more susceptible to environmental loss, such as ammonia volatilization (NH3), nitrous oxide (N2O) emissions, nitrate leaching (NO3), etc. Any form of N losses from agricultural systems can spell major limitations for crop production, soil sustainability, and environmental safeguarding.[15]

The balance of carbon and nitrogen, known as the C:N ratio, is pivotal for soil health, because it governs the activity of the microorganisms crucial for nutrient cycling. During organic matter decomposition, microbes require this balance for energy and enzyme production.

A proper ratio promotes humus formation, stabilizes pH levels, and prevents nutrient leaching. It also ensures efficient nutrient availability for plants, while well-balanced soils show more resilience to environmental stressors. Consequently, it is vital to monitor and manage the C:N ratio through practices like organic matter addition and cover-cropping, to sustain healthy soil and foster robust plant growth.

How we measure it?

The precise measurement of nitrogen in soil samples is accomplished using the DUMAS dry combustion method. This involves a temperature-regulated dry combustion furnace with automatic control of gas flow and pressures. This method measures Total Nitrogen (TN). Total Nitrogen is the measure of all forms of nitrogen (organic and inorganic) in the dried sample, and is expressed as a %.

We then compare this Total Nitrogen figure to your Carbon figure to generate your C:N ratio.

To calculate a C:N ratio for the whole farm, we weigh the results per zone area (i.e. with similar soil characteristics) and extrapolate to the farm.

How we score it?

There is no industry standard for Total Nitrogen or C:N Balance, but it's generally accepted that a range of 10-12 parts carbon to 1 part nitrogen is a good balance.

The Exchange Benchmarks allow farmers to compare themselves against all farms and farms with similar:

- Rainfall ranges (average/year in mm)
- Soil texture (British Geological Survey mapping)
- Landcover classes (UKHAB categorisation)

Earthworms

Why we measure it?

Earthworms are ecosystem engineers that benefit food production and provide the ecosystem services associated with soil security.[16] As such, they're primary candidates for national soil health monitoring.

Earthworms help drainage, improve soil structure, redistribute organic materials, increase nutrient availability and increase soil penetrability. A healthy population of Earthworms is a good indicator of optimum soil conditions for plant growth.

How we measure it?

We dig a soil pit of 20 cm x 20 cm x 20 cm on either Arable or Grassland land and place the soil on a mat. We sort through the soil before we sort, count and record the total number of Earthworms.

We give farmers the option to count individual ecological types: epigeic (litter-dwelling), endogeic (topsoil) and anecic (deep burrowing) earthworms – each group having a unique and important function.[17]

We also offer the option to categorise the Earthworms into juvenile or adult.

Given that the time of year and rainfall/soil moisture have significant impact on worm counts, we'll report the previous week's rainfall. It should also be noted that sandy soils will, by their nature, contain fewer Earthworms.

How we score it?

There is no industry standard for Earthworms.

Exchange has created its own 1-5 indicative scoring based on counts of Earthworms on Arable and Grassland (see Table 5).

The Exchange Benchmarks allow farmers to compare themselves against all farms and farms with similar:

- Rainfall ranges (previous week in mm)
- Rainfall ranges (average/year in mm)
- Soil texture (British Geological Survey mapping)
- Landcover classes (UKHAB categorisation)

Table 5 Earthworm scoring. Unit: Number of Earthworms

Score	Status	Cropping*	Grassland
1	Depleted	<2	<5
2	Depleted	2-3	9-5
3	Intermediate	4-8	10-19
4	Active	9-12	20-30
5	Active	>12	>30

Soil Cover %

Why we measure it?

Living roots create the space for the bacteria, insects, and fungi that contribute to soil organic matter to live and thrive.

Roots can prevent capping on the soil surface, which helps with the infiltration and absorption of water when it rains.

With a well-developed root system, the physical structure of the soil is improved. This helps with all manner of functions, such as coping better with the seasonal flooding and/or droughts. Roots also create a more efficient system, optimising the cycle of air, water and nutrients.

Consequently, it is important that soils have a living root whenever possible.

How we measure it?

Farmers provide monthly estimates of % Soil Coverage across their farm for the last cropping year. The farmer can provide this history across the last three years.

We define a cropping year from September to August.

To calculate the average % Soil Cover for the farm, we average the Soil Coverage per month in a specific cropping year and then average multiple years (if provided). E.g. if we calculate an average 12% coverage in cropping year 2022-23 we then average the year's figure with other preceding years.

How we score it?

There is no industry standard for Soil Cover.

The Exchange Benchmarks allow farmers to compare themselves against all farms and farms with similar:

- Geographies (county)
- Rainfall ranges (average/year in mm)
- Enterprise classification

Why we measure it?

Soil pH is a measure of the relative acidity or alkalinity of a soil. It regulates the capacity of soils to store and supply nutrients, and thus contributes substantially to controlling productivity in terrestrial ecosystems.[18 19] Soil pH also has a profound effect on the form and availability of essential nutrients (like phosphorous) to crops, and the degree of toxicity of some trace elements (like zinc or copper) for some plants.

It is important to manage soil pH for ecological improvement schemes, since it can affect how plant species and habitats develop on the land for treatment, restoration or maintenance.[20]

There is good evidence to show that gradients of soil properties such as soil pH are strong drivers of soil microbial diversity and in using soil pH as an integrated proxy of land use change, parent material and climate to determine the site-specific effects of land management strategies on SOC accumulation.[21]

How we measure it?

We capture soil pH using a digital probe at one decimal point sensitivity. In each sampled field, three samples are taken at a depth of 15cm.

While the scale goes from 0 to 14 (with a neutral pH represented by 7.0) most agricultural soils have pH values of between 5.5 and 7.5.

Most essential plant nutrients are available to most crop plant species within the pH range of 6.0 to 6.5 for arable systems (i.e. not natural systems). However, managing pH may not always mean a pH in this range.

To obtain a farm pH score, we average the three pH readings for the parcel, then obtain pH readings per zone, and weight the overall score per zone area.

How we score it?

The industry standard is from an AHDB (2019) report that proposed six sets of scores ranging from 1 to 3. These scores are based on region (England & Wales and Scotland), land use (arable and grassland) and soil type (mineral and peat soils). Version 2 of the Protocol uses a simplified version of the thresholds which are adapted from the AHDB Soil Health Scorecard Tool v1.1. [22 23]

By default, very chalky/alkaline soils are not scored. This is because sites with chalky soils are characterised by an alkaline pH (generally between 7.1 and 10) caused by high concentrations of calcium carbonate from built-up sediment. High calcium levels can cause zinc, magnesium, manganese, and phosphate to be locked up and therefore unavailable to the growing plant. For this reason, topical applications aimed at altering the pH may not be effective and there is a limit to how much influence a farmer can have.

Similarly, acid grasslands will also not be scored using the standard industry benchmark because of their expected acidity.

The Exchange Benchmarks allow farmers to compare themselves against all farms and farms with similar:

- Rainfall ranges (average/year in mm)
- Soil texture (British Geological Survey mapping)
- Landcover classes (UKHAB categorisation)

pH (continued)

Table 6 Unit: pH

England & Wales and Scotland		
Cropping (Arable)	**Grassland**	**Score**
< 5.0	< 5.0	1
5.0 - 5.49	5.0 - 5.49	2
5.5 - 5.99	5.5 - 5.79	3
6.0 - 6.49	5.8 - 5.99	3
6.5 - 6.99	6.0 - 6.49	4
7.0 - 7.49	6.5 - 7.49	5
7.5 - 7.99	7.5 - 7.99	n/a
> 8.0	> 8.0	n/a

Adapted from the AHDB Soil Health Scorecard Tool v1.1.

Contextual Soil Information

Why we measure it?

For each farm (and in addition to the aforementioned metrics) we will also provide a set of contextual information to help farmers better understand their soils.

The contextual information will be:

- Soil texture
- Parent material
- Peat or mineral soils
- Soil depth

All sourced from British Geological Survey datasets.

How we measure it?

All these data points are collected using satellite imagery and third-party data.

How we score it?

There is no industry or Exchange Benchmark for these datasets as they are only provided for context.

Water

Introduction to Water

Measuring a farm's impact on water quantity and quality is crucial. Not only is proper water management vital to a farm's success, but it plays a central role in safeguarding the local environment for generations to come.

Tracking water usage and availability/scarcity helps to maximise the efficiency of irrigation practices and future-proof the farm. Runoff from farms can carry pollutants into the water ways and water monitoring allows the farmers to identify contamination/pollutants. This can also help farmers stay on the right side of the regulators, since many regions have strict legal requirements around reporting, with potential penalties for failure to comply.

For example, they might be able to reduce their use of pesticides and fertilisers or implement conservation practices to mitigate runoff and erosion. In this way, water measurement is an essential tool in protecting aquatic ecosystems and human health.

And in the long term? As climate change means weather patterns become more unpredictable, knowing how the farm interacts with water quantity and quality will allow farmers to adapt their practices to changing conditions, ensuring the long-term resilience.

In essence, measuring water impact lies at the heart of responsible and sustainable agriculture – helping farmers find the balance between profitable production and environmental stewardship.

Water Storage

Why we measure it?

Water Storage is important as it helps interrupt, slow, or divert overland water flow across the landscape, thereby encouraging infiltration. All measures that manage runoff have multiple functions and co-benefits - such as improving water quality, increasing biodiversity and minimising flood risk.

Water Storage involves measures to create and maintain capacity on runoff pathways across the landscape and reduce overland flow. The general principle is that they fill during rainfall events and empty slowly, thus slowing runoff.[24] Common storage measures include ponds, lakes, scrapes, swales, leaky dams and bunds. As with runoff management measures, Water Storage can provide co-benefits such as habitat creation for wildlife and water quality improvements, alongside natural flood management impacts.

Runoff Attenuation Features (RAF) are a class of features that target runoff flow pathways and create new temporary flow storage (such as ponds and bunds). The effectiveness of such RAFs at larger catchment scales and for managing extreme flood events has been the subject of extensive research,[25] with strong evidence emerging that well-designed RAFs in the correct locations can deliver a range of ecosystem services.[26]

How we measure it?

We quantify the volume of Water Storage on farm, weighted to account for farm size.

We calculate this by taking the total volume of temporary Water Storage on the farm (m3) and dividing it by the total farm area (m2).

To calculate the volume of the temporary Water Storage on the farm, the farmer adds 'water features' on the farm map (categories available as per the list below) including approximate depth. Where no depth is given, average default figures will be used as follows:

- Ponds: Average Depth 1.5 meters
- Scrapes and Swales: Average Depth 0.45 metres
- Reservoirs: Average Depth 10 meters
- Bunds: Average Depth 1.5 meters
- Lakes: Average Depth 15 metres

The total Water Storage in the water features above is summed and the volume/ha figure is used in the Exchange Benchmark.

How we score it?

There is no industry standard for Water Storage.

The Exchange Benchmarks allow farmers to compare total storage volume/ ha against all farms and farms with similar:

- Geographies (counties)
- Average rainfall (average/year in mm)

Nitrogen Balance

Why we measure it?

Nitrogen is a vital nutrient for plant growth, but its excess or inefficient use can lead to environmental issues such as water pollution, greenhouse gas emissions, and soil degradation.

By measuring their Nitrogen Balance, farmers can assess the overall nitrogen status of their farm. This information enables them to adjust fertiliser application rates, timing, and methods to match crop requirements, minimise nitrogen losses, and prevent nutrient runoff.

By maintaining a balanced nitrogen cycle, farmers can reduce the risk of pollution, protect water quality, optimise resource use, and promote sustainable agricultural practices.

How we measure it?

Measuring Nitrogen Balance involves accounting for nitrogen inputs (such as fertilisers, manure, and atmospheric deposition) and outputs (such as harvested crops, leaching, and emissions), We are building the Exchange Platform to be compatible with third-party softwares that have been designed for this purpose, such as Planet, and Farmscoper. Of these we particularly recommend Planet.

The Exchange advisor and farmer input data into Planet to obtain a final Nitrogen Balance per kg per hectare per year. We input this figure into the Exchange Platform.

We then use this figure in the Exchange Benchmark and indicate the acceptable range for farms (30-120kg/ha/year).

How we score it?

There is no industry standard for Nitrogen Balance.

Our Exchange Benchmarks allow farmers to compare their Nitrogen Balance per kg per Hectare per year against all farms and farms with similar:

- Enterprises classification
- Geographies (counties)

Phosphate Balance

Why we measure it?

Measuring the Phosphate Balance on a farm is vital for efficient nutrient management, maintaining soil fertility for healthy crop-growth. It prevents excess phosphorus (which can lead to water pollution and harm aquatic ecosystems) and ensures regulatory compliance and cost-effectiveness.

How we measure it?

As with Nitrate Balance, we calculate a farm's Phosphate Balance using Planet.[27] If other farmers wish to use other tools, they can indicate them and add the same data.

The farmer answers a series of questions about their inputs and practices and Planet calculates the farm's Phosphate Balance per kg per hectare per year.

We use this figure in the Exchange Benchmark to indicate the acceptable range to the farmer (0-30kg/ha/year).

How we score it?

There is no industry standard for Phosphate Balance.

Our Exchange Benchmarks allow farmers to compare their Phosphate Balance per kg per hectare per year against all farms and farms with similar:

- Enterprise classification
- Geographies (counties)

Potash Balance

Why we measure it?

We measure Potash Balance because it helps farmers understand where there are opportunities to improve their nutrient use efficiency, alongside Nitrogen and Phosphate. It does not have an adverse impact on water quality and there aren't any adverse environmental impacts associated with it.

How we measure it?

As with Nitrate Balance and Phosphate Balance, we calculate a farm's Potash Balance using Planet. If other farmers wish to use other tools, they can indicate them and add the same data.

The farmer answers a series of questions about their inputs and practices and Planet calculates the farm's Potash Balance per kg per hectare per year.

We use this figure in the Exchange Benchmark and indicate the acceptable range to the farmer (0-30kg/ha/year).

How we score it?

There is no industry standard for Potash Balance.

Our Exchange Benchmarks allow farmers to compare their Potash Balance per kg per hectare per year against all farms and farms with similar:

- Enterprises classification
- Geographies (counties)

Water Resource Availability

Why we measure it?

Water from rivers and other surface water bodies provides essential water for people, agriculture and industry but in England, nearly 15% of surface water bodies are being impacted by over-abstraction.[28]

We measure Water Resource Availability to understand the water availability status of surface water bodies in the farm's location. This is important to inform usage habits.

How we measure it?

We calculate a farm's water resources availability by accessing the following datasets.

In England and Wales, we capture this information from an Environment Agency dataset.[29]

In Scotland, we capture this information from a SEPA dataset on Risk of Water Scarcity.[30]

Both of those datasets are analysed by Exchange to give an indicative Resource Availability Score as demonstrated in this table.

Table 7 below shows that we receive the % of time that consumptive abstraction is available from the above data sources. We then use this indicator in the Exchange Benchmark.

How we score it?

There is no industry standard for Water Resource Availability. Water Resource Availability will not impact your overall Exchange score.

Our Exchange Benchmarks allow farmers to compare their Water Resource Availability status against all farms and farms with similar:

- Enterprise classification
- Geographies (counties)

Table 7

Resource availability dataset with consumptive abstraction available		Resource availability dataset for SCOTLAND	
Very low risk	≥95	Very low risk	Normal condition
Low risk	70 - <95	Low risk	Early warning
Moderate risk	50 - <70	Moderate risk	Alert
High risk	30 - <50	High risk	Moderate Scarcity
Very high risk	<30	Very high risk	Significant Scarcity (no area with that class)

Groundwater Status

Why we measure it?

Groundwater is essential both for drinking-water supplies and for supporting dependent rivers, streams, lakes and wetlands. Water from groundwater provides essential water for people, agriculture and industry; but in England, 27% of groundwater bodies are being impacted by over-abstraction.[31]

We measure Groundwater Status to understand the availability status of groundwater where the farm is located. This is important to inform usage habits.

How we measure it?

We calculate a farm's Groundwater Status using the following datasets. These datasets are given an indicative Groundwater Quantitative Status Score.

- Groundwater Quantitative Status
  - In England and Wales, we capture this information from this Environment Agency dataset[32] either as 'Poor' or 'Good'.
  - In Scotland, only ~3% of the total area has Groundwater Status classified as 'Poor'. As such, we assume that Groundwater quantitative Status is 'Good' everywhere in Scotland.[33]

These datasets are given an indicative Groundwater Quantitative Status Score.

How we score it?

There is no industry standard for Groundwater status. Groundwater Status will not impact your overall Exchange score.

Our Exchange Benchmarks allow farmers to compare their Water Resource Availability status against all farms and farms with similar:

- Geographies (counties)

Water Usage Actions

Why we measure it?

Water from rivers and groundwater provides essential water for people, agriculture and industry. But in England, nearly 15% of surface water bodies and 27% of groundwater bodies are being impacted by over-abstraction.[34]

Judicious water usage is to be encouraged, regardless of Water Resource Availability (surface and groundwater). We evaluate Water Usage practices on the farm to help the farmer understand where they might be able to make improvements, using the water resource availability and groundwater availability status information to provide further contextual advice.

How we measure it?

We calculate a farmer's Water Usage Actions through a survey.

First, we establish whether the farmer is accessing the water from water mains, abstracted ground water, abstracted surface water, stored and collected rainwater and/or recycled grey water.

Then we ask them questions about their water usage, specifically irrigation. This allows us to calculate an Exchange score for the Water Usage Actions (independent of water availability status). This Exchange Score is used in the Exchange Benchmark.

How we score it?

There is no industry standard for Water Usage Actions.
Our Exchange Benchmarks allow farmers to compare their Water Usage Actions (independent of water status against all farms and farms with similar:

- Enterprises classification
- Geographies (counties)

Water Runoff Management

Why we measure it

The principle of Water Runoff Management is to interrupt, slow, or divert overland water flow across the landscape, thereby encouraging infiltration. All measures that manage runoff have multiple functions and co-benefits - such as improving water quality, increasing biodiversity and minimising flood risk.

Runoff storage involves measures to create and maintain capacity on runoff pathways across the landscape and reduce overland flow. The general principle is that they fill during rainfall events and empty slowly, thus slowing runoff.[35]

The effectiveness of such runoff attenuation features at larger catchment scales and for managing extreme flood events has been the subject of extensive research,[36] with strong evidence emerging to suggest that well-designed RAFs in the correct locations can deliver a range of ecosystem services.[37]

How we measure it?

We survey the farms water management practices to understand their efforts to reduce water runoff. This involves asking questions on the following topics:

- Green cover
- Reduced cultivation and drilling across a slope
- Field grass strips, hedgerows and wetlands
- River and streams management
- Land use change relevant to water runoff avoidance
- Other flood mitigation actions

The survey answers are tallied and farms are provided with an Exchange Score. This score is used for benchmarking.

How we score it?

There is no industry standard for Water Runoff Management.

The Exchange Benchmarks allow farmers to compare the Exchange Water Runoff Management score against all farms and to farms with similar:

- Geographies (counties)
- Average rainfall (average/year in mm)

Contextual Water Information

Why we measure it?

For each farm (and in addition to the aforementioned metrics) we will also provide a set of contextual information. This information is in part to enable a farmer to better understand and evidence the condition of the catchment in which their farm is located, but also to address some of the shortcomings in the sampling approach of Version 1 - which focused on single on-farm surveys rather than understanding the underlying the water quantity and quality issues in the area.

The contextual data layers are listed in Table 8.

How we measure it?

All of these data points are collected using third-party data.

How we score it?

There is no industry or Exchange standard for these datasets as they are only provided for context.

Table 8

What	Data Source	Why
Catchment Location of Farm	England - Environment Agency	To help the farmer understand which river catchment they will impact and where they are likely to receive funding
Priority Catchments	Wales - Natural Resources Wales[B] Scotland - SEPA[BA]	To demonstrate whether the farm is in a catchment where there is a particular focus on improving water quality
Water Quality Archive Data	England – Environment Agency[C]	To understand the quality of water bodies near the farm
Flood Risk	England – Environment Agency Wales[D]	To understand the flood risk level in that region and the subsequent need for a farmer's actions
Priority River Habitat	England - DEFRA[E]	To understand if the farm is near a particularly important river habitat that needs protecting
Safeguard Zones	England - Environment Agency[G] Scotland[H] Wales[I]	To understand if the farm is in or near an area that has special protections (e.g. because the water is used for drinking water abstraction)
Nitrate Vulnerable Zones	England - Environment Agency Scotland Wales[J]	To understand if a farm is in a particular zone that has specific problems with nitrate pollution. Often important for compliance
River Basin Management Plans	England[K] Scotland[K] Wales[K]	Opportunity for a farmer to receive funding for contributing to the improvement of a river basin

A SEPA - HYPERLINK "https://www.sepa.org.uk/environment/water/river-basin-management-planning/delivering-rbmp/diffuse-pollution-in-the-rural-environment/"priority catchments

B Natural Resources Wales - HYPERLINK "https://naturalresources.wales/about-us/what-we-do/strategies-and-plans/area-statements/sector-specific-information/area-statements-and-opportunity-catchments/?lang=en"opportunity catchments

C Environment Agency HYPERLINK "https://environment.data.gov.uk/water-quality/view/landing"water quality archive data on water quality measurements. API available - https://environment.data.gov.uk/water-quality/view/doc/reference

D HYPERLINK "https://www.data.gov.uk/dataset/42c31542-228d-439b-8dbe-e72135dae71c/flood-risk-areas"Environment Agency Flood Risk Areas - Flood Risk Areas identify locations where there is believed to be significant flood risk. The EU Floods Directive refers to Flood Risk Areas as 'Areas of Potentially Significant Flood Risk' (APSFR). Flood Risk Areas have been defined by the Environment Agency (main rivers and the sea) and Lead Local Flood Authorities (surface water). Other sources of flooding are not covered. This dataset includes Flood Risk Areas defined for both Cycle 1 (December 2011) and Cycle 2 (December 2019)

E Consists of HYPERLINK "https://environment.data.gov.uk/dataset/39c267c0-5014-4e34-85f8-2318c4c74787"rivers and streams that exhibit a high degree of naturalness. The naturalness classification used to map priority river habitat is based on recent work to review the river SSSI series © Natural England copyright.

G HYPERLINK "https://environment.data.gov.uk/farmers/"Drinking water safeguard zones – are established to reduce and prevent pollution of water abstracted for drinking water supplies

H HYPERLINK "https://www.gov.scot/publications/drinking-water-protected-areas-scotland-river-basin-district-maps/"Drinking water protected areas - Scotland

I HYPERLINK "https://datamap.gov.wales/layers/inspire-nrw:NRW_Source_Protection_Zones"Source Protection Zones (SPZ) - Natural Resources Wales

J HYPERLINK "https://environment.data.gov.uk/farmers/"Nitrate Vulnerable Zones (NVZs) are areas designated as being at risk from agricultural nitrate pollution.

K Each river basin district has a HYPERLINK "https://environment.data.gov.uk/catchment-planning/v/c3-plan"river basin management plan. These plans set out the environmental objectives and a summary programmes of measures to achieve those objectives. There are similar plans for HYPERLINK "https://informatics.sepa.org.uk/RBMP3/"Scotland and HYPERLINK "https://naturalresources.wales/evidence-and-data/research-and-reports/water-reports/river-basin-management-plans/river-basin-management-plans-2021-2027?lang=en"Wales.

Biodiversity

Introduction to Biodiversity

'Biodiversity' is really just a technical term for 'all life on earth'. A scientific measure of the variety of species, habitats and ecosystems across the planet, it underpins the food we eat and the air we breathe: it is essential for human existence.

Increasingly, policy, legislation and regulation are evolving to reflect this. Not only is the protection of biodiversity enshrined in the UN's Sustainable Development Goal No. 15 (which aims to prevent land degradation and biodiversity loss) but initiatives such as the Taskforce for Nature-related Disclosures (TNFD) now put biodiversity risk at the forefront of their corporate- and private market-reporting.

Although home to 70,000[38] species of plants, animals, fungi and microorganisms, most assessments agree that the abundance of UK wildlife is declining.[39] Indeed, a piece of 2019 research from the Natural History Museum and the RSPB put the UK at the bottom of the G7 league table for remaining biodiversity.[40]

Of course, food production is critical, and so we also capture a new metric within our People and Society section, looking at the amount of food a farm produces. This will be important in ensuring that farms are always making informed decisions. What is certain though, is that never has it been more important to understand and conserve the biodiversity of our spaces – and since around 70% of UK land is agricultural, farmers are on the front line of the fight to reverse biodiversity decline. Our measurement framework can help them do just that.

Crop and Livestock Diversity

Why we measure it?

Planting a diverse range of plants and having a variety of animals on your farm is vital for ecological balance. It promotes natural pest control, as different species attract beneficial insects that prey on pests. Diverse plants also improve soil health by reducing erosion and nutrient depletion. Moreover, it fosters biodiversity, creating a resilient ecosystem that can better withstand environmental stressors.

Different species of animals contribute to nutrient cycling, enhancing soil fertility. They also aid in pollination, crucial for many crops.

Ultimately, this diversity ensures a more stable and sustainable farm, reducing the reliance on chemical inputs and mitigating the impact of potential crop failures or disease outbreaks.

How we measure it?

We collect this information through a short survey that the farmer completes, either alone or with the support of an Exchange advisor.

The survey covers:

- Crop diversity
- Livestock diversity

The crop and livestock diversity survey answers are given points and the total score is used for Exchange benchmarking.

How we score it?

There is no industry standard for Crop and Livestock Diversity.

The Exchange Benchmarks allow farmers to compare their Crop and Livestock total points against all farms and farms with similar:

- Geographies (counties)
- Enterprise classification

Habitat Management

Why we measure it?

Habitat Management is an essential part of wildlife conservation. A habitat is the area that provides the necessary resources and environmental conditions for species to survive and thrive.

Habitat Management involves influencing the successional stage and physical structure of vegetation to benefit specific species. It is a species-specific concept as each species has its own unique requirements.

Habitat conservation is important for protecting biodiversity and ensuring the long-term survival of species. When these habitats are lost or degraded, it can have serious consequences for the species that depend on them.

How we measure it?

We collect this information through a short survey that the farmer completes, either alone or with the support of an Exchange advisor.

The survey covers habitat management practices for the following habitats:

- Grasses
- Watercourses
- Hedgerows
- Nesting resources for wildlife
- Perennial grassy or flower rich areas
- Pools and ponds

The Habitat Management survey answers are given points and the total score is used for Exchange benchmarking.

How we score it?

There is no industry standard for Habitat Management.

The Exchange Benchmarks allow farmers to compare their Habitat Management total points against all farms and farms with similar:

- Geographies (counties)
- Enterprise classification

Biodiversity Connectivity Features

Why we measure it?

Connectivity is a measure of the relative ease with which typical species can move through the landscape between patches of habitat. Habitat loss and fragmentation can reduce the size of populations and hinder the movement of individuals between increasingly isolated populations, threatening their long-term viability.

Unfortunately, the expansion and intensification of agricultural practices has had a negative impact on biodiversity levels in rural areas. This is due to habitat fragmentation, with remnant patches of natural and seminatural landcover being the only safe havens for wildlife.[41] Consequently, the persistence, abundance and diversity of species are reduced, leading to degradation of ecosystem functions.[42]

Increasing landscape connectivity is therefore crucial in improving species persistence in fragmented landscapes and in facilitating species range shifts in a changing climate.[43] When measuring connectivity we use a number of proxys of farm features that benefit wildlife.

How we measure it?

To give an indicator for the farm's biodiversity connectivity, we look at the area of different farm features.

Having a large area of connected wildlife-friendly features results in high Biodiversity Connectivity scores and having a large area of connected farming features results in a lower Biodiversity Connectivity score.

We look at the following wildlife-friendly features, expressed as % of total farm size

- Hectares of woodland
- Hectares of hedgerows[44]
- Hectares of field margins
- Hectares of water bodies
- In the farming features, we look at one measure:
  - Average field size on the farm

How we score it?

There is no industry standard for Biodiversity Connectivity Features.

The Exchange Benchmark will enable farmers to compare their Biodiversity Connectivity features to all farms and other farms with similar:

- Geographies (county)
- Enterprises classification

Space for Nature

Why we measure it?

It is generally accepted that there are two main approaches to wider management on farm for biodiversity: wildlife-friendly farming (where agricultural practice is tailored to enhance populations of wildlife by creating a more integrated system) and land sparing (where portions of agricultural land are managed intensively to allow other land to return to a semi-natural state for the benefit of biodiversity).[45]

Both approaches have potential benefits and are not necessarily mutually exclusive; the goal in both cases is to increase the availability of resources for wildlife - such as food and shelter.

Local conditions (eg. topography) may inform which system is most appropriate or feasible for any given farm[46] but overall this can best be achieved where the amount of land set-aside for wildlife is increased.

How we measure it?

To understand what percentage of the farm is 'Space for Nature' we automatically or manually assign the farm land parcels into UKHAB classifications. The UKHAB classifications are split into 'space for nature', 'farmed land' and 'other land'.

The habitat classifications come first from a best-guess, derived from either RPA data or the UKCEH Land Cover Map, harmonised using the UK Hab classification. This data is then confirmed with the farmer to ensure all spaces are captured. The farmer has the option to classify more land parcels or provide a more specific UKHAB classification (adding accuracy to the land type). The output is a percentage of land which allows Space for Nature on farm. This is used in the Exchange benchmark.

How we score it?

The RSPB's Fair to Nature standard includes the requirement for farmers to create wildlife habitats on at least 10% of their land. The biodiversity benefits of this threshold are supported by the scientific literature. 10% or more of land as non-farmed habitats (devoted to bird-friendly agri-environmental schemes) would have beneficial impacts on the population stability and growth of farmland birds[47] and pollinating insects.[48]

Based on the RSPB, Exchange provides an indicative score to the farmer to help them understand their progress (see table).

The Exchange Benchmark will enable farmers to compare their Space for Nature % to all farms and other farms with similar:

- Geographies (counties)

Table 9

Score	Threshold
5 - Very good	>10% land provides space for nature
4 - Good	>7.5 - 10.0%
3 - Moderate	>5 –7.5%
2 - Poor	>2.5 - 5.0%
1 - Very poor	Less than 2.5% of land provides space for nature

Bird Species Abundance

Why we measure it?

Bird populations have long been considered a good indication of the broad state of wildlife in the UK. This is because they occupy a wide range of habitats, and respond to environmental pressures that also impact other groups of wildlife. In addition, there are considerable long-term data on trends in bird populations, allowing for useful comparison between short-term and long-term changes.

Because birds are a well-studied taxonomic group, drivers of change for birds are better understood than for some other species groups, which helps us interpret the observed changes.[49]

Bird indicators for the UK and Scotland also form part of the government's suite of biodiversity indicators, and provide a useful overview of the respective fortunes of birds associated with different landscapes.[50]

How we measure it?

We measure the abundance of bird species in three key ways:

- Firstly, we use a baseline set of occurrence data for birds as the starting point for each farm. Data will be harvested via an API from NBN National Biodiversity Network- or if this is not feasible, from GBIF (Global Biodiversity Information Facility). This will be done for all bird observations within 1km of the farm boundaries and for observations in the past 6 years.
- Secondly, the farmer or the Exchange team will conduct a bird survey on the farm.

During habitat surveys on the farm bird surveys will be conducted at the same time at both the linear and square plots, at each plot selected for sampling. This will include include hedgerows, arable, field margins and grassland. During the survey, birds are identified visually or acoustically (using the Merlin app) over a ten-minute period – two surveys of five minutes each. Surveys will always include the date and weather, since observations will depend on both.

All birds that are recorded using these two methodologies are then assigned either Red or Amber status if they are protected/endangered, or left Green (See Birds of Conservation Concern 5 for the full Red and Amber lists). [51] Generalist and specialist bird species are also indicated on the observation list for the farmer and advisor (5 – Farmland species - GOV.UK (www.gov.uk). [52]

The number of unique species is then counted and assigned a score of 1-5. This gives the farmer an indicator of progress; this number of unique species is also used in the Exchange Benchmark.

How we score it?

The industry standard for Bird Species Abundance is based on expert opinion from Nat Cap Research. This is the 1-5 scoring table on Table 10.

Our Exchange Benchmark will enable farmers to compare their total count of unique bird species with all farms and to other farms with similar:

- Geographies (county)
- Enterprises classification

Table 10

5 (Very good)	20 or more species
4 (Good)	15 to 19
3 (Moderate)	10 to 14
2 (Bad)	5 to 9
1 (Very bad)	Below 5

Why we measure it?

Agricultural intensification has led to drastic population declines in Europe's arable plant vegetation, and continuous monitoring is a prerequisite for assessing measures to increase and conserve remnant populations of endangered arable plant species.[53] Arable plants are wildflowers that grow on land usually used for crops. Many species are threatened and declining. Uncropped cultivated areas give arable plants space to grow and arable plants are important as they provide food for pollinators, nest sites and food for birds.

The advantages associated with sampling only a small set of species, rather than an entire community, has been the subject numerous scientific publications and to the identification of indicator species.[54]

As a rule, species should be chosen as indicators if they consistently (i) reflect the biotic or abiotic state of the environment; (ii) provide evidence for the impacts of environmental change; or (iii) predict the diversity of other species, taxa or communities within an area.[55] In addition, they should be easily observable and amenable to sampling. For this reason, plants are often used as indicators in habitat assessments.[56]

Arable land in the UK tends to be under-surveyed which means there is often a dearth of data relating to them. Plantlife aimed to bridge the gap through the Arable Indicator Survey[57] which is 'designed to identify locations that have potential to support rare or threatened arable plants. Rare and threatened species are usually scarce throughout the landscape, so the survey involves identifying more common species that are often found in association with the rarer species'. The same principle embodied in this Protocol.

In relation to grasslands, recent research in Ireland into the selection of appropriate plant indicator species for result-based agri-environment payments schemes reported that indicator plant species occurrence and diversity (species richness and Simpson's Diversity Index) were correlated with variables within farmers' control and variables outside farmers' control. Specifically, grassland indicator species' occurrence and diversity were mainly related to grassland semi-naturalness and to the diversity of habitats existing on the farm – both variables within farmers' control; the paper therefore concluded that they were appropriate indicators for assessing the effectiveness of management and suitable for use in result-based payment schemes.[58]

Hedgerows offer many farms an opportunity to protect, enhance and create plant diversity and habitats on farmland. Different features of a hedgerow will be important to different species. The more diverse in composition a hedgerow is the more species it is likely to support due to a diversity of flowering and fruiting times. In general, native hedge plants such as blackthorn, hawthorn, hazel, dogwood and field maple will support many more species than non-native plants such as garden privet, leylandii and sycamore. Hedge bases are an important feature and provide a buffer zone to protect root systems and which can be an important habitat in its own right.[59]

How we measure it?

We measure Arable, Hedgerow, Field Margin and Grassland Flora by sampling a given area of the habitats. This sampling is carried out by either the farmer or the Exchange team.

All samples species are assessed using a simplified version of the National Plant Monitoring Scheme (NPMS) survey methodology.[60] For Arable (in-field) and Grassland samples, we'll choose a square plot 5m x 5m. For Field Margin and Hedgerow samples, we'll choose a linear plot of 25m x 1m. Within each plot, all plant species are recorded and the total number of distinct species listed beneath the specific habitat. We assume that the level of identification will be predominantly wildflower.

Plant species are identified and collated, either manually, using a plant species list, or by using the “Picture This” application. (This identifies plants through user-submitted photos via a user-friendly interface.)

For each indicator species identified, further contextual information is provided to aid the farmer and/or advisor. Using the NPMS where possible, this will include:

1) Whether the plant positively or negatively affects the habitat quality

2) Whether the plant is at the simpler Wildflower Level of identification

3) Whether it is an important early- or late-flowering species for the farm.[61]

How we score it?

There is no Industry standard for Arable, Hedgerow, Field Margins and Grassland Flora. Grassland and Arable flora.

We sum the total unique species per habitat, then benchmark the total unique species in each individual habitat - as well as the total unique species for the four different habitats.

Based on the total unique species measured, a score will be given for each habitat and for the farm (see scoring tables on the next slide). The Exchange Benchmark will enable farmers to compare total unique species per habitat and for the farm to all farms and themselves to other farms with similar:

- Geographies (counties)
- Enterprise classification

Table 11

Scoring

Arable Field Square Plot

Exchange Score	Number of species
1	Bare ground 0
2	1-2
3	3
4	4-5
5	6 and above

Hedge Linear Plot

Exchange Score	Number of species
1	<4
2	5-9
3	10-14
4	15-19
5	≤20

Grass Field and Field Margin Linear Plot

Exchange Score	Number of species
1 Very Bad	1 or 2 species
2 Bad	3-5 species
3 Moderate	6-8 species
4 Good	9-24 species
5 Very Good	25 and above

Hedgerow Structure

Why we measure it?

Hedgerows are considered vital for the survival of many farmland plants and animals, especially in intensive agricultural systems.[62] Hedgerows provide habitat, shelter and resources for many species including functionally important taxa and threatened species. Hedgerows store carbon both above- and below-ground and provide a range of other ecosystem services.[63] They also occur predominantly in lowland farmland - upland farms should not be disadvantaged by the use of this metric.

The definition of a hedgerow used by Natural England's Favourable Conservation Status (FCS) is "Any boundary line of trees and/or shrubs over 20m long and less than 5m wide, where any gaps between the trees or shrub species are less that 20m wide, and where England native woody species form 80% or more of the cover. Any bank, wall, ditch or tree within 2m of the centre of the hedgerow is considered to be part of the hedgerow, as is the herbaceous vegetation within 2m of the centre of the hedgerow" in all states of growth. Although FCS is specific to England, FCS is defined in terms of three parameters: natural range and distribution, area, and quality structure and function attributes which are equally applicable to hedgerows anywhere in the UK.

There is some evidence to support an increase in hedgerow extent in the United Kingdom to an average of 10 km/km2, to optimize availability of resources and habitat for several wildlife taxa, potential habitat connectivity and also carbon storage. Evidence also supports improving the quality of hedges through appropriate management that would result in denser, larger hedges. A diversity of hedgerow structures and management across the landscape should be retained and extended, giving due consideration to the needs of particular conservation priority species in any local area or region.[64]

How we measure it?

We conduct a survey of the hedgerows of one or more fields, following the Adams Hedgerow Management Scale. (https://hedgerowsurvey.ptes.org/hedge-structures) This survey requires the farmer or technician to first draw the hedges around the field to understand the length of hedgerow being surveyed. They then collect information on the hedge's structure (using the Healthy Hedgerows hedge structure key) including average height, average width, number of hedgerow trees, hedgerow gaps and average base canopy (average height of this canopy from the floor). We assess dominant species of the hedge, in line with the hedgerow survey.

An Exchange Hedgerow Structure score is given based on the Adams Hedgerow Management Scale.

The Hedgerow Structure survey scores are averaged to obtain a farm Hedgerow Structure score. This is used for the Exchange Benchmark.

How we score it?

There is no Hedgerow Structure industry standard.

The Exchange Benchmark will enable farmers to compare Hedgerow Structure scores with all farms and to other farms with similar:

- Geographies (counties)
- Enterprises

Contextual Biodiversity Information

Why we measure it?

For each farm and in addition to the aforementioned metrics, we will also provide a set of contextual information. This information is in part to enable a farmer to better understand the biodiversity of their farm, but also to help them understand what larger landscape initiatives their farm might be linked to.

The contextual information is:

- Habitat networks (England, Scotland, Wales) - Natural England, Scotland + Wales Gov
- Woodland habitat networks (Wales) - Wales Gov
- Habitat scheme (Wales)
- Protected areas (Scotland) - Scotish Gov
- Priority habitats (SSSI) (England, Scotland, Wales) - Environment Agency
- Priority habitats (AONB) (England, Scotland, Wales) - Environment Agency

How we measure it?

All of these data points are collected using third party data.

How we score it?

There is no industry standard or Exchange benchmark for these datasets as they are only provided for context.

* Farmed landscapes with an average field size of less than 5 ha provide networks for nature and corridors of movement for birds, bats, bees and butterflies to move through the countryside.

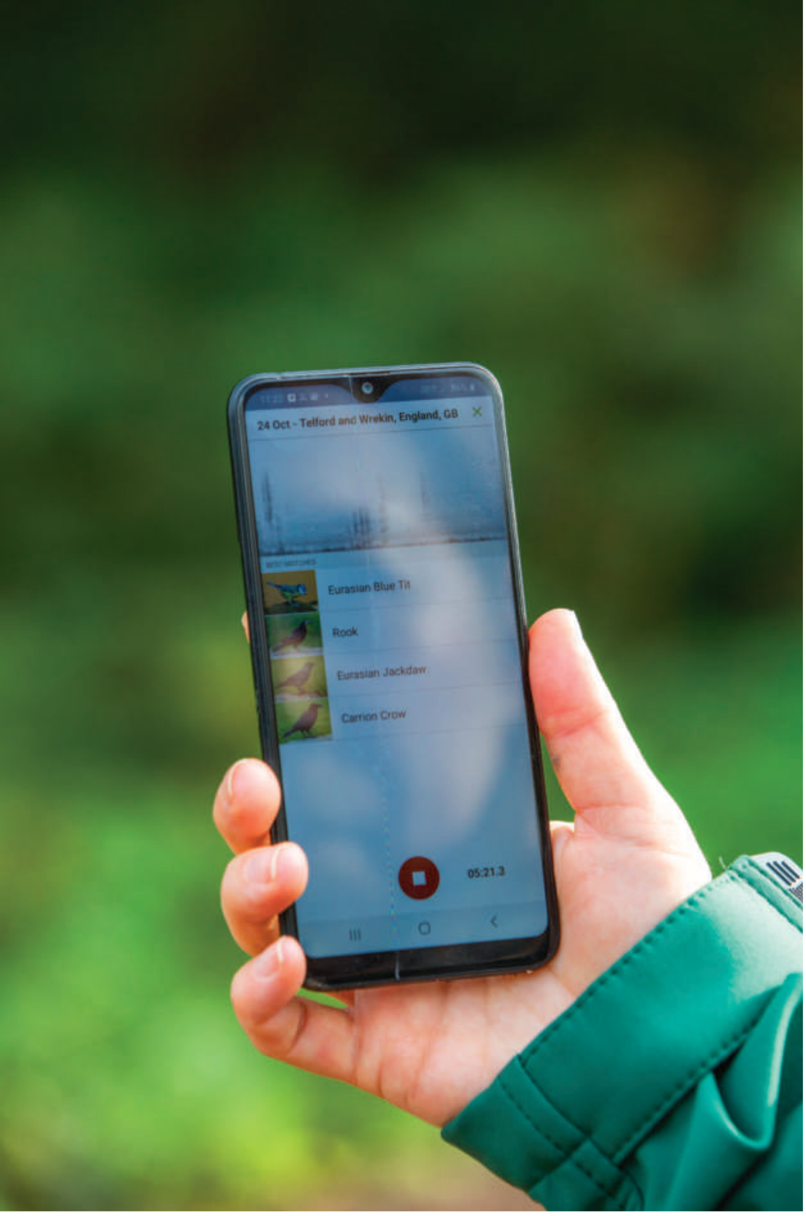
** 63 https://records.nbnatlas.org/explore/your-area#52.9548|1.1581|12|ALL_SPECIES for England and Wales and https://scotland- records.nbnatlas.org/explore/your-area#56.998999|-4.505723|12|ALL_SPECIES for Scotland

*** Natural England's Habitat Networks (Individual Habitats) England Data

**** Natural England's Priority Habitats Inventory (England) data

Table 12

Measure	What
Farm size*	Hectares
Habitat size	(ha and % of farm size) – wooded elements (woodland and hedgerows); grassland elements (grassland, grassy strips) and cropland elements (Uroy et al., 2022).
Species occurrence records	NBN** /GBIF
Habitat Networks***	Is the farm located in a nature network scheme? Can they connect to this scheme?
Protected areas	condition score (favourable, unfavourable-recovering etc) [where applicable]
Priority Habitats****	
Designations (protected areas)	SSSI etc (ha and type) [where applicable These are the bits that need to go in the biodiversity context data table.


24 Oct - Telford and Wrekin, England, GB
Eurasian Blue Tit
Rook
Eurasian Jackdaw
Carrion Crow
05:21.3

Carbon Emissions and Sequestration

Introduction to Carbon Emissions and Sequestration

Nearly all human activity releases some level of greenhouse gas emissions. But since these gases contribute to the warming of our planet and the destruction of habitats, both the UK government and the international community have committed to drastically reducing emissions across the world by 2050.

As the sector responsible for a full 10% of greenhouse gas emissions in the UK, agriculture clearly has its part to play.[65] Of course, when it comes to reducing emissions, the additional questions of food security, land use and natural resources pose unique challenges to the industry.

Likewise, although carbon dioxide (CO2) is typically considered the 'benchmark' for emissions globally, the big players in agriculture are methane and nitrous oxide.[66] Since these are produced in the greatest quantities, these are the crucial GHG markers in our sector.

When analysing a farm's GHG balance sheet, don't forget that good farming practices and conservation efforts can counteract farm emissions through carbon sequestration.

A note on terminology: In the following section, we talk about 'stocks' and 'flows'. For clarity, 'stocks' represent the total amount of carbon locked up, and 'flows' means the total amount of carbon that's added to/removed from those stocks on an annual basis. (For the avoidance of doubt, a farm's carbon balance means its carbon emissions minus carbon flows.)

Carbon Balance

Why we measure it?

When it comes to carbon, understanding the balance between how much a farm emits and how much a farm sequesters is fundamental.

To calculate a farm's true impact on climate change, you need both.

Too often, only emissions are captured, effectively ignoring all the important work a farmer is doing to draw carbon down into their trees, hedges, habitats and soils.

How we measure it?

We take the annual emissions total expressed in CO_2e. (See the next metric for more detail around this calculation).

Next we calculate sum the carbon that is sequestered into the farm's trees and hedges (calculated on the Exchange Platform), as well as carbon sequestered annually by habitats, land use change and soils (calculated on a third party carbon calculator, the Farm Carbon Toolkit).

We subtract the emissions from the sequestrations. The resulting figure is the farm's 'Total Carbon Balance'. To help inter-farm comparability, we then take the Total Carbon Balance figure and divide it by the size of the farm, indicating the tons of CO_2e per hectare per year.

How we score it?

There is no industry standard for Carbon Balance.

The Exchange Benchmark will enable farmers to compare their CO_2e/hectare results to all farms and other farms with similar:

- Geographies (counties)
- Enterprises classification
- Carbon calculators (carbon calculator providers)

GHG Emissions

Why we measure it?

Measuring carbon emissions on a farm is essential for several critical reasons.

- Firstly, it aids in mitigating climate change. Agriculture is a significant contributor to greenhouse gas emissions. By quantifying emissions, farmers can identify areas for improvement, adopt sustainable practices, and reduce their carbon footprint.
- Secondly, it enhances resource efficiency. Understanding emission sources allows farmers to optimise inputs like energy, fuel and fertiliser, leading to cost savings and improved profitability.

Moreover, it supports regulatory compliance. Monitoring helps farms adhere to legal standards, avoiding potential fines. It also facilitates participation in carbon credit and offset programs, providing financial incentives.

How we measure it?

A carbon calculator estimates a farm's Greenhouse Gas Emissions by gathering information on:

- Cropping data – crop types, yields, areas, inputs etc • Livestock – herd or flock size, feed use, manure management
- Energy and waste – fuel and energy use, water use, plastic waste and transport

The Exchange platform allows a farmer to add emissions data from any calculator that aligns with the GHG Protocol. If a farm has never previously completed an emissions calculation, the Exchange team uses the Farm Carbon Toolkit as the default calculator. This is because it accounts for carbon sequestration and different production systems.[67]

The Farm Carbon Calculator is designed to be used as a whole-farm carbon footprinting tool. The Calculator covers Scope 1 (direct emissions), Scope 2 (emissions resulting from the generation of purchased electricity or gas on farm) and Scope 3 (indirect emissions) in its calculations.[68]

The Farm Carbon Calculator is divided into several data input categories: Fuels, Materials, Inventory/Capital, Fertility, Inputs (Agro-chemicals), Livestock, Waste, Distribution and Processing

How we score it?

There is no industry standard for GHG Emissions.

The Exchange Benchmark will enable farmers to compare their CO2e/hectare/year results to all farms and other farms with similar:

- Geographies (counties)
- Enterprises classification
- Carbon calculators (carbon calculator providers)

Carbon Stored in Woodland and Forest: Stocks

Why we measure it?

Woodlands and forests are excellent carbon stores due to their dense vegetation. Trees absorb carbon dioxide during photosynthesis, converting it into oxygen and carbon stored in biomass. Soil in these ecosystems also traps carbon. As trees mature, their carbon storage capacity increases, making them crucial in mitigating climate change.

The potential of trees, woodland and forests for carbon storage far exceeds any other habitat (whether semi-natural or productive) apart from peatlands. Therefore, planting the right trees in the right place – be it for forestry, agroforestry or hedgerows - is encouraged. Carbon storage in contrasting habitats and land managements is illustrated in Table 13 and uses the best available data.

Native broadleaved woodlands are reliable carbon sinks that continue to take up carbon over centuries, with benefits for biodiversity and other ecosystem services. However, the rate varies greatly with tree species and age and is strongly influenced by soils and climate.[69]

How we measure it?

Carbon Stocks in woodlands and forests are estimated using a machine learning algorithm[70] that we license from Natural Capital Research. The model relates a set of predictor variables to stand-level carbon storage estimates from the National Forest Estate (R2 = 0.86, RMSE = 70 tCO2e ha-1).

Predictor variables used include canopy height estimates from the National Tree Map; Sentinel NDVI data for summer and winter; stand age; yield class; and climate and soil properties.

The accuracy of this model has an R2 = 0.86 (0 being no correlation with reality and 1 being perfect correlation).

Newly planted and/or felled areas are not captured by the model, which is updated every 3-5 years). We can capture woodland areas based on UKHAB codes as ‘Young trees’ or ‘Felled Trees’ and ask the following optional information:

- Species (conifers, broadleaf or mixed)
- Date when planted/felled
- Density of trees

Exchange advisors will use this data to understand further Woodland Carbon Stock potential and, in future, we will integrate the carbon calculation of these areas.

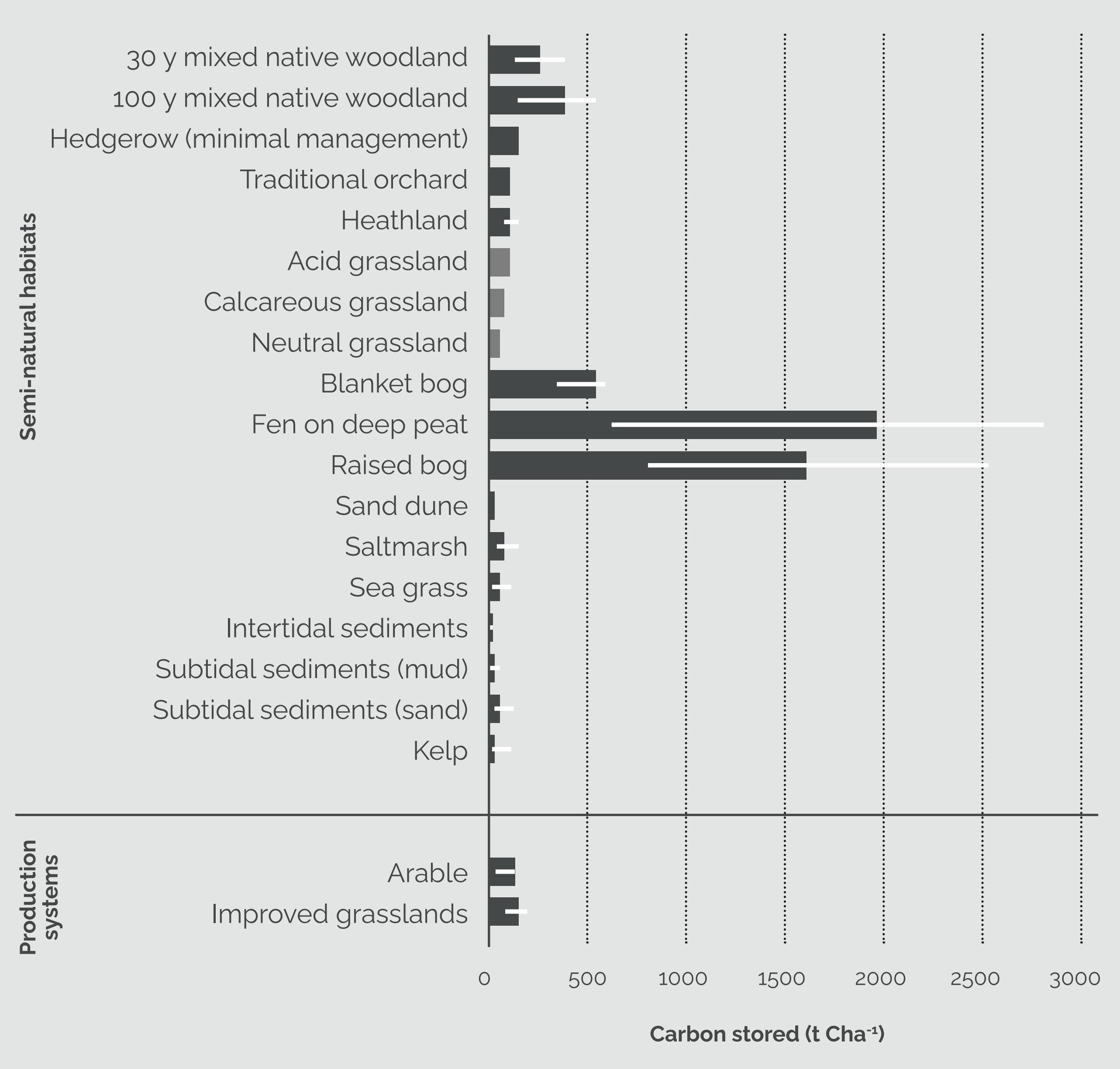
How we score it?

There is no industry standard for Carbon Stored in Woodland and Forest: Stocks.

The Exchange Benchmark will enable farmers to compare their CO2e /hectare results to all farms and other farms with similar:

- Geographies (counties)
- Enterprises classification

Table 13


30 y mixed native woodland
100 y mixed native woodland
Hedgerow (minimal management)
Traditional orchard
Heathland
Acid grassland
Calcareous grassland
Neutral grassland
Blanket bog
Fen on deep peat
Raised bog
Sand dune
Saltmarsh
Sea grass
Intertidal sediments
Subtidal sediments (mud)
Subtidal sediments (sand)
Kelp
Semi-natural habitats
Arable
Improved grasslands
Production systems
0
500
1000
1500
2000
2500
3000
Carbon stored (t Cha-1)

Carbon Stored in Woodland and Forest: Sequestration

Why we measure it?

Trees act as a natural 'carbon sink' through the process of photosynthesis, through which leaves release oxygen whilst absorbing atmospheric carbon dioxide and locking up carbon. The largest Carbon Sequestration rates amongst seminatural habitats are in woodlands and forests.[71]

How we measure it?

We measure Carbon Sequestration rates using carbon modelling.[72] We predict current rates of annual sequestration into trees and woodlands using estimates of forest age and yield class, as detailed above for Carbon Storage. Using published growth curves for key forest species, we can estimate the expected rate of carbon drawdown each year. (We work with the assumption that forests are managed, giving us a conservative estimate.) Newly planted and felled woodlands may not be detected by the National Tree Map immediately; updates are available every 2-5 years.

Table 14 summarises the Carbon Sequestration values for trees in woodland (annualised carbon stock changes).[73] Annualised carbon stock changes (equivalent to net CO2 uptake or loss) over the specified reporting period (1 ha created in 2022), expressed in units of tonnes CO2 per year (tCO2 yr-1). Annualised values are calculated by finding the average annual value over the specified reporting period.

As with Carbon Stored in Woodland and Forest: Stocks, newly planted or felled woods are captured during the farm setup.

Newly planted and/or felled areas are not captured by the model, which is updated every 3-5 years. We can capture woodland areas based on UKHAB codes as 'Young trees' or 'Felled Trees' and ask the following optional information:

- Species (conifers, broadleaf or mixed) Date when planted/felled
- Density of trees

How we score it?

There is no industry standard for Carbon Stored in Woodland and Forest: Sequestration.

The Exchange Benchmark will enable farmers to compare their CO2e /hectare results to all farms and other farms with similar:

- Geographies (counties)
- Enterprises classification

Table 14

Woodland - trees	Annualised net carbon stock change (tCO2-equiv. ha-1 yr-1)
Broadleaves light management	4.2
Natural recolonisation, rapid	3.9
Natural recolonisation, gradual	3.2
Production broadleaves	3.1
Production pine	2.4
Moderate growing conifer unthinned	3.3
Fast growing conifer unthinned	5.1
Moderate growing conifer thinned	2.3
Fast growing conifer thinned	3.6
Fast growing Sitka spruce thinned	6.2
Conifer mixture	3.3
Complex conifer/ broadleaf mixture	3.8

Carbon Stored in Trees Outside Woodland/Forest: Stocks

Why we measure it?

As we've said, woodlands are reliable carbon sinks that continue to take up carbon over centuries. This means benefits for biodiversity and other ecosystem services, although the rate at which carbon is sequestered varies greatly with tree species and age and is strongly influenced by soils and climate.[74]

Importantly, trees do not only exist in woodlands and forests, but can be integrated into the farmed landscape. Agroforestry – which is a key way to integrate trees in the farmed landscape - provides a range of benefits, including improved soil health, shelter and food for livestock, diversified income, carbon sequestration, biodiversity conservation, reduced erosion, enhanced water quality, increased productivity, sustainable resource management, and heightened resilience to extreme weather events.

How we measure it?

We use the same modelling approach to measure Carbon Storage in trees which lie in parklands and agroforestry areas as we do in woodland and forestry.[75]

This covers all trees outside woodlands and forest, across the whole farm or farm enterprise.

The National Tree Map[76] product is used in the modelling approaches taken for both Carbon Storage and Sequestration in trees. There is a full national update on a three- to-five-year cycle. The time lag - and the constraint of not measuring trees under 2m - means that on some occasions, newly planted and/or felled trees will not be accounted for in the model.

In such cases, newly planted and/or felled trees can be added on the Platform and the Carbon Stock potential will be acknowledged by the advisor.

How we score it?

There is no industry standard for Carbon Stored Outside Woodland and Forest: Stocks.

The Exchange Benchmark will enable farmers to compare their CO_2e /hectare results to all farms and 2 other farms with similar:

- Geographies (counties)
- Enterprises classification

Carbon Stored in Trees Outside Woodland/Forest: Flows

Why we measure it?

As stated in the previous section, trees act as a natural 'carbon sink' through the process of photosynthesis, through which leaves release oxygen whilst absorbing atmospheric carbon dioxide and locking up carbon. The largest carbon sequestration rates amongst seminatural habitats are in woodlands and forests.[77]

By introducing more trees to the farmed landscape, a farmer can soon start to offset some of their emitting activities, helping the farm get closer to Net Zero.

How we measure it?

We use the same modelling approach to measure carbon sequestration in trees which lie in parklands and agroforestry areas as we do in woodland and forestry.[78]

As before, considering the 2m height limitations and update lag, newly planted and/or felled trees can be added on the Platform and the carbon sequestration potential will be acknowledged by the Exchange advisor.

How we score it?

There is no industry standard for Carbon Stored outside Woodland and Forest: Flows.

The Exchange Benchmark will enable farmers to compare their CO^2e /hectare results to all farms and 2 other farms with similar:

- Geographies (counties)
- Enterprises classification

Carbon Stored in Hedgerows: Stocks

Why we measure it?

Hedgerows are a widespread Priority Habitat (i.e. a habitat of principal importance for biodiversity conservation). They provide a key semi-natural habitat for a broad range of biodiversity, including many threatened species.[79]

Hedges are woody linear features delineating field boundaries in many agro-ecosystems in the UK. Agroforestry practices, such as hedgerow planting, are widely encouraged for climate change mitigation, and there is an urgent need to assess their contribution to national Net Zero targets.[80] Hedgerows can sequester and store carbon, as well as providing other benefits within an agricultural and biodiversity context - but empirical data on their carbon (C) stock in the UK is lacking.[81] Where biomass carbon stocks have been quantified, it's been with a focus on how these change according to hedgerow height and width,[82] rather than how they change over time since planting.

The width and height of hedgerows directly influence the amount of carbon they can store. Most hedgerows are managed and undergo trimming every 1–3 years to maintain their width and height. In addition, a large proportion of the woody biomass is removed on a 20- to 40-year timescale via hedge laying or coppicing, which rejuvenates the hedge. These management regimes mean that a proportion of the biomass is regularly removed, causing a loss of carbon from the habitat. This makes it difficult to estimate carbon sequestration rates.[83]

Hedgerows and hedgerow management are complex and vary across space and time. Consequently, our scientific knowledge and understanding of hedgerow functions is still developing. Hedgerows are also managed in many different ways and for many purposes, including, but not limited to: shelter, shade, boundaries, biodiversity conservation and natural flood management. Consequently, we recognise that carbon storage and sequestration may not always be the top priority when managing hedgerows on a farm.

How we measure it?

Natural England's report on Carbon Storage and Sequestration by Habitat: a Review of the Evidence[84] provided a summary of carbon storage values for hedgerow biomass based on the scientific literature.

We gather data on hedgerows in two ways:

- Using the farm's RPA data...
- We manually enter the farm's hedge length (this can be in addition to step 1).

We use a farm default of 5m width, though this can be changed.

With the above information, we can calculate the proportion of landcover made up of hedgerows by:

length x width hedgerows = (m2) / 10,000 = hedgerows (ha)

How we score it?

There is no industry standard for Carbon Stored in Hedgerows: Stocks.

The Exchange Benchmark will enable farmers to compare their CO2e /hectare results to all farms and other farms with similar:

- Geographies (country)
- Enterprises classification

Carbon Stored in Hedgerows: Flows

Why we measure it?

Hedgerows are now widely recognised as an important part of the UK's journey to Net Zero: with a 40% increase in length included in the land use change scenarios.[85] However, hedgerow management means that a proportion of hedgerow biomass is removed on a regular basis, representing a carbon loss from the habitat and making it difficult to provide an annual sequestration rate.

Natural England's report on carbon storage and sequestration by habitat[86] indicated that, at a conservative estimate, hedgerows could sequester 0.13–0.51 tC ha-1 y-1 (0.47–1.87 tCO2-e ha-1 y-1) depending on their height.[87] The report found that above-ground carbon stock increased with hedge age from sapling to mature hedges, with young hedgerows (≤12 years) sequestering on average ~2.0 Mg C ha−1 yr−1, while mature, 39-year- old hedgerows sequestered ~0.86 Mg C ha−1 yr−1; the analysis was based on destructive sampling.

Further scientific research is needed to better understand the role of hedgerows and associated management on both carbon storage and sequestration. However, it is generally accepted that for hedgerows to accumulate carbon in the longer-term, they should be managed to be taller and wider. Raising their height from 2.0 m to 2.7 m (with widths ranging from 2.8–4.3 m) would currently represent an increase in size for 70% of managed hedgerows across England and Wales. Such an increase has the potential to sequester an additional 2.0 Mt carbon in hedge biomass in the farmed landscape.[88]

How we measure it?

We gather data on hedgerows in the same way as described in the 'Carbon Stored in Hedgerows: Stocks' metric. Similarly, we remove the carbon sequestered by trees as it is counted in the 'Carbon Sequestered In Trees Outside Woodland' metric. Then we estimate the Carbon Sequestration by taking the proportion of hedgerow landcover on farm (ha) multiplied by the Carbon Sequestration rate per year. The result will be reported as the approximate carbon storage in hedgerows on farm in tC ha^{-1}.

The proportion of landcover which is made up of hedgerows is calculated as follows:

length x width = (m2) / 10,000 = hedgerows (ha)

To allow for differences in hedgerows, the common species in hedges and the complexity of management, we take a conservative approach to estimating carbon storage. For the purposes of this Protocol, we apply Natural England's conservative estimate for Carbon Sequestration in hedgerows of 1.99 t CO2e per hectare per year (p.215 Natural England, 2021),[89] which is based on Robertson et al. (2012).[90]

We calculate, on average, how much carbon is stored by trees in hedges and reduce the carbon storage value per ha accordingly.

Hedgerows (ha) x 1.99t CO2e per hectare per year = ~annual carbon sequestration into hedgerows on farm (t CO2e per hectare per year)

How we score it?

There is no industry standard for Carbon Stored in Hedgerows: flows.

The Exchange Benchmark will enable farmers to compare their CO2e /hectare results to all farms and other farms with similar:

- Geographies (counties)
- Enterprises classification

Carbon Stored in Soils: Stocks

Why we measure it?

Soil Organic Carbon (SOC) improves a soil's biological, chemical, and physical properties, its water-holding capacity and its structural stability. It's also a major contributor to overall soil health, agriculture, climate change, and food solutions.

Soils represent the largest terrestrial sink of carbon on Earth, containing more carbon than is stored in terrestrial vegetation and the atmosphere combined.[91]

It is estimated that UK soil contains about 10 billion tonnes of carbon - roughly equal to 80 years of annual greenhouse gas emissions. However, it's difficult to quantify the amount of SOC due to the spatial variability inherent in agricultural soils.[92]

Although the relative amounts vary over the range of different soil types, carbon is found in two main forms in soils. Firstly, soil organic carbon (SOC) is made up of living and dead components of organisms, including fine plant roots, fungi, microbes and decomposing plants and animal residues. This comprises about 60% of the total carbon in UK soils. Secondly, soil inorganic carbon (SIC) is made up of minerals such as chalk. SIC is generally more stable than SOC, making up about 40% of total carbon in UK soil.[93] In this Protocol, both SOC and SIC are measured and reported but only SOC is scored.

How we measure it?

We take samples in-field at a preferred depth of 30cm, as per the IPCC recommendation (see sampling and zonation for more details). We record the samples' depth (if not 30cm) and stone content to obtain accurate Soil Organic Carbon Stock from the laboratory, as soils with coarse fragment volumes of >2% will impact results.[94] Samples are then sent to the laboratory for analysis and Soil Organic Carbon Stock per hectare is reported (t/ha).

We use the DUMAS-dry combustion method to measure soil organic carbon. A pre-acid (mild) treatment is applied to remove any carbonates - thus accounting for inorganic carbon in the sample.

To calculate Co2e capture (CO2e/ha), we multiply Organic Carbon Stock by 3.67 (mole mass CO2/mole mass C). [95] CO2e/ha can be can be converted to a meaningful volume for a farm by multiplying it by the total hectares in that specific zone (i.e. the areas with similar soil characteristics) and repeating this for the different zones as categorised by our Zonation process.

How we score it?

The industry standard for Soil Organic Carbon Stock is taken from Woodland Carbon Code 2011 and Bradley et al., 2005 - see Table 18.

The Exchange Benchmarks allow farmers to compare themselves against all farms and farms with similar:

- Rainfall ranges (average/year in mm)
- Soil texture (British Geological Survey mapping)
- Landcover classes (UKHAB categorisation)

Table 15

Average soil carbon density (tCO2e/ha) for four main land use types across the UK at 0 - 30 cm depth (adapted from WCC 2011 and Bradley et al., 2005 - Table 6)

	Semi-natural	Pasture	Cropping (ara-ble)	Woodland
England	440	293	257	367
Scotland	587	587	440	623
Wales	403	330	257	440

Note:

Semi-natural includes semi-natural vegetation and grassland that received no management

Pasture includes permanent managed grassland

Arable includes arable and rotational grassland

Woodland includes broadleaved and conifer woodland

Carbon Stored in Soils: Flows

Why we measure it?

Soils are an important carbon sink, as they contain more carbon than is stored in terrestrial vegetation and the atmosphere combined.[96]

This process of storing organic carbon in soils, better known as carbon sequestration, describes how organic carbon is transferred into soils and converted into stabilized forms for the long-term (> 100 years).[97]

Soil organic carbon (SOC) sequestration is one of the most cost-effective options for mitigating climate change in the short-term. It also improves soil fertility and provides other ecosystem services.[98] However, we still have knowledge gaps to plug - particularly in relation to the need for databases of carbon sequestration rates in biomass and soil, along with the equilibrium period for ecosystems.[99]

There is no single universal management practice to increase SOC sequestration,[100] but in general, soil carbon stocks can be increased by: "(a) increasing the rate of carbon addition to soil, which removes CO_2 from the atmosphere, and/ or (b) reducing the relative rate of loss (as CO_2) via decomposition, which reduces emissions to the atmosphere that would otherwise occur."[101] In short, the aim is to increase soil organic matter.

The carbon sequestration potential of a farm's soil management will vary significantly depending on local factors - particularly the soil texture and the starting state of the soil. Additionally, the sequestration potential is finite. Once management practices are introduced, rates of carbon accumulation may increase sharply over periods of around 20 to 50 years, but after this time the rate will plateau as soils reach a carbon saturation point.[102]

Agriculture tends to drive soil carbon loss, unless measures are taken to improve soil carbon explicitly. Overall, the UK potential for soil carbon sequestration is estimated at 1 - 31 $MtCO_2$-equiv. per year.[103]

A synthesis of existing studies suggests that improving grassland management can lead to soil carbon sequestration, by an average of 0.47 Mg C per hectare per year.[104] However, there is little evidence of UK-wide potential for sequestration through pasture management practices.[105] For soil beneath hedgerows, the sequestration rate has been estimated as in the region of 1.48 Mg C per hectare per year.[106]

How we measure it?

Measuring annual changes in soil organic carbon are very challenging because of the many variables at play. Factors such as soil type, average rainfall, historic practices, soil depth and many more besides all have an impact on a soils ability to store carbon. As such the figures for the sequestration potential are indicative and can be helpful to demonstrate the type of soil management practices that are beneficial/ detrimental. However, please note that Soil Association Exchange and the SA Exchange science advisory group and authors of this Protocol do not support the sale of soil carbon credits in the UK and strongly advise that this Protocol should not be used for this purpose.

We measure soil carbon sequestration using the Farm Carbon Toolkit's methodology. The modelled sequestration figures are from peer reviewed scientific papers and align to the GHG Protocol.

Using Farm Carbon Toolkit, we are able to model the Carbon Sequestration of the following:

- Uncultivated field margins
- Permanent wetland
- Peatland states
- Some Countryside Stewardship practices
- Habitat changes
  - Arable to unfertilised grassland
  - Arable to floristically enhanced grassland
  - Arable to grass buffer strips
  - Arable to beetle banks
  - Rough permanent pasture to wood pasture and parkland
  - Rough permanent grassland to rough grazing for birds
  - Rough permanent grassland to scrub
- Land use change:
  - Woodland to pasture
  - Woodland to arable
  - Peatland to arable
  - Wetland to arable
  - Grass to arable
  - Moorland grass to arable
  - Perennial crops to arable

Furthermore, if a farmer has reliable historic Soil Organic Matter and/or Soil Organic Carbon data measured to at least 30cm with DUMAS, we can make even more accurate predictions on how much is being sequestered/emitted each year.

How we score it?

There is no industry standard for Carbon Stored in Soils.

The Exchange Benchmark will enable farmers to compare their CO2e/hectare results to all farms and other farms with similar:

- Geographies (counties)
- Enterprises classification

Animal Welfare

Introduction to Animal Welfare

Animal welfare sits at the crossroads of sustainability, ethics and productivity. Not only do we believe we have a moral obligation to prevent unnecessary suffering, but proper monitoring also benefits farmers, consumers and wider society.

Perhaps you're already collecting animal welfare data for another scheme? At Exchange, we still think it's an important means of understanding the close relationship between animal welfare and nature friendly farming.

That's because the more a farmer knows about their animals' welfare, the better they can identify and address potential issues – boosting health and productivity for their farm and ultimately delivering really great lives for their animals. Rigorous monitoring also helps farmers comply with legal and regulatory standards, stopping disease outbreaks in their tracks and safeguarding other animals and humans alike.

With the public more educated and invested in the food chain than ever before, responsible stewardship will be rewarded with loyal customers.

Finally, accurate data on animal behaviour, physiology and well-being is of great value to scientific research, which spells progress for all.

Next steps for animal welfare metrics:

As we further develop this protocol we will look to maximise the opportunity for farmers to enter and benchmark welfare outcome data that is being collected under the requirements for existing schemes, either through AssureWel data collection, Red Tractor standards or retailer contracts.

We will explore a positive welfare resource checklist for farmers to complete as a self-assessment questionnaire. This would be an exercise that focuses on what farmers are actively delivering for their animals that meets their positive welfare needs and in turn highlight to them activities and resources that they may not be providing but that would be valuable.

Antibiotic Usage

Why we measure it?

Overall, better animal welfare has been found to be associated with lower antibiotic use.[107] Animals do not need routine antibiotics to stay healthy and high welfare systems (including organic)[108] use antibiotics sparingly, only when animals need it.

Livestock can - and should - be kept healthy through good husbandry and welfare, and low-stress systems. Overwhelming evidence shows that animals are more susceptible to disease when stressed. Stress releases hormones such as cortisol in animals, which can reduce immunity by compromising the immune system.

How we measure it?

We rely on the antibiotic usage data routinely processed by farmers' vets as part of farm assurance and industry surveillance schemes.

This is collated using calculator programmes to convert antibiotic product purchase data and livestock data into milligrams per population corrected unit (mg/PCU), mg/KG and for laying hens, % bird days treated.

Each farm is asked a series of questions to assess their antibiotic usage across a recent 12-month period for each livestock type:

- Dairy (mg/kg or mg/PCU figure)
- Beef (mg/kg)
- Sheep (mg/kg)
- Pigs (mg/kg)
- Laying hens (% bird days)
- Meat Chickens (mg/kg)

If this figure is not available from farm records, it needs to be calculated using the AHDB medicine Hub / e-medicine book for ruminants and pigs, or Nottingham calculators:

- https://medicinehub.org.uk/
- https://emb-pigs.ahdb.org.uk/
- https://ahdb.org.uk/amu-calculator
- https://ahdb.org.uk/sheep-antimicrobial-usage-tool

For poultry, figures must be submitted to industry collation hubs and should therefore be calculated on the farm. however calculation details are provided on the platform if data needs to be processed at point of collection. For example The laying hen sector uses bird-days as the standard denominator to calculate all proportions or percentages. For the year, it is the mean daily population of birds in the Lion scheme (including breeding birds and pullets in rear) multiplied by 365. A daily dose is a single chicken treated with an antibiotic for one day. Courses of treatment will vary with the clinical need, but are typically 3-5 days. So a flock of 5,000 chickens treated with an antibiotic for 3 days is 15,000 daily doses. The standard reporting metric is daily bird doses/100 bird days at risk (% doses).

How we score it?

The industry standards for Antibiotic Usage Data have been calculated from the following sources:

- The industry average for pigs, broilers, and laying hens is taken from UK-VARSS (2021).[109]
- The industry average for dairy and beef is taken from UK- VARSS (2020).[110]
- The industry average figure for sheep is taken from RUMA (2019).[111]

Version 2 Protocol updates:

- Pigs, Broilers and Laying Hens with minimum score 3 range industry average from UK-VARSS (2022).[112]

The Exchange Benchmark will enable farmers to compare their results to other farms with similar:

- Enterprise classification

Table 16
Antibiotic scoring

	mg/kg				
SCORE:	1 (> 50%)	2 (> 25%)	3	4 (< 50%)	5 (< 75%)
Dairy	> 33.75	33.74 - 22.6	22.5* - 11.26	11.25 - 5.64	≤5.63
Beef	> 36.6	36.5 - 24.50	24.40* - 12.30	12.20 - 6.20	≤6.10
Sheep	> 25.05	25.04 - 16.80	16.70* - 8.36	8.35 - 4.19	≤4.18
Pigs	> 130.95	130.94 - 87.31	87.30 - 43.66	43.65 - 21.84	≤21.83
Broilers	> 20.55	20.54 - 13.71	13.70 - 6.86	6.85 - 3.44	≤3.43
Layers (% bird days)	> 0.50	0.49 - 0.34	0.33 - 0.18	0.17 - 0.09	≤0.08

Introduction to Welfare Outcomes

Most welfare standards for farm animals (such as those used by farm assurance schemes) are based on resource 'inputs': the housing, space, feed, veterinary care and management practices that must be provided to the animals.

To truly understand the effect of these measures on animal welfare, we need to look at the 'outcomes': the impact of these inputs on the health, physical condition and behaviour of the animals themselves. Known as 'welfare outcome assessment', this is a practical and scientifically-informed method of assessment designed to provide a more objective, accurate and direct picture of animal welfare.

The Soil Association was involved in the development of AssureWel,[113] a six-year collaborative project with the RSPCA, the University of Bristol and funded by the Tubney Charitable Trust. Designed as a practical system of welfare outcome assessment for the major farm animal species, the protocols have since been adopted by a number of other national and international certification schemes.

This version of the Exchange protocol includes the records measures from the AssureWel welfare outcome assessment protocols, (with some amendments for full alignment with Red Tractor for ease of data collection). This is predominantly data associated with mortality and culling, also for dairy it includes lameness and mastitis. We are looking at including more opportunity for farmers to collect direct animal assessment data in future protocols.

The records mortality measures are harmonised across species with Red Tractor, Lion Code and AHDB.

Welfare Outcomes – Dairy

Why we measure it?

Lameness: this is a huge welfare issue across the dairy industry, with over 30% of the national herd being lame at any one time. However, the prevalence of lameness has been shown to range from 0% to 70% at an individual farm level. Lame cows are not only in considerable discomfort and pain, but are predisposed to further disease challenges (e.g. mastitis, swollen hocks), reduced fertility, lowered milk yield and decreased appetite.

Mastitis: This is another common problem across the dairy industry, and the number one use of antibiotics. It is caused by pathogens that are either environmental or passed from cow to cow. It is a painful condition that can vary in severity from being a fairly mild, easily curable case to a severe, life-threatening, toxic case.

Mortality: In the UK, 8% of calves are stillborn. 15% of live heifers never reach their first lactation and of those that do, 20% will not survive until their second lactation. Common reasons for this include infectious diseases (particularly scour & pneumonia), congenital abnormalities, injuries, parasite burdens, difficult calvings and metabolic imbalances. All these have the potential to negatively affect welfare and result in significant financial costs through treatment, reduced growth rates, labour and losses. Lower mortality rates can be achieved by avoiding ill health through good stockmanship, suitable housing/ bedding, adequate nutrition, biosecurity and appropriate vaccination protocols.

Culling: Monitoring the numbers and reasons for both voluntary and involuntary culling provides a useful reflection of herd health, welfare and longevity and can indicate areas of weakness.

How we measure it?

We ask farmers to provide information on the following:

Lameness:

- The number of recorded cases of lameness per 100 cows for the previous 12 months.

  (No. of new cases of lameness in the herd in the most recently completed 12 month period x 100) / Average no. of cows in the herd in the most recently completed 12 month period)

Mastitis:

- No. of recorded cases of clinical mastitis per 100 cows for the previous 12 months.

  (No. of recorded cases of clinical mastitis in the herd over the previous 12 months x 100) / Average no. of cows in the herd over the previous 12 months)

Mortality:

- Calf losses: Birth - 24 hours (m & f; including stillborn) % (per 100) for a 12 month period

  (No. calf deaths (still born to hours) x 100 / No. cows calved).

- Calf losses: 24 hours - 42 days (m & f) % (per 100) (For a 12 month period

  (No. calf deaths (24 hours – 42 days) x 100) / No. cows calved). We do not include animals which are sold or calves that are slaughtered off-farm.

- Heifer losses: 42 days - 1st calving % (per 100) (For a 12 month period)

  (No. heifer deaths (42 days – 1st calving) x 100) / No. cows calved)

- Heifer losses: 1st calving - 2nd calving % (per 100) (For a 12 month period

  (No. heifer deaths (1st calving - 2nd calving) x 100) / No. cows calved)

Culls:

- Planned culls % (per 100 cows):
  For the previous 12 months

  (No. planned culls (do not include animals sold for herd reduction) x 100) / Average no. of cows in the herd over the previous 12 months)

- Unplanned culls % (per 100 cows):
  For the previous 12 months

  (No. unplanned culls x 100) / Average no. of cows in the herd over the previous 12 months)

- Casualty cows (died or killed on farm) percentage (per 100 cows) For the previous 12 months

  (No. casualty cows (died or killed on farm) x 100) / Average no. of cows in the herd over the previous 12 months)

Please note, Defra enforced culls e.g. TB are not included. For further details on how to assess a new lameness or mastitis case, see the AssureWel Dairy Welfare Outcome Protocol.

How we score it?

The industry standards data comes from the following papers:

- Mobility; Archer et al (2010) plus expert opinion (Ed Bailey)[114]
- Mastitis; Kingshay Dairy Costings focus report 2019 and 2022, Hanks & Kossaibati (2021) plus expert option (Ed Bailey)[115]
- Mortality calves; Hyde et al 2020 plus expert opinion[116]
- Mortality heifers; Brickell & Wathes (2011); Brickell et al (2009)[117]
- Culls and Casualty cows; Kingshay Dairy Costings Focus Report 2022; Hanks & Kossaibati (2021) plus expert option (Ed Bailey)[118]

The Exchange Benchmark will enable farmers to compare their welfare results to other farms with similar:

- Geographies

Table 17

	Welfare outcome measure	1	2	3	4	5
Mobility	No. of recorded cases of lameness per 100 cows for the previous 12 months.	≥40%	30 – <40 %	20 – <30%	10 – <20%	<10%
Mastitis	No. of recorded cases of clinical mastitis per 100 cows for the previous 12 months.	≥40%	30 – <40%	25 – <30%	15 – <25%	<15%
Mortality	Calves: birth - 24 hours (m & f (including stillborn)) % (per 100)	≥7%	6 - <7%	5 - <6 %	4 - <5%	< 4%
	Calves: 24 hours - 42 days (m & f) % (per 100)	≥7%	6 - <7%	5 - <6 %	4 - <5%	< 4%
	Heifers: 42 days - 1st calving % (per 100)	≥15%	12 - <15%	7 - <12%	4 - <7%	< 4%
	Heifers: 1st calving - 2nd calving % (per 100)	≥25	20 - <25%	15 - <20%	9 - <15%	<9%
Culls & Casualty cows	Planned culls %	≥34%	29 - <34%	26 - <29%	21 - <26%	<21%
	Unplanned culls %					
	Casualty cows (died or killed on farm) %	≥10%	5 - <7%	4 - <5%	3 - <4%	< 3%

Welfare Outcomes – Beef

Why we measure it?

Mortality:

- Mortality rates vary between different age groups of cattle within one farm and also between farms. High levels of mortality are not only associated with greater suffering but also represent a significant economic loss to the farmer. Early losses are a good indicator of herd health and fertility, also reflecting abortions and calf mortality around calving.

How we measure it?

Mortality – Suckler herd:

- Calves alive 24 hours after birth (%)

  (Number of calves alive 24 hours after birth / number of cows put to the bull + number of heifers put to the bull) x 100)
- Calves weaned percentage

  (Number of calves weaned / number of cows put to the bull + number of heifers put to the bull) x 100). Please note this includes any calves sold before weaning and excludes any calves bought in
- Cow and Heifer deaths percentage

  (Number of cow and heifer deaths / number of cows put to the bull + number of heifers put to the bull) x 100, for the farm's production year. Please note, Defra enforced culls e.g. TB are not included.
- Cows and Heifer culls percentage

  (Number of cows and calved heifers culled / number of cows put to the bull + number of heifers put to the bull) x 100, for the farm's production year
- Mortality - Beef stores & Finishing:

  (Number of animals that died on farm)/(Number of animals in post-weaning group at start + Number of animals purchased/transferred in) x 100 = Mortality %

This includes any calves sold before weaning and excludes any calves bought in

How we score it?

The industry standard for Beef Welfare Outcomes comes from AHDB beef sector performance indicator KPI[119] plus expert opinion (Ed Bailey).

Our Exchange Benchmark will enable farmers to compare their results to other farms with similar:

- Enterprise classification

Table 18

Welfare Outcome Measures - Beef	1	2	3	4	5
Suckler herd measures:					
Calves alive 24 hours after birth	<80%	80 - <85%	85 - <95%	95 - <105%	>=105%
Calves weaned	<80%	80 - <84%	84 - <94%	94 - <102%	>=102%
Cow and Heifer deaths	>=4%	3 - <4%	2 - <3%	1 - <2%	<1%
Cow and Heifer culls	>=22%	19 - <22%	16 - <19%	15 - <16%	<15%
Beef stores & Finishing					
Mortality	>=2%	1 - <2%	0.5 - <1%	0 – <0.5%	0%

Welfare Outcomes – Sheep

Why we measure it?

Mortality:

- Mortality rates among sheep vary between different age groups and farming systems. For example, estimates of lamb pre-weaning mortality in the UK vary considerably between 10% and 30%, with most of these mortalities occurring within the first 3 days of postnatal life. Annual ewe mortality rates in the UK are estimated at around 5-7%. High levels of mortality are not only associated with suffering but also represent a significant economic loss to the farmer. It is calculated that neonatal lamb deaths cost between £20-25 per lamb, whilst ewe and ram deaths cost significantly more.

How we measure it?

Ewe culls:

- Ewe Culls percentage

  (Total number of culled ewes for a 12 month production year / number of ewes put to the ram last year) x 100). This is calculated using the difference between females put to the ram last year vs this year, plus any females purchased or transferred-in, minus animals that were sold for breeding or slaughter.

Ewe mortality:

- Ewe Mortality percentage

  (Total number of ewe Unplanned culls or casualties (died or killed on farm) for a 12 month production year / number of ewes put to the ram last year) x 100

Lamb mortality:

- Lamb losses from scanned to reared percentage
  - Difference between:
  - Scanning Percentage

    (Number of lambs scanned / Number of ewes put to the ram x 100, and
  - Rearing Percentage

    (Number of lambs reared / Number of ewes put to the tup) x 100

How we score it?

The industry benchmark for Sheep Welfare Outcomes is based on AHDB lamb sector KPI performance indicator[120] plus expert opinion (George Vets)

The Exchange Benchmark will enable farmers to compare their results to other farms with similar:

- Geographies

Table 19

Welfare OutcomeMeasures - Sheep	1	2	3	4	5
Ewe culls	>=40%	27 - <40%	23 - <27%	17 - <23%	<17%
Ewe mortality	>=7.5	5 - <7.5%	2.5 - <5%	1 - <2.5%	<1%
Lamb losses from scanned to reared	>=30	20 - < 30%	12 - < 20%	10 - < 12%	<10%

Welfare Outcomes – Pigs

Why we measure it?

Mortality:

- Mortality includes both pigs that have died naturally and those that have been culled prematurely on welfare grounds, usually due to chronic injury or disease. High levels of mortality and culling rates within a herd may suggest suboptimal management, inadequate environmental conditions or disease challenge, amongst other things.

How we measure it?

Breeding Sows mortality:

- Mortality percentage (died but not actively culled) in the last 12 months

  (Number of sows died /
  average number of sows in the herd) x 100 /

Breeding Sows culls:

- Culls percentage in the last 12 months

  (Number of sows culled /
  average number of sows in the herd) x 100

Finisher Pigs mortality:

- Mortality percentage

  (died but not actively culled) on farm in the last 12 months or for the last batch (finishing mortality is the % of live piglets that entered the finishing stage and died before slaughter, either for a 12 month period or a batch)

How we score it?

The industry standard for Pig Welfare Outcomes is Based on AHDB Pork Tools Costing and Herd Performance, and divided into 3 categories:

- Indoor herd[121]
- Outdoor herd[122]
- Rearing / Finishing – 7 to 110 kg[123]

The Exchange Benchmark will enable farmers to compare their results to other farms with similar:

- Enterprise classification

Table 20

Welfare Outcome Measures		1	2	3	4	5
Breeding sows						
Indoor	Mortality	>=9%	8 to <9%	7- <8%	6 - <7%	<6%
	Culls	<50%	50 – <51%	51 – <52%	52 – <54%	>54%
Outdoor	Mortality	>=7%	6 - <7%	5 - <6%	4 - <5%	<4%
	Culls	<44%	44 – <45%	45 to <46%	46 to <50%	>50%
Finishing Pig: Mortality		>=8%	7 - <8%	6 – <7%	5– <6%	<5%

Welfare Outcomes – Poultry

Why we measure it?

Mortality:

- This is a key welfare measure that can reflect incidence of poultry disease, predation, high levels of injurious feather pecking, or other serious welfare issues.

Recording levels of poultry mortality can help establish relationships between potential welfare issues (e.g. injurious feather pecking) and resulting levels of mortality.

How we measure it?

Data collected - Laying hens

Mortality:

- Mortality (%) of previous flock

  (Number of birds died (died and killed on farm) / total number of birds placed at the beginning of the laying cycle) x 100

Data collected - Meat Chickens

Mortality:

- First week mortality – inc. culls percentage (current & previous flock)

  (Number of birds died (died and killed on farm) in the first week / total number of birds placed at the beginning of the growing cycle in a flock) x 100

- Mortality to date of current flock percentage

  (Number of birds died to date in current flock / total number of birds placed at the beginning of the growing cycle in a flock) x 100 [NB. Dead birds only not including culls]

- Mortality of previous flock percentage

  (Total number of birds died for previous flock / total number of birds placed at the beginning of the growing cycle of the flock) x 100

Culls:

- Culls to date –of current flock percentage

  (Number of birds culled (killed on farm) to date in current flock / total number of birds placed at the beginning of the growing cycle in a flock) x 100

- Culls of previous flock percentage

  (Number of birds culled (killed on farm) in the previous flock / total number of birds placed at the beginning of the growing cycle in a flock) x 100

How we score it?

The industry standard for Laying Hen Welfare Outcomes is based on Assurewel partner laying hen benchmark data.

We aren't yet able to benchmark against an industry standard for Meat Chickens.

The Exchange Benchmark will enable farmers to compare their results to other farms with similar:

- Enterprise classification

Table 21

Welfare Outcome Measures	1	2	3	4	5
Total Mortality In Last Flock	>=11%	7 – <11%	5 - <7%	4 – <5%	<4%

People and Society

Introduction to People and Society

Understanding a farm's impact on the wider community is crucial for fostering sustainable and harmonious relationships between agriculture and society.

A farm's impact and relationship with the local community is multifaceted and complex. Firstly, land access is fundamental, as it provides opportunities for the wider public to explore nature, get exercise and better understand rural landscapes.

Secondly, community engagement events, school visits, markets and local gatherings play a vital role in education and awareness. Not only do they provide valuable local community spaces, but they offer valuable opportunities for people to connect with the source of their food, learn about agricultural practices, and appreciate the effort and expertise involved. This encourages a deeper understanding of the agricultural sector and cultivates a sense of respect for farmers' contributions.

Of course, food production is at the core of any farm's impact. Understanding a farm's production capacity and practices is essential for assessing its role in local and regional food security. It also helps in evaluating the sustainability of farming methods, ensuring they align with long-term environmental and health goals.

In summary, a farm's influence on the wider community encompasses sustainable land management, educational outreach, food security, and social integration. Understanding this impact promotes a more inclusive, resilient, and mutually beneficial relationship between farms and the communities they serve.

Food Production

Why we measure it?

We believe a farmer's foremost public service is providing nutritious food. Food is the cornerstone of our sustenance, and establishing robust, community-based food production is essential for both stable societies and individual well-being.

While understanding a farm's environmental influence is pivotal, it's equally important to assess its food output. Failure to do so might lead to an unintended scenario where farming successfully mitigates climate change and restores nature to our landscapes, yet falls short in meeting our food needs.

How we measure it?

We measure the food output of the farm in terms of energy output.

Farmers can add production data (crop/livestock and quantity) covering the last three cropping years. We use an FAO Food Composition table[124] to convert the food quantity into energy.

We calculate the average food produced annually (in energy), averaged per hectare to allow for more effective comparison between farms.

How we score it?

There is no industry standard for Food Production on the Exchange platform, but farmers can find this information on other platforms, such as AHDB.

The Exchange Benchmark will enable farmers to compare their annual average food produced (in energy/hectare) to all farms and other farms with similar:

- Geographies (counties)
- Enterprise classification

Land Access

Why we measure it?

Public access to farms in the UK is hugely valuable for several reasons. It serves as an educational platform, allowing people to gain insight into agriculture, food production, and rural life. This knowledge fosters a deeper understanding of the origins of food and the challenges faced by farmers.

It encourages the uptake of outdoor activities, promoting physical health, mental well-being, and a connection to nature.

Allowing public access to farmland also supports conservation efforts, as visitors appreciate and engage in initiatives for wildlife habitats and sustainable land management.

Ultimately, public access to farms bridges the gap between urban and rural communities, creating a more informed, engaged, and connected society.

How we measure it?

We do two things to calculate how much land access a farm offers to the local community:

- Firstly, we use third-party data sources from the UK government to see the extent of footpaths, byways, trails, bridleways etc that cross the farm. We use these datasets to give a figure in kilometres.
- Secondly, we allow the farmer to indicate any permissive byways they have created on their farm. These byways are added during the farm setup.

In Scotland, there exists the 'right to roam', so we assume all farms are effectively completely open to the public.

To find the total area of accessible land, we sum up the total length of paths from both methods. To allow for farm comparison, we calculate the length of accessible footpaths divided by the total number of hectares of the farm. This number is used for the Exchange Benchmark.

How we score it?

There is no industry standard for Land Access.

The Exchange Benchmark will enable farmers to compare their total length of accessible land/ hectare to all farms and other farms with similar:

- Geographies (counties)
- Enterprises classification

Community Engagement

Why we measure it?

Overall, community engagement events on a farm serve as a platform for education, cultural enrichment, economic stimulation and community building, creating a more informed and connected society.

Holding community engagement events on a farm fosters education and awareness about agriculture, allowing people to learn about food production, sustainability, and rural life. These events provide a first-hand experience of the farming process, enabling a deeper understanding of where food comes from.

Secondly, they promote a sense of community and belonging, bringing people together in a shared space. Such events can showcase cultural practices and traditions associated with farming, preserving local heritage.

Moreover, they stimulate economic activity, as visitors may purchase farm products and support local businesses. This not only benefits the farm but also contributes to the broader local economy.

How we measure it?

We collect this information through a short survey that the farmer completes, either alone or with the support of an Exchange advisor.

The survey covers:

- Community events
- School visits
- Open Farm Sunday
- 'Farmer Time' Programme
- Other community engagement

Once the survey has tallied up the number of Community Engagement activities, this figure is used for benchmarking. Farmers can assess their progress against the Exchange categories provided.

How we score it?

There is no industry standard for Community Engagement.

The Exchange Benchmark will enable farmers to compare the number of Community Engagement activities to all farms and other farms with similar:

- Geographies (counties)
- Enterprises classification

Contextual People and Society Information

Why we measure it?

In addition to the aforementioned metrics, we also provide a set of contextual information for each farm.

This information is designed to enrich the farmer's understanding of their farm's impact on People and Community, and also to understand opportunities for payments and improvements.

The contextual sub-metrics will be:

- Historic environment –
  - England: World Heritage sites, scheduled monuments, registered battlefields, registered buildings and registered parks and gardens
  - Scotland: World Heritage sites, scheduled monuments, listed buildings and registered battlefields.
  - Wales: World Heritage sites, scheduled monuments and listed buildings
- AONB (Wales, England and Scotland)
- National Parks (Wales, England and Scotland)

How we measure it?

All of these data points are collected using satellite imagery and third-party data.

How we score it?

There is no industry standard or Exchange benchmark for these datasets as they are only provided for context.

Zonation and Sampling

Soil Zonation

When soil sampling, it's fundamental that we capture an accurate picture of the different landcovers and soil types across the farm - but sampling the soils of every single field can be prohibitively expensive for the farmer. Our 'Zonation' methodology ensures we collect data that is representative of the whole farm and can be collected in a couple of days.

Simply put, Zonation is an automated process that groups areas of farmland with similar land cover, soil texture and soil grain size. This creates 'zones' with similar soil characteristics, meaning that a soil sample at any location within that specific zone acts as a proxy for the entire zone area. Our zonation algorithm factors in the field size and area of the zone(s) to ensure to sampling is achievable. There is no maximum limit to the number of fields a farmer can sample through the Exchange platform; indeed, the more samples they choose to take, the better the accuracy of the overall farm representation.

Soil Sampling

Soils are sampled throughout the year (taking the weather into consideration) avoiding fields that have been recently cultivated (within the previous 3 months) or had muck spread on them.

Once we have run the Zonation algorithm, we finalise this with the farmer based on their knowledge of the farm's variability and other practical considerations. We finalise the sampling fields with the farmer, based on the farmer's knowledge of the practicality of sampling; any activity that took place on the field that may bias the sampling; and their general understanding of the farm's variability.

A composite sample is collected from each sampling zone by traversing a 'W' across the zone. Cores will be collected from a zone, depending on its size. Two additional samples are collected perzone for a better understanding of soil health, earthworm count and VESS.

2.1 Zonation

Zonation is run using four layers: field parcel data (Figure 1), landcover, soil texture and parent material. The geoprocessing is done using overlay analysis, where landcover (Figure 2), soil texture (Figure 3) and parent material (Figure 4) layers are overlayed to parcels to create zonation (Figure 5).

Figure 1: Field Parcel Data

Figure 2: Landcover

Figure 3: Soil Texture

Figure 4: Parent Material

Figure 5: Zonation

Biodiversity Sampling Plan

Sample Area: Flora Diversity

To assess diversity of flora on a farm, we'll sample four different habitats:

1. Arable Margin (linear plot)
2. Hedgerow (linear plot)
3. Grassland (square plot)*
4. Arable In-field (square plot) *

Square sample plots are 5mx5m and linear plots are 1mx25m. For a hedge, this would include the flora around the base canopy.

The plots to sample are chosen by Exchange and the farmer.

*Grass and Arable square plots (5mx5m) might coincide (where appropriate/representative of the farm) with the fields already being visited for soil sampling.

Linear plots are also selected by the farmer/adviser, on the same hedgerows chosen for Hedgerow Structure samples. Ideally these hedgerows will be representative of the farm. The farmer/adviser then choose a start point for the 1mx25m sample.

Sample Area: Hedgerow Structure

The fields for Hedgerow Structure sampling are chosen by the farmer/advisor and indicated on the farm map.

All hedge lengths are assessed per field using the Exchange Hedgerow Marker feature, which allows for easy farm mapping and length calculation.

Hedgerow Structure can be assessed at the same time as Flora Diversity (left), using linear plot samples (1m x 25m per plot only for species) and including the base canopy.

End-to-End Farmer Journey

End-to-End Farm Process

To calculate a farm's impact on the environment accurately, Exchange collects farm data in three distinct ways.

- Firstly, we use third-party data to start to build a picture of the farm. In this stage, we start to collect data like landcover, soil type, number of hedges and average rainfall.
- Secondly, we conduct a series of surveys with the farmer to learn more about their farm habitats and farming practices. At this stage, we capture information on things like input usage, animal welfare practices and community engagement.
- Thirdly - and importantly - we collect lots of primary data from the farm. In partnership with the farmer themselves, our Exchange team collects soil samples; conducts hedgerow assessments; counts birds, plants and worms; and much more besides.

The process from a farmer signing up to a final report of recommendations can be broadly split up in the following steps:

1. Initial Farm Registration
2. Farm Map Setup
3. Sampling Plan
4. Surveys
5. Sampling Results
6. Report

1. Initial Farm Registration

The first stage is for the farmer to provide some general information on their farm.

This includes enterprise types, as well as assurance schemes.

2. Farm Map Setup

The second stage of getting set-up is adding the Farm Map.

To complete the Farm Map Setup, a farmer will need to:

- Have a Rural Payment Agency (RPA) Single Business Identifier (SBI) number, OR
- Have a shape file of their farm, OR
- Digitise their farm's geographic footprint using the drawing tools on Exchange, OR
- Use a combination of the three options detailed above

The Exchange team works with farmers to help them set up their farm and add/modify parcel information if required. We use farm mapping software and the UKHAB classification to indicate the landcover of a given parcel.

End of Step 2 (Results)

Once that data is loaded, this unlocks the 1) Farm Map, 2) Sampling Plan and 3) Funding Tool (for farm-dependent funding options).

On the Farm Map, we can visualise a series of overlaid data layers for the farmer that correlate to their farm. These data layers include:

- Soil texture
- Landcover
- Parent material
- Peat or mineral soils
- Land access
- All the contextual data listed in the document above (in Soils, Water, Social, Biodiversity)

Landcover is of particular importance, since using the UKHAB classification to mark out the habitats on your farm in more detail than is tagged in your existing SBI or Shapefile is important to get a picture of the farm. This habitat information informs many of the Exchange metrics, especially in the Biodiversity section, and it's important in helping your advisor to understand to provide recommendations and improvements.

A few metrics that are solely reliant on third-party data are automatically filled up – for example, water resource availability and groundwater status.

3. Sampling Plan

The third stage of getting a full Exchange Report is finalising a Sampling Plan that works for the farmer.

To ensure a seamless and efficient sampling process, the Sampling Plan ensures the Soils and Biodiversity measurement points are agreed before the farm visit.

Soils:

- The farmer/advisor runs Zonation to get a baseline of the best fields for sampling for a fair representation of the farm.
- The farmer/advisor can select different fields to sample in the same zone, based on practicality and recent farm practices.
- The soil sampling points are marked on the map and ready for data entry. For ease of the person sampling, we add Earthworm and VESS sample points on the same fields.

Biodiversity:

- The Flora sample points are chosen among the 4 habitats (Grassland, In-field Arable, Arable Margins and Hedgerows).
- The Hedgerow structure sample fields are chosen.
- All points are marked on the map ready for data entry.

4. Surveys

Once the Farm Map Setup and Sampling Plan have been completed, the farmer answers a series of surveys to help us better understand the farm.

These surveys include:

- Soils survey: This asks the farmer about the percentage of the year their farm soil is covered
- Water survey: This forms the basis for the farm's Exchange results relating to water runoff management and water usage
- Carbon emissions survey: Farmers need to use an emissions calculation tool - either Farm Carbon Toolkit or another provider
- Animal health and welfare survey: This asks the farmer about antibiotic usage and welfare outcomes of livestock on their farm
- Biodiversity survey: This asks the farmer about what practices they are engaging in to improve farm biodiversity
- Social survey: This gathers information on community engagement and food production surveys will feed into the Exchange report and benchmarks, so it's important they're completed as accurately as possible.

5. Sampling Results

Once the surveys are complete, the final stage of data collection is to input the Sample Data. Sample Data is collected directly on the farm and is fundamental to ensuring the Exchange report is an accurate representation of the farm. The farmer can either collect the data themselves or receive support from the Exchange technicians.

The following Sampling Data is required:

Soils:

- Collected in field: VESS, pH (Exchange technicians use probes but the farmer can also add this data through lab test results), Earthworm count
- Soil core samples sent to lab: Soil Organic Matter, Soil Organic Carbon, C:N Ratio, Total N, Bulk Density

Biodiversity (collected in field)

- Birds, Plants, Hedgerows Structure

5. Exchange Report

Once all the data has been collected, all results are reported back from the laboratory and all data entered onto the Exchange platform, a farmer will receive their Exchange Report.

The Exchange Report has two levels. We provide benchmarking against other farmers and with farmers that have similar characteristics relevant to the metric e.g. in the same county, the same kind of enterprise, at each level:

- Impact Area Level: Where all underlying Metric Level results are averaged to show how a farm is doing on a particular Impact Area (e.g. Soil or Biodiversity)
- Metric Level: Where all underlying Field Level samples are averaged to show how the farm is doing on a particular metric (e.g. Soil Organic Matter or Bird Species Abundance).

Once the farmer has received their score, they can use accompanying Exchange services to seek advice on how they can improve, and the financial incentives available for doing so.

Appendix

Metric	How we collect data	Comparison to V1.	Detail of change
Soil Organic Matter	Sampling	Changed	In Protocol Version 1, we provided a 1-5 score based on the Soil Organic Matter. The accuracy for this score was challenged, so we removed the score. Since there is no industry benchmark we are showing the data on the Exchange Benchmark only (compared to other Exchange farmers).
Soil Organic Carbon Stocks	Sampling	New metric	This is a new metric requested by farmers and the industry. We were not measuring this in Version 1.
Soil Structure: Bulk Density	Sampling	Changed	Adding Exchange Benchmarking (comparing against Exchange farmers on relevant criteria).
Soil Structure: VESS	Sampling	Changed	Adding Exchange Benchmarking (comparing against other Exchange farmers on relevant criteria).
Total Nitrogen and C:N Balance	Sampling	New metric	This is a new metric requested by farmers and the industry. We were not measuring this in Version 1.
Earthworms	Sampling	Changed	In Version 1, we only captured the number of earthworms. Version 2 provides far more information, by grouping them into ecological types and age distribution and recording last week's reported rainfall.
Soil Cover %	Farmer Survey	New metric	This is a new metric requested by farmers and the industry. We were not measuring this in Version 1.
pH	Sampling	Changed	In Version 1, we measured pH using a laboratory test from a soil sample to 30cm. This was both expensive and farmers had issues with its accuracy. The probe method in this protocol should improve both challenges.
Contextual Soil Information	Third-party Data	New Metric	This is a new metric requested by farmers and the industry. We were not measuring this in Version 1.
Water Storage	Third-party Data/Farmer Survey	New Metric	This is a new metric. In version 1, we had a metric called Surface Runoff Avoidance which asked a question around on-farm storage. In Version 2, we have created a new metric and are using RPA data and features for farmers to add in their water features on the map.
Nitrogen Balance	Farmer Survey	Changed	In Version 1, we measured Nitrogen Balance using Farm Carbon Toolkit. Their methodology had significant shortcomings and so have moved to using Planet.
Phosphate Balance	Farmer Survey	New Metric	This is a new metric requested by farmers and the industry. We were not measuring this in Version 1. We use Planet to calculate it.
Potash Balance	Farmer Survey	New Metric	This is a new metric requested by farmers and the industry. We were not measuring this in Version 1. We use Planet to calculate it.
Water Resource Availability	Third-party Data	Changed	In Version 1 we had one metric for Water Usage that combined Water Resource Availability, Groundwater status and Water Usage Actions. In Version 2 we have separated them for better understanding and visualisation.
Groundwater Status	Third-party Data	Changed	In Version 1 we had one metric for Water Usage that combined Water Resource Availability, Groundwater status and Water Usage Actions. In Version 2 we have separated them for better understanding and visualisation.
Water Usage Actions	Farmer Survey	Changed	In Version 1 we had one metric for Water Usage that combined Water Resource Availability, Groundwater status and Water Usage Actions. In Version 2 we have separated them for better understanding and visualisation. Based on feedback from Version 1, we've altered the scoring to make it independent of water availability status. This helps farmers understand the Water Usage Actions that they themselves can take: the factors under their control).

Contextual Water Information	Third-party Data	New Metric	This is a new metric requested by farmers and the industry. We were not measuring this in Version 1.
Crop and Livestock Diversity	Farmer Survey	Changed	In Version 1 of our Protocol, we measured Crop and Livestock Diversity in the Biodiversity Practices metric. We have since isolated these questions as a seperate metric.
Habitat Management	Farmer Survey	Changed	In Version 1 of the Protocol, we measured Habitat Management (listed as Habitat Measures) within the Biodiversity Practices metric. We have since isolated this as a seperate metric.
Biodiversity Connectivity Features	Farmer Survey/Third-party Data	New Metric	Version 1 of the Protocol included a metric relating to "connectivity of the landscape" which assessed the connectivity of woodland using a 100 km grid square moving window. Feedback from both advisors and farmers showed that this metric was too limited (covering native woodland over 2m in height only) and interpretation of the results was difficult: it was not clear how an individual farm could impact the connectivity score at a landscape scale. Version 2 of the Protocol therefore aims to find an alternative metric for connectivity which is more meaningful to the user/farmer, and more impactful in driving change in practice, or enabling access to alternative funding sources.
Space for Nature	Third-party Data/Farmer Survey	Changed	In Version 1 of the Protocol, the ratio of farmed to non-farmed land (based on landcover) was included as a metric. In Version 2 of the Protocol, we revised the metric as Space for Nature (in a farm context). In Version 2, we have also much improved a farm's ability to map its habitats by aligning to UKHab (to level 5) and allowing farmers to add in-field features as well as whole field designations.
Bird Species Abundance	Sampling	Changed	In Version 2 we have made some significant improvements to this metric. Instead of relying on a one-day sample, we can provide a more complete picture of the nearby bird species using data from NBN and GBIF. And by allowing the entry of verified third party data, we're able to enrich our data set and score farms more accurately. Furthermore, our Exchange benchmarking will enable us to better compare similar farms by taking into account weather and seasonality. Finally, we have changed the Benchmarking to better recognise farms that are providing the resources needed for endangered bird species.
Arable, Hedgerow, Field Margins and Grassland Flora	Sampling	Changed	In Version 2, we have improved the scoring to take better account of Arable Fields. Since Version 1, we have also added the ability to account for Flora diversity in Hedgerows and Field margins. We have also made the provision for farmers to add multiple data entries over the year, in order to capture seasonal differences.
Hedgerow Structure	Sampling	Changed	We have improved the scoring of Hedgerows in Version 2 by making it possible to collect information about hedgerow gaps.
Contextual Biodiversity Information	Third-party Data	New Metric	This is a new metric requested by farmers and the industry. We were not measuring this in Version 1.
Carbon Balance	Farmer Survey/Third-party Data	Changed	In Version 2, we have made it easier for farmers to use different carbon calculators to input their emissions scores
GHG Emissions	Farmer Survey/Third-party Data	Changed	In Version 2, we have made it easier for farmers to use different carbon calculators to input their emissions scores
Carbon Stored in Woodland and Forest: Stocks	Third-party Data	Changed	In Version 2, we have added the ability for farms to capture the sequestration data from newly planted or felled trees to indicate recent changes in their carbon stored in woodland.
Carbon Stored in Woodland and Forest: Sequestration			

Carbon Stored in Hedgerows: Stocks	Third-party Data	New Metric	Carbon stored in hedgerows was not captured at all in V1 of the Exchange protocol. It has been added in V2 following farmer feedback and its importance in helping them reach Net Zero.
Carbon Stored in Hedgerows: Sequestrations			
Carbon Stored in Soils: Stocks	Farmer Survey/Third-party Data	Changed	Version 1 did not have a methodology to approximate the sequestration potential of different agricultural practices in soils. Though still scientifically challenging, this has been added in V2 to support farmers in the adoption of more climate-friendly practices.
Carbon Stored in Soils: Sequestration			
Antibiotic Usage	Farmer Survey	Changed	Version 2 Protocol updates: Pigs, Broilers and Laying Hens with minimum score 3 range industry average from UK-VARSS (2022).
Welfare Outcomes	Farmer Survey	Changed	We've improved the scoring, and added benchmarking to this metric
Food Production	Farmer Survey	New Metric	This is a new metric requested by farmers and the industry. We were not measuring this in Version 1.
Land Access	Farmer Survey/Third-party Data	Changed	In Version 1 of the Protocol, we only analysed the third party data to demonstrate land access. By allowing farmers to also highlight their permissive byways, Version 2 better helps farmers demonstrate how their actions are opening up the farm to the public.
Community Engagement	Farmer Survey	New Metric	This is a new metric requested by farmers and the industry. We were not measuring this in Version 1.
Contextual People and Society Information	Third-party Data	New Metric	This is a new metric requested by farmers and the industry. We were not measuring this in Version 1.

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