Farm Carbon Toolkit

Carbon footprinting baseline for Wild Ken Hill

The current and future opportunities for Wild Ken Hill to achieve net zero and beyond

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Farm Carbon Toolkit

About us

The Farm Carbon Toolkit was created by farmers for farmers. For over a decade, we've worked to further the understanding of greenhouse gas emissions in agriculture. We provide tools and services to measure impact and projects that inspire real action on the ground.

Our vision is a farming sector that minimises its carbon emissions and maximises its carbon sequestration, whilst producing quality food and a wide range of public goods, all produced by resilient and profitable farm businesses.

Farm Carbon Toolkit

Report contents:

Project Brief: Overview

In every project, our mission is to a provide a practical, scientifically robust and accurate approach with guidance and outputs that are high-quality, accessible and easy to understand.

Farm Carbon Calculator

Our carbon calculator is a leading tool to help farmers and growers in the UK to measure, understand and reduce their carbon footprint. It has been recommended by the NFU to its members as one of just three leading carbon calculators.

Started in 2009, Farm Carbon Calculator (FCC) is designed to be user friendly, comprehensive and intuitive. It is the only calculator available that fully considers carbon sequestration on farm.

Calculations are made on a whole farm basis and give a total carbon balance that includes all greenhouse gas emissions from the business and all carbon sequestration in soils and biomass.

FCC can also be used as a decision making tool, thanks to the way results are calculated and displayed in real time. A business could model impacts of proposed management changes to understand the impacts on the carbon footprint of its business. To see more visit https://calculator.farmcarbontoolkit.org.uk/

The Project: The brief

1. Completion of carbon footprints for the farming operations, the commercial portfolio, Forestry and stewardship and any other activities taking place within the estate.
2. Creation of graphical summaries and reports detailing the carbon balance of each part of the business, and the combined impacts
3. Creation of the current carbon baseline for the estate highlighting the proximity to net zero and the steps that could be undertaken to reach it
4. Separation of the farm carbon footprint within the estate wide balance so that the farm can be scrutinised as a separate entity.
5. Provision of help and guidance through the process so that in future years the carbon position and balance can be updated by the estate team (with guidance if required from the FCT).

Methodology: Carbon calculator – the scope

The Farm Carbon Calculator ('the Calculator') is a farmer-led calculator which takes account of emissions and sequestration on the farm. The Calculator is peer reviewed and updated regularly; the latest version was released in January 2020 and includes a range of new functionality and factors which have been used with the report.

It is important to understand the scope of the calculations that are being completed. Within greenhouse gas accounting, emissions are categorised into three groups (scopes). Whether the calculation includes all scopes is important, especially when focussing on mitigation for the future. These scopes have been designed by the World Business Council for Sustainable Development. These scopes are defined in more detail.

Scope 1 – Direct emissions from sources that are owned or controlled by the company; for example, CO_2 emitted as a result of diesel used in tractors and farm machinery, gas for heating, land use change; N_2O from manure applications; CH_4 emissions from enteric fermentation.

Scope 2 – Emissions associated with the generation of purchased electricity used on the farm.

Scope 3 – indirect emissions associated with the production, processing and distribution of inputs into the farming system, e.g. bought in grain and compound feed, fertilisers, pesticides etc. This also includes embedded emissions in machinery, building materials and farm infrastructure.

The scope of the Calculator includes scope 1, 2 and 3 which allows it to calculate footprints in a comprehensive way and cover both direct and indirect emissions.

The Calculator Scope

The Calculator uses a farm gate approach to carbon footprinting, allowing all activities and enterprises that exist on the farm to be assessed within the calculation.
All inputs to the farm are included, including diesel, electricity, water, livestock feed, plant protection products, fertilisers and materials used throughout the year.

The emissions associated with producing these inputs are also included. Fertiliser emissions, for example, include the manufacturing process of the product as well as the emissions occurring from applying the fertiliser in the field. This allows the farmers to be able to take account of any sustainable sourcing practices, which could include, for example, the purchase of abated fertiliser.

The Calculator allows for the differentiation between sources of energy used on the farm; including whether a farm is generating or using renewable energy. If this renewable energy is exported to the grid, this is considered a carbon asset and can be used in offsetting the farm's emissions.

Although the calculator allows the inclusion of product distribution from the farm (for example cattle to the abattoir, milk to the processor etc), these have not been considered as part of this study. This is so that actions that are recommended focus on the areas that are within the farmer's control; logistics are often outside of possible changes.

The Calculator: Sequestration and Offsets

The Calculator allows an understanding of the carbon that is being sequestered on the farm through a number of different categories. Areas of on-farm woodlands, hedgerows, and in-field trees are all calculated and included.

Environmental areas on the farm that May be in stewardship schemes including buffer strips, field margins and permanent wetlands are also able to be included in the calculations.

Any renewable energy that is being produced and exported on-farm is considered a carbon offset and is accounted for within the calculator. Additionally, any waste generated on-farm which is recycled also provides a net benefit to the farm carbon balance .

Calculating soil carbon sequestration

Soil carbon sequestration is also a key part of the Calculator's modelling as it is recognised that soils are not just a large store of carbon, but also have the potential to sequester additional carbon as a result of management. This is an area with large potential impact, both in terms of positioning agriculture as a climate solution but also through the opportunity to improve the overall health and function of the soils, through improving the carbon content. Carbon is one of the primary drivers of soil health, providing the energy source which allows the soil to fulfil its ecosystem functions.

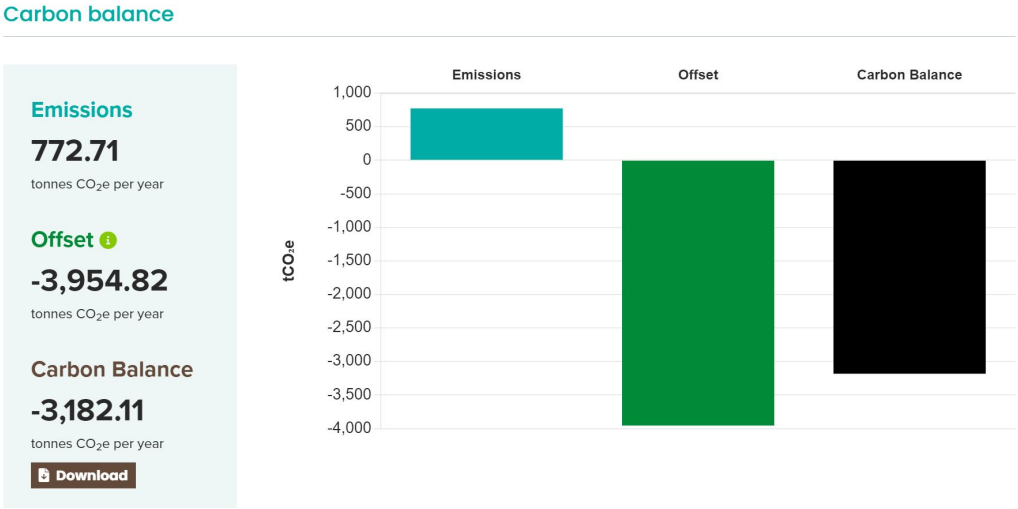
Soil carbon sequestration can be calculated when there are two sets of soil organic matter data which can be inputted into the calculator. The difference between the values is combined with information on sampling depth and bulk density to calculate the additional carbon that has been accrued in the accounting year.

The data
Carbon results

Results: Current Estate Carbon balance

The carbon balance for Wild Ken Hill is -3,182 tCO2e / year.

This figure can be expressed as a carbon balance per hectare of **-1.89 tCO2e/ha/yr** based on the 1684 ha the farm occupies. The farm is currently producing 1,472 tonnes of output predominantly through growing the crops on-farm. As such, the carbon balance can also be reported per tonne of product which is **-2.16 tCO2e / tonne** product.



Results: Emissions breakdown

The emissions from Wild Ken Hill total **772.71t CO2e.**

The headline carbon balance can be broken down into emissions and sequestration categories. Emissions categories can be seen in the table to the right.

Just over 37% of the emissions are coming from fertiliser use on-farm, with the livestock contributing a further 31%. Fuel use is the third highest category contributing 16%.

Material use and inventory (the carbon associated with buildings and machinery on the farm) are small contributors.

Emissions	tonnes CO_2e	%
Fuels	125.34	16.22%
Materials	21.31	2.76%
Inventory	13.20	1.71%
Crops	79.87	10.34%
Inputs	291.79	37.76%
Livestock	241.21	31.22%
Total	**772.71**	**100%**

Results: Sequestration breakdown

Total sequestration and offsets contribute -3,654t to the total carbon balance. This can be split into sequestration taking place in soils which is contributing 53.5% of total sequestration, the woodland contributing 32% and the stewardship options contributing 12%.

Offset	tonnes CO_2e	%
Countryside Stewardship	-481.13	12.17%
Habitats	-36.14	0.91%
Hedgerows	-47.89	1.21%
Other (E.G. Recycling)	-1.02	0.03%
Permanent Wetland	-2.21	0.06%
Soil Organic Matter	-2,117.41	53.54%
Woodland	-1,269.01	32.09%
Total	**-3,954.82**	**100%**

Results: Enterprise contribution

As can be seen from the table below, the Estate's carbon position is as a result of the good amounts of sequestration which are taking place within the woodlands, arable soils and habitats. It is important to understand the footprint of each sector so as to be able to develop a strategy for emissions reductions so that the carbon storage and sequestration that is taking place can be maximised.

Enterprise	Area	Total emissions (t CO2e)	Percentage of total emissions (%)	Total offset and sequestration (t CO2e)	Percentage of total offsets (%)	Carbon balance (t CO2e)
Arable	500.52ha	494.09	64%	-2,109.54	53%	-1,615.45
Stewardship	926.57ha*	257.31	33%	-564.48	14%	-307.17
Woodland	257.52ha	0	0	-1271.90	33%	-1271.90
Commercial		21.31	3%	0	0	21.31
TOTAL	**1,684.61**	**772.71**	**100**	**-3,954.92**	**100**	**-3,182.11**

*made up of 466ha arable, 445ha grassland option and 15ha WF03. Full details in the appendix

Results: Farming enterprise

The arable operations on the farm are contributing **494.09t CO2e** to the overall carbon footprint of Wild Ken Hill. The footprint has been calculated on the 500ha that is producing 1,456 t of arable crops. Emissions associated with their production is included (for example fuel and fertiliser) and sequestration that is accounted for here is from soil organic matter results. Soil sequestration is accounting for -532t CO2e across 168 ha.

The Carbon footprint can also be broken down into more useful KPIs which allow for some comparison with other arable enterprises. The carbon footprint per hectare and per tonne are common starting points.

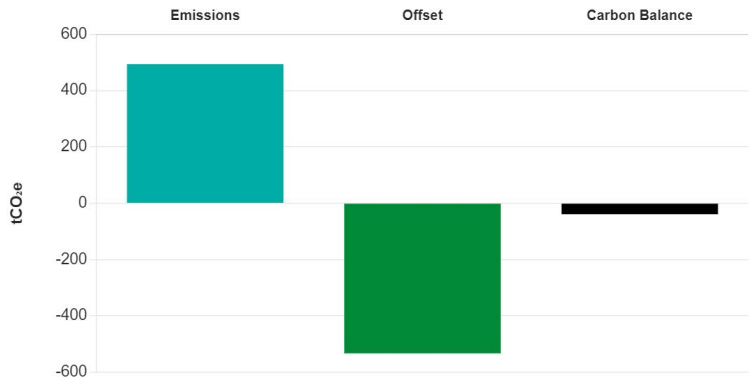
Carbon balance

Emissions
494.09
tonnes CO_2e per year

Offset
-533.03
tonnes CO_2e per year

Carbon Balance
-38.94
tonnes CO_2e per year

Download

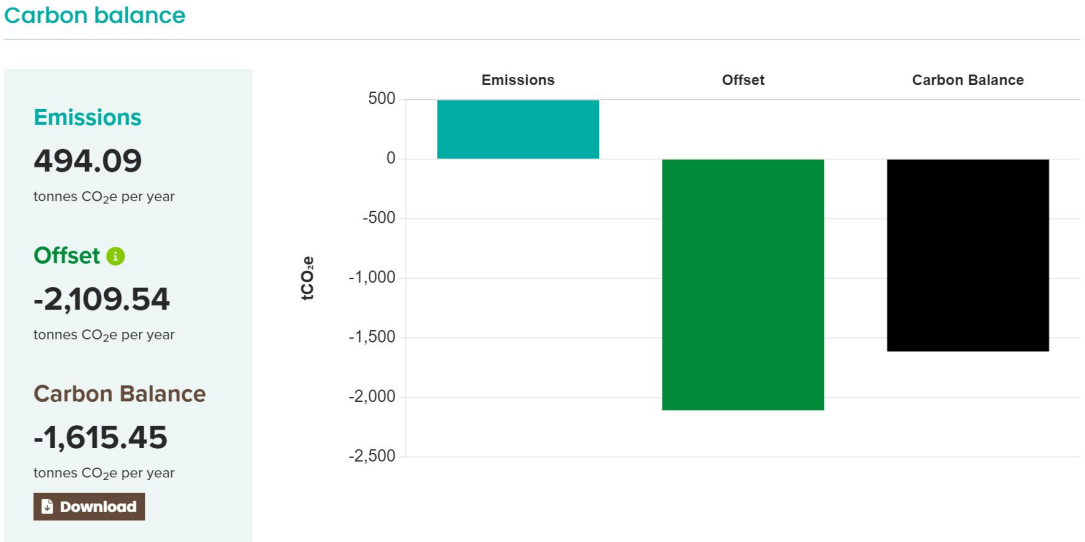


Carbon Balance / hectare:
-0.08
tonnes CO2e/hectare/year

Carbon Balance / tonne:
-0.0267
tonnes CO2e/tonne of product

Results: Arable Farming enterprise

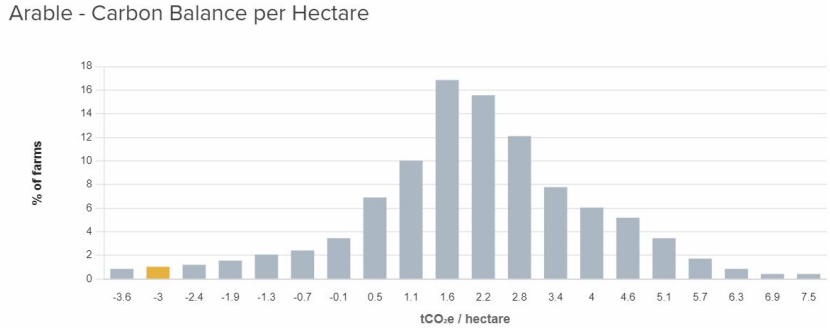
The previous slide reports the carbon balance for the arable operations including the soil sequestration data that has been tested using laboratory analysis. The data from the 8 fields with historical and current data has been taken as a representative sample of the farm and used as an average figure to provide insight into the sequestration across the whole arable platform. The analysis data reports an annual increase in soil organic matter of 0.05%. This figure has been inputted into the calculator for all the fields. The impact on the carbon balance of the arable enterprise can be seen.

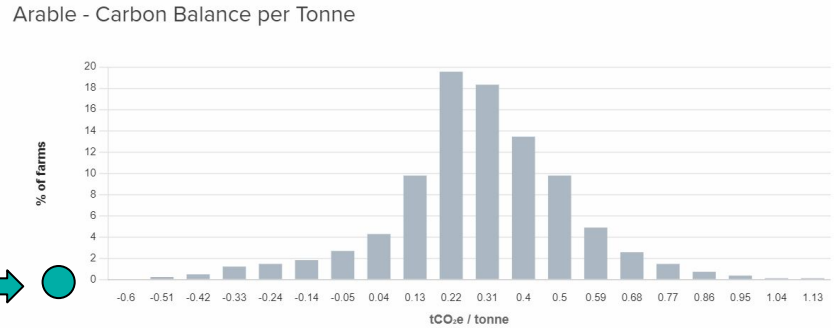


The carbon balance for the arable enterprise when sequestration in each field is included is **-1,615.45 t CO2e**. This equates to a carbon balance per ha of **-3.23t CO2e** and a carbon balance per tonne of **-1.11t CO2e**. The arable enterprise is sequestering more carbon than it is emitting and as such is carbon positive.

Results: Arable benchmarking

When comparing the arable enterprises with other farms that have completed the carbon calculator - the farm performs well. The carbon balance depicts the total emissions minus sequestration.
The benchmarked average for the carbon balance per ha for arable enterprises is **1.6t CO2e** (Wild Ken Hill is **-3.23 t** /ha). For the benchmarked figure per tonne, the average is **0.22 t CO2e** / t, again Wild Ken Hill is currently **-1.11 t** CO2e (completely off the benchmarking chart!)





The arable benchmarking performance

Emissions categories

Although overall carbon balances are a useful first step in terms of identifying the current position of the farm, if the footprint is to be scrutinised in any detail, it is important to understand where the current emissions are being generated from and where the hotspots are. Within the carbon calculator data is collected in 6 emissions categories which are explained below.

Fuels: diesel and fuel used in cultivations and farming operations, electricity usage

Materials: items that are used during the year as part of day to day farming operations – including consumables (silage wrap, spray cans, fencing, aggregates etc).

Inventory: the embedded carbon within the capital items on the farm, includes tractors and farm machinery and buildings. These items depreciate their carbon cost over 10 years.

Crops: emissions associated with annual crops grown on the farm. This category represents the nitrous oxide emissions as the residues from these crops break down.

Inputs: Emissions associated with fertilisers and agro chemicals which are used on the farm.

Livestock: any livestock that are on-farm depending on age and breed, manure management and any feed / bedding coming onto the farm.

Waste: Emissions associated with any rubbish that is not recycled

Emissions categories: Arable

The breakdown of emissions from the different categories can be seen in the table. These tables are useful to identify where GHG hotspots are and where efforts May be focussed in terms of emissions reductions. Emissions are dominated by Inputs which accounts for fertiliser and plant protection applications. This is followed by emissions from fuels which are the second highest category. Emissions from crops are the third highest category of emissions followed by inventory which accounts for the embedded carbon within capital items on the farm.

Emissions	tonnes CO_2e	%
Fuels	109.23	22.11%
Inventory	13.20	2.67%
Crops	79.87	16.16%
Inputs	291.79	59.06%
Total	**494.09**	**100%**

Emissions Categories comparison

The table below details the emissions categories from the arable enterprise at Wild Ken Hill, compared with the average emissions per ha values for arable farms within the Farm Carbon Calculator database.

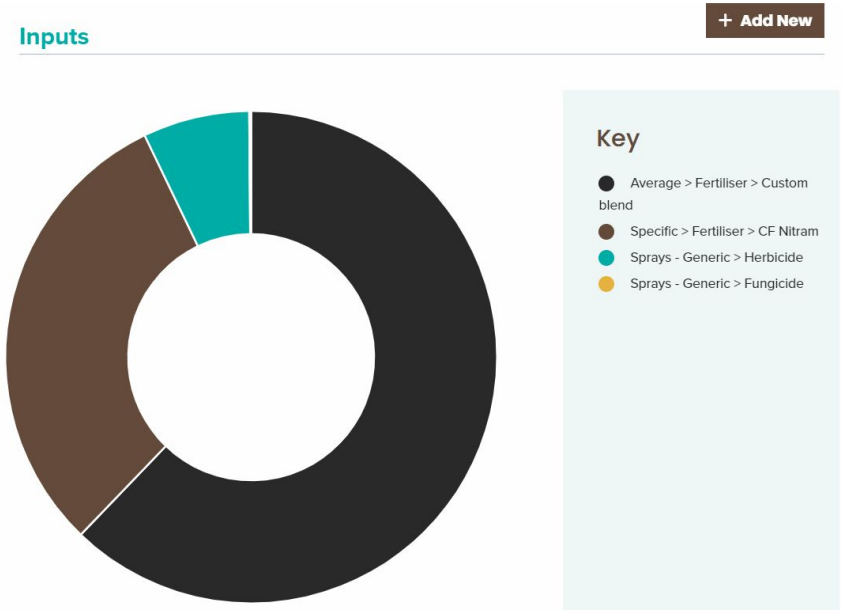
Emissions categories	Wild Ken Hill emissions (kg CO2e)	Wild Ken Hill emissions kg CO2e/ ha	FCC benchmarked arable average emissions kg CO2e / ha*
Fuel	109.23	0.22	0.56
Inventory	13.20	0.03	0.23
Crops	79.87	0.16	0.59
Inputs	291.79	0.58	1.51
Total	494.09		

*these benchmarking figures are based on a selection of 100 arable farms, the ability to do this level of benchmarking across the whole cohort is currently being built within the calculator.

Input emissions: Arable enterprise

Inputs represent a large carbon cost to the farm in terms of GHG emissions. Fertilisers, especially Nitrogen based compounds, have a high carbon footprint, as the Haber Bosch process is very energy intensive and produces nitrous oxide as a by-product. As such, emissions from fertiliser are always significant in carbon footprints. Within this carbon footprint, 35% of total emissions across the Estate (55% of the arable emissions) are coming from the use of Nitrogen and 4% from the use of plant protection products. Efficient use of Nitrogen is a key requirement for the future, both from an environmental perspective (Nitrous oxide is a very potent greenhouse gas) but also from an economic perspective.

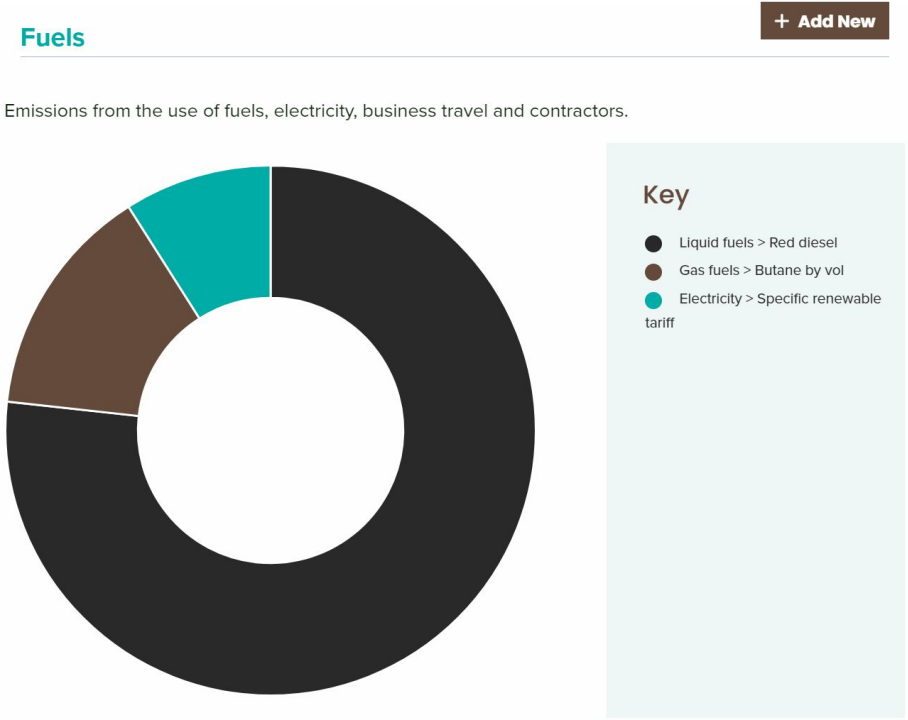
Nitrogen use is low across the arable enterprise with **0.32t** N used /ha. Whereas there May be limited opportunities to reduce Nitrogen further improving Nitrogen use efficiency should be a priority through improvement of soil health and biological function. Across the cohort of farms using the calculator, the benchmarked average Nitrogen use per ha is **0.78t N / ha.**



Fuel emissions: Arable enterprise

Fuel emissions total **109.23 t CO2e** and contribute 22% of total arable emissions.

Red diesel is contributing the majority of fuel emissions totalling 76% of the arable fuel emissions. The use of a green renewable tariff is providing a saving of 3.5 t CO2e. There May be potential for renewable energy generation on-site to further improve energy resilience. Fuel use per ha is very low for an arable operation and as such, is already showing a carbon benefit. Fuel emission per ha on the arable enterprise is **0.22t / ha**; the average fuel emission per ha across the arable farms within the calculator is **0.56t/ha.**



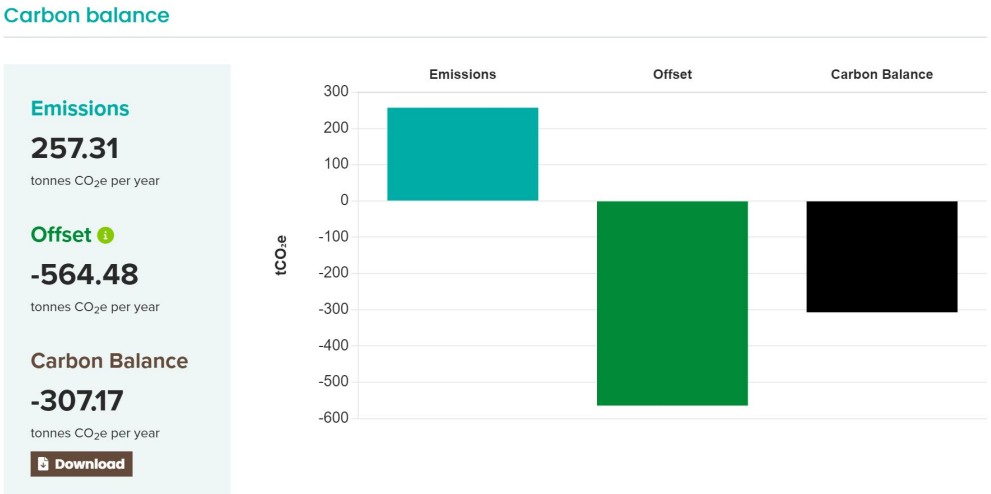
Sequestration: Arable enterprise

Farmers are in a unique position that they are able to sequester carbon on the farm. This sequestration can be generated through carbon held in soils, habitats, woodland, hedgerows and then offsets from renewable energy generation and recycling.

Within the arable footprint sequestration is occurring from soil sequestration. Soil sampling has not been completed by FCT as part of this project. There has been comprehensive soil sampling completed in 2015 using the LOI method. These results have been inputted into the carbon calculator to provide the baseline. Where additional results have been provided (and have been analysed using the same (LOI) method), these have also been incorporated into the calculations to provide an assessment of progress over time. It should be noted that changing analysis method is not recommended if results are to be compared. Where the soil data has been added to the calculation, a bulk density of 1.2 g / cm3 and a sampling depth of 20cm has been applied. Currently sequestration through soil is accounting for **532t CO2e** which helps to turn the arable enterprise from a net emitter to a net sequesterer.

Carbon balance for stewardship activities

The carbon balance of the stewardship activities at Wild Ken Hill is **-307.17t CO2e**. This footprint represents the performance of the 65km of hedgerows, the 7.57ha of hedgerow margins, the 459 ha of arable options*, the 445 ha of grassland options (including the wood pasture), the coastal park and the 15ha of wetland present across the Estate. A full breakdown of the numbers and options used is available in the appendices.



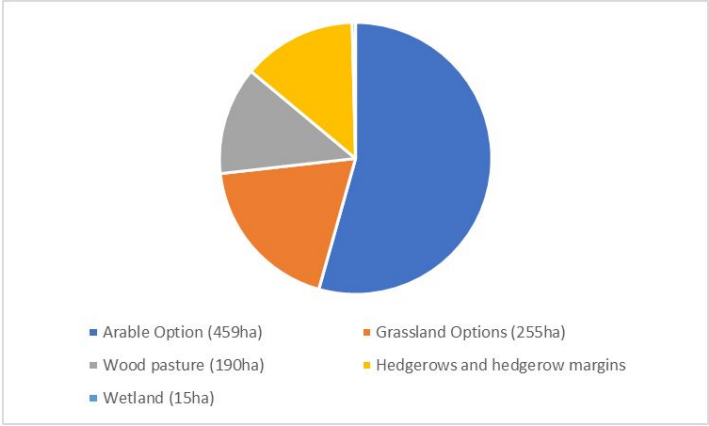
*including SW1 and SW6 options

Emissions from stewardship

Emissions within the stewardship footprint arise from fuel use (which is predominantly concerned with managing the habitats) and the livestock which are used to graze the grassland options and wood pasture. The livestock have been added in their various groups; the owned livestock have been added in total, the livestock which are grazed on licences have been added using a pro-rata system to account for their impact when they are on the Estate.

The emissions from the livestock system are solely from the animals themselves, there is no additional feed / bedding required as the owned animals are outside grazing all year round and the additional stock are housed on other farms and are outside the scope of this report.

Emissions	tonnes CO_2e	%
Fuels	16.11	6.26%
Livestock	241.21	93.74%
Total	**257.31**	**100%**



Sequestration from stewardship

The stewardship enterprise is currently providing **-564.48 t CO2e** of sequestration through the various habitats that are found across the Estate. The data that is used to populate the habitats and countryside stewardship data originates from work completed by Natural England which classifies various habitats according to their environmental features and assigns a carbon value to them.
Currently arable options are providing 55% of total sequestration with grassland options at 17.6%.
It should be noted that as well as providing carbon benefits, these areas will also be contributing to wider biodiversity and habitat creation options which help with other sustainability objectives.

Offset	tonnes CO_2e	%
Countryside Stewardship	-481.13	85.23%
Habitats	-33.24	5.89%
Hedgerows	-47.89	8.48%
Permanent Wetland	-2.21	0.39%
Total	**-564.48**	**100%**

Carbon balance from Woodland

The carbon balance from the 257.52ha of woodland across Wild Ken Hill Estate is **-1,272t CO2e** which equates to a carbon balance of **-4.95t CO2e/ha.**
The values included in the carbon calculation have been modelled using average values which are based on broad categorisation. To improve the accuracy of this data in the future, it May be useful to use the detailed woodland categories which reflect the species and age of the woodlands as is the protocol for the Woodland Carbon Code. Management of woodlands will ensure a balance of carbon storage and habitat quality as woodlands mature.

There are variations between the sequestration ability of different tree species and any additional woodland planting that is planned should consider (alongside site suitability and end use) the carbon value that new plantings provide.

Emissions

0.00

tonnes CO_2e per year

Offset

-1,271.90

tonnes CO_2e per year

Carbon Balance

-1,271.90

tonnes CO_2e per year

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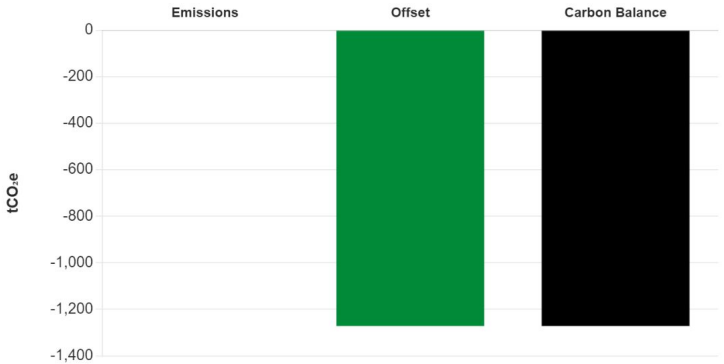
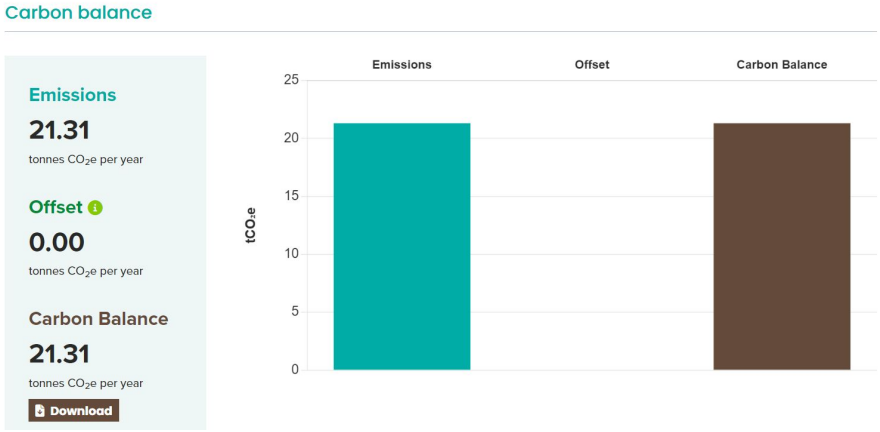


Carbon balance from commercial / residential

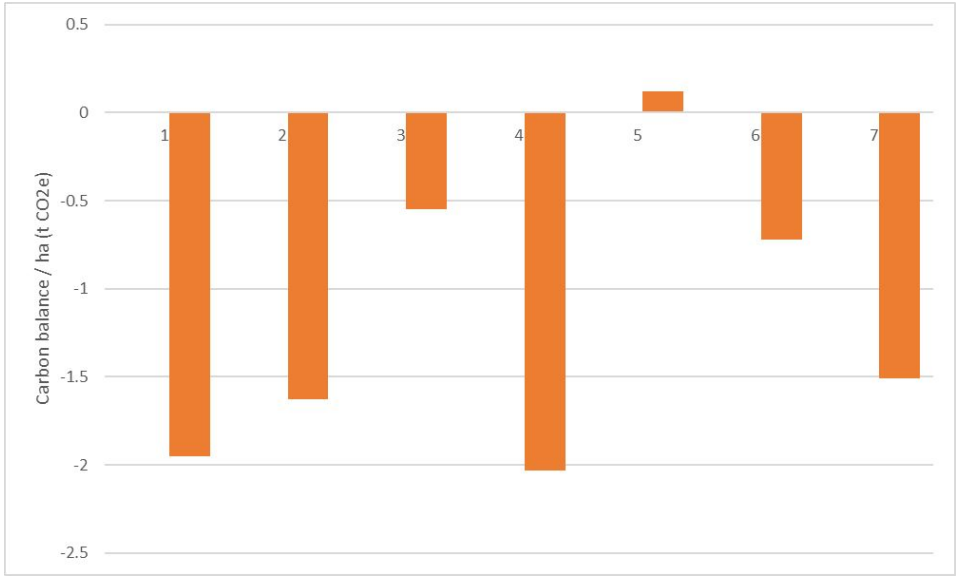
The carbon balance below depicts the current carbon position of the commercial activities happening at Wild Ken Hill through the residential portfolio. The carbon balance is currently **21.31t CO2e.**

To calculate this footprint, figures have been used that are an average of materials required for maintenance of properties. Through looking at the EPCs for the portfolio, there are areas that could be improved in the future which helps with the energy efficiency of the properties, which can be used against the tenant's carbon footprint.



Benchmarking: Estate wide

Whilst it is very difficult to compare carbon performances across estates, due to the diversity of different enterprises residing within them, the graph below highlights the performance of other Estates currently. Wild Ken Hill is represented by number 1 on the graph. The footprints have been shown using the carbon balance per hectare to allow for different land areas.



Where next?

Discussion

Carbon accounting is the vital first step in being able to document the position of a farm in terms of emissions, sequestration and what this means as a carbon balance. However, undertaking a carbon footprint should be the first step in being able to identify some key mitigation strategies that can be implemented on the farm to reduce emissions and improve sequestration opportunities for the benefit of the business as well as the environment.

The process of carbon footprinting allows the farm to be scrutinised in terms of its resource use efficiency; as such, there are normally many opportunities to improve resource use, and cut the emissions. These are usually practises that can be implemented in the short term, with minimal cost to the farmer (indeed, sometimes a cost saving) and using proven technologies. Wild Ken Hill Estate is already implementing some management practises that reduce emissions and improve soil health. It is important to recognise this progress before assessing future opportunities.

The purpose of the carbon footprint modelling is to be able to assess progress accurately against net zero goals for Wild Ken Hill Estate.

Wild Ken Hill Estate is already at net zero.

The arable enterprise is already carbon positive

The inclusion of soil sequestration data

Soil underpins the entire farm system. Healthy, well-managed soils support productive and healthy crops and pasture, which in turn support a profitable and resilient farming system. A soil that accumulates organic matter will sequester carbon, increase fertility and increase productivity.

Improving soil carbon sequestration is a fundamental part of ensuring optimal levels of carbon within the soil, which are contributing to healthy and resilient farming systems. As well as providing a climate change solution which is unique to agriculture, increasing soil organic matter has a number of co-benefits including improving water holding capacity, improving nutrient use efficiency and soil fertility, as well as supporting biodiversity.

It is important to differentiate between the carbon stock within the soil and the additional carbon that can be sequestered as a result of management, which can be used as a genuine offset solution. While it is important to protect the existing carbon stocks that are found within farm soils, it is also important to understand the potential for these fields to continue to sequester additional carbon and the management practices that contribute to the change.

By continuing to include soil analysis for organic matter - improvements in soil carbon can be documented and included in future footprints providing evidence of the progress that is taking place across the Estate with soil health.

Development of on-farm carbon assets

Managing existing on-farm woodlands through development of management plans (to highlight areas for coppicing, trimming and replanting) can enhance the existing carbon storage potential of woodlands and should be prioritised before planting additional trees. While it is recognised that trees and woodland provide key functions in water management, flood management and carbon sequestration, any additional tree planting should ensure that the correct species are planted and that they are planted at suitable sites.

There are a large number of hedgerows present across the estate. There Maybe scope to manage them as a feature for carbon and biodiversity by cutting them less frequently, which encourages growth of additional biomass (sequestering additional carbon).

Each additional 100m of hedgerow can sequester an additional 70kg of CO2e when it is trimmed annually, and 450kg when it is left longer.

Reduction in Nitrogen usage

Emissions from fertiliser represent a large carbon cost to the farm in terms of GHG emissions. Fertilisers, especially Nitrogen based compounds, have a high Carbon footprint. There are two reasons for this; the process of manufacturing fertiliser is very energy intensive (with a high carbon footprint). The manufacturing process can also generate nitrous oxide (a potent GHG) as a by-product. Once the fertiliser is applied in the field, it is at risk of being lost, depending on weather and soil conditions, through a number of pathways, one of which is nitrous oxide emissions. These are the main reasons why emissions from fertiliser are always significant in carbon footprints. There are savings to be made through regular soil testing, correcting soil pH (to ensure that applied fertiliser is able to be taken up by the plant efficiently), integrating the use of manures with fertiliser and incorporating more legumes where possible into improved pastures (which will fix atmospheric nitrogen).

Fertiliser also represents a large cost to the farm, both financially and environmentally, so any measures that can improve nutrient use efficiency on the farm will be beneficial. In studies that have focused on management practices that are beneficial to the environment, nutrient management planning is always identified as a key practice to adopt. Ensuring that the right product is applied at the right time to meet crop demand will benefit GHG emissions, water quality, biodiversity and the farm's profitability.

Further opportunities to reduce emissions

Although the farm is already implementing some management options which are low in emissions, there are other mechanisms which could be employed to reduce emissions further.

These could include:

- Switching to a fully **renewable electricity** tariff for electricity used on-farm.
- Generating renewable energy on-farm, there is currently no generation taking place
- Improve **fuel efficiency** - a 5% annual reduction in fuel use would provide a carbon saving of 15.76 t CO2e/yr.
- **Fertiliser usage** - There could be further opportunities to reduce Nitrogen use through the further use of leguminous cover crops to catch atmospheric Nitrogen for crop uptake.
- Regular soil testing to allow for accurate assessment of soil carbon sequestration within the business.
- Enhanced woodland management to optimise carbon sequestration within the wooded areas of the farms.

Conclusions

The activities that have taken place as part of this project are hopefully just the start. It is encouraging to see the current carbon position of Wild Ken Hill Estate as positive. Carbon assessment is the first step in understanding the current position of the farm and businesses across the Estate and provides a baseline, but continued efforts in terms of taking the carbon footprint and implementing some of the actions suggested will continue to help the Estate to transition to a position which is more resilient and restorative.

Appendix 1a - areas for stewardship calculations

Land Use option classification	Code	Area (ha)
Arable	AB6	62
Arable	AB8	10.25
Arable	AB9	16.78
Arable	AB10	20
Arable	AB11	58
Arable	AB14	17
Arable	AB15	18
Arable	AB16	6
Arable	SW6	159
Arable	SW1	24
Arable	HS9	68
Arable	Hedgerow margins	7.57
TOTAL		**466.6**

Appendix 1b - areas for stewardship calculations

Land Use option classification	Code	Area (ha)
Grassland	GS7	4
Grassland	GS8	4
Grassland	GS9	79
Grassland	GS10	53
Grassland	GS13	76
Grassland	GS14	39
Grassland	WD5	47
Grassland	WD6	143
Total Grassland options		**445**
Hedgerows	Hedgerows	65.25km
Permanent wetland	WF03	15ha
TOTAL (grass / arable / wetland)		**926.6**