Measuring your carbon impact

Which is the right tool?

Kite Consulting | Rachael Madeley Davies | June 2021

Foreword
from Andy Warne, Managing Director National Milk Records

Livestock farmers identify themselves by how many animals they have or acreage of the farm but rarely with their farm carbon emissions, and how they represent the Scope 3 emissions of their supply chain. What are Scope 3 emissions and why are they important? The most widely-used international accounting tool, the Greenhouse Gas (GHG) Protocol defines emissions into direct or indirect. Scope 3 emissions include all indirect emissions that occur in a company's value chain, which means retailers must account for the emissions on the livestock farms which supply them. Livestock farmers will be responsible for measuring their carbon emissions and be held accountable for them. It might be a while before the size of a livestock farm is defined commonly in their annual tonnage of carbon rather than the number of animals or acreage but it is coming and livestock farmers must begin to familiarise themselves with the currency of carbon.

This journey has already begun with Arla UK publishing a report based on the carbon footprints of all their individual farmer suppliers, showing an average carbon footprint of 1.13 kg CO_2e / litre. At the same time TESCO has stiplulated that their Sustainable Dairy Group has to have a maximum threshold of 1.4 kg CO_2e / litre for 2022.

I am personally very keen that farms begin to begin to take back control of this space. Quite rightly retailers and processors have taken the lead in measuring farm carbon footprints however this leaves the farmer in a weaker position in terms of data ownership. Over time I believe farmers will want to take responsibility for their own measurement of such a key parameter.

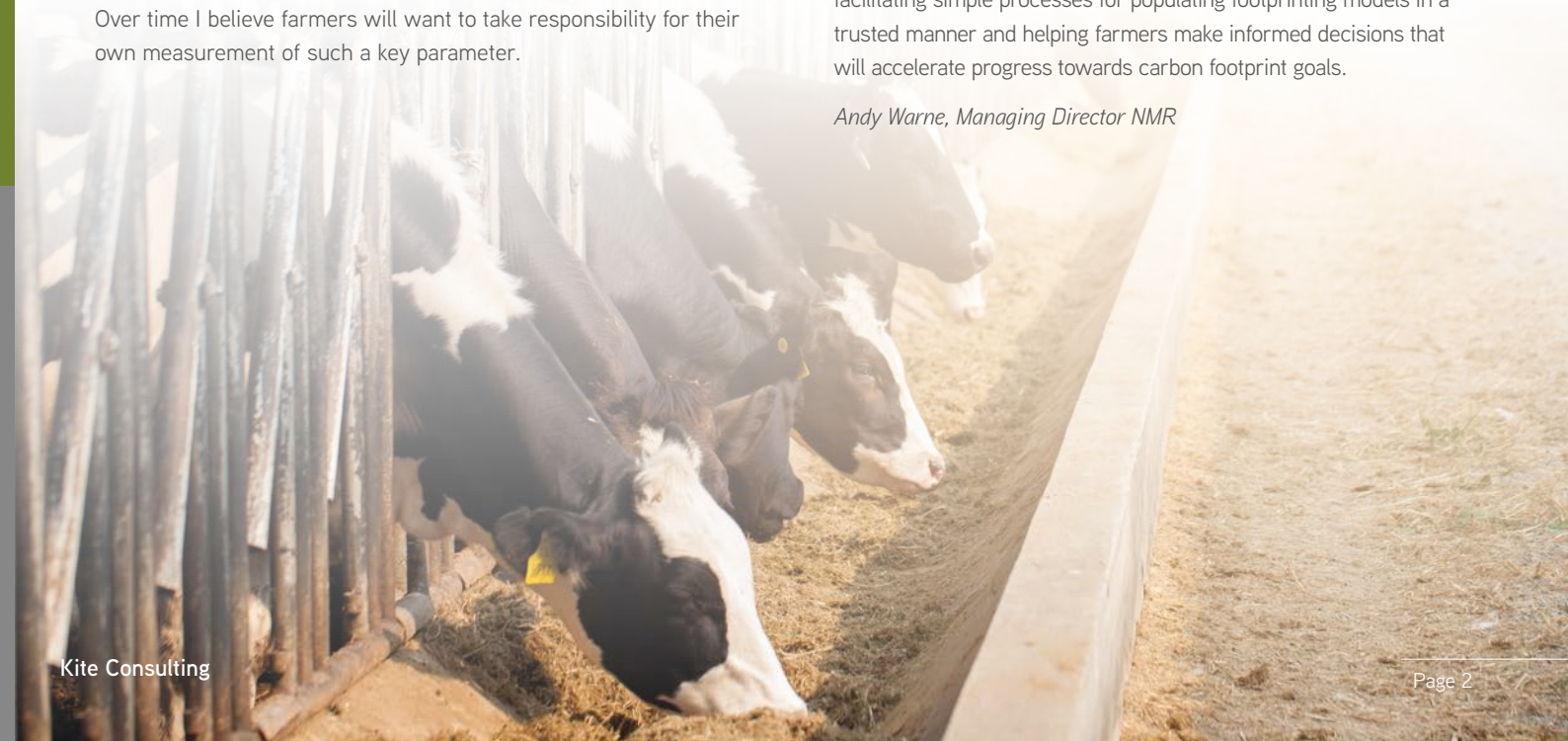
The Government has committed to achieving net zero by 2050, with pressure on agriculture and the land use sector to play its part in decarbonisation. A range of mitigation strategies on farm will be required for agriculture to decarbonise, but of course the adage of 'if you can't measure, you can't manage' rings true with respect to carbon footprinting.

Anecdotal reports of different carbon footprint outcomes from different calculators used on the same farm highlights the risk of confusion and disengagement by the industry and as a result NMR has commissioned this report to inform farmers, advisers and stakeholders.

Calculating carbon impact has been described as the 'Wild West' and seen as a bit of a gold rush for some suppliers. NMR already holds a significant proportion of the herd technical data, such as fertility, health and longevity, required by carbon calculators. NMR believes it has a role to play in trying to bring some order to the sector. This review highlights the potential challenges and pitfalls associated with measuring carbon footprinting that need to be taken into account when considering the approach to meeting the net zero target. It also makes some recommendations on how the sector needs to adopt some common principles and measures to ensure progress can be tracked effectively over time.

As an information provider NMR looks forward to working in the field of sustainability by providing standard data that is robust and reliable, facilitating simple processes for populating footprinting models in a trusted manner and helping farmers make informed decisions that will accelerate progress towards carbon footprint goals.

Andy Warne, Managing Director NMR



Executive summary

- The measurement of Scope 3 emissions is becoming commonplace.
- There is much for farmers and stakeholders to learn about carbon footprint measurement – carbon footprinting will in time become a key metric for ruminant enterprise performance.
- There is a debate around GWP* as the preferred metric, but the situation is constantly evolving.
- The industry needs to acknowledge the dynamic nature of carbon footprint assessment – if the UK ruminant sector can keep ahead of the curve there is scope for the sector to secure competitive advantage in domestic and export markets. Equally failure to engage will lead to a lack of confidence in the sectors ability to rise to the challenge of emission reduction.
- Key to effective carbon footprint measurement is having access to reliable data from trusted sources. There is a requirement for standardisation in calculations and assurance in data quality.
- Each of the calculators assessed have different strengths and weaknesses – such that the choice of calculator needs to be based on the purpose of the calculation. For example, if the carbon footprint is by product, whole farm or both.
- The technical performance of both dairy and beef herds can have a marked impact on the outcome. Achieving high levels of efficiency in production will in itself deliver gains in terms of carbon footprinting
- Carbon footprinting methods are likely to continue to evolve rapidly. The challenge facing the industry will be to ensure that users are able to act effectively on the information provided, following best practice management techniques, which themselves may well evolve over time.

Recommendations

- There is a need for industry collaboration to ensure a common approach in the definition of measures.
- The industry needs to acknowledge the range in data quality used to populate carbon footprint tools, regardless of the tool. If the data used to populate the tool is not reliable, the output of the tool will be worthless.
- It is crucial to utilse recognised, pre-existing data sources and enable carbon calculators to automatically access the data in order to minimise farmer data entry.
- Farmers will need support in establishing short, medium and long term plans for sustainability at farm level. In the same way as herd health plans are overseen by the farm vet, sustainability plans should be overseen by an experienced adviser.
- Farmer engagement requires the farmer to acknowledge that they can make progress in addressing their footprint quickly. In this context all models should highlight the scope for improvement through improved cow management.

Introduction

There are multiple drivers accelerating the need for food and drink supply chains to decarbonise, the first step in this journey must be to establish a carbon emissions baseline at farm level to assess the current level of emissions and to enable targeted decarbonisation of key areas.

This report will independently assess the available carbon calculating tools applicable to ruminant agriculture in the UK, highlighting their data requirements, ease of use, methodology and how their results can assist on-farm decision-making.

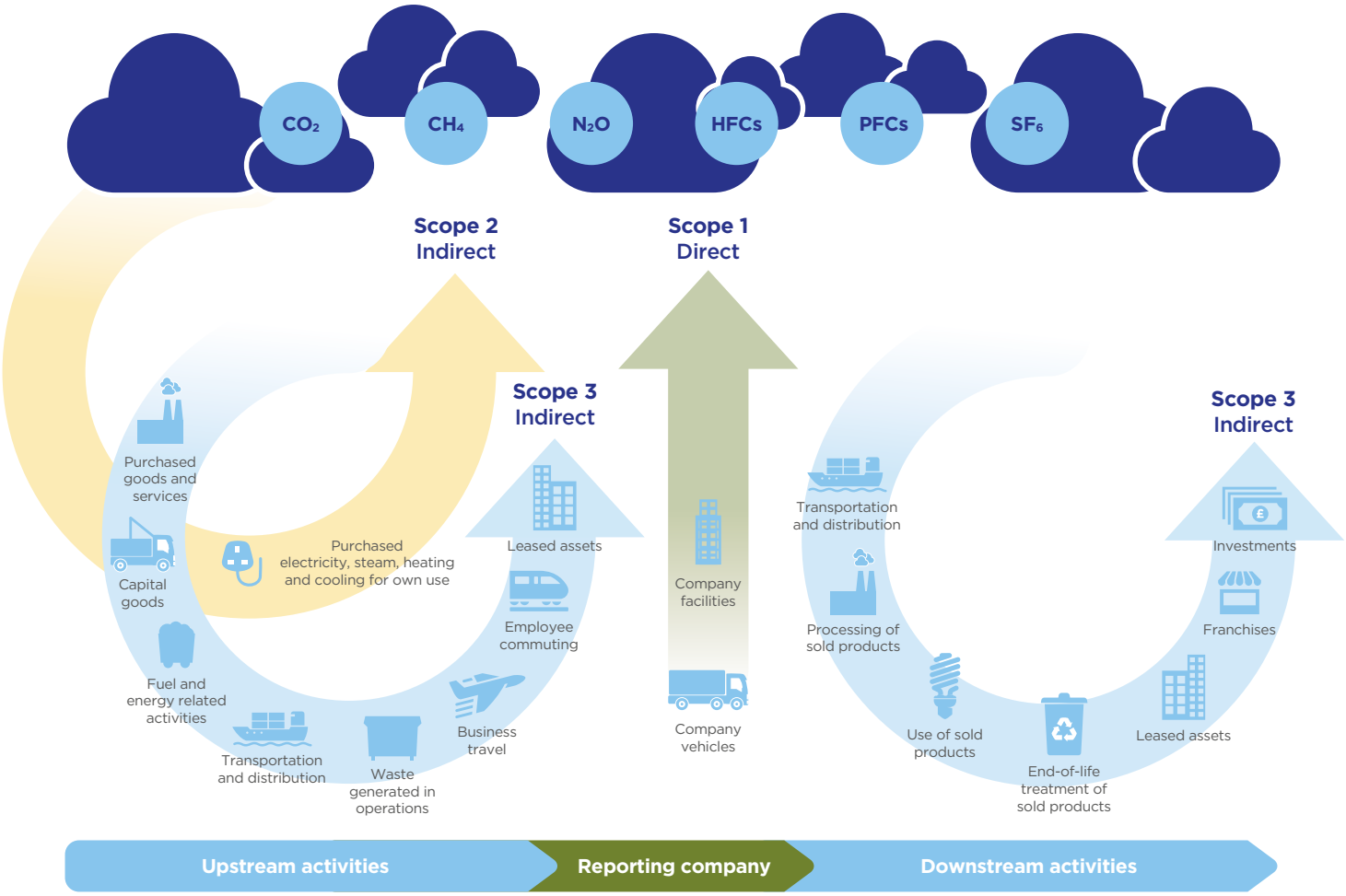
This assessment covers the tools that are relevant to UK ruminant farmers and are currently, or soon to be, available.

What is driving the need to measure?

Scope 1 and 2 reporting methodology will be familiar to companies of a certain scale[1], but Scope 3 represents a substantial shift in emissions reporting that aims to encourage big companies to essentially become responsible for their entire value chain emissions and incentivises them to pressurise suppliers or distributors to make progress on decarbonisation efforts.

This brings substantial challenges, particularly for industries like agriculture where emission calculations are already a complicated issue and supply chains are complex and diverse. Figure 1.1[2] gives an overview of what each Scope includes.

Figure 1.1: Overview of GHG Protocol scopes and emissions across the value chain



Graphic modelled on https://ghgprotocol.org/sites/default/files/standards/Corporate-Value-Chain-Accounting-Reporing-Standard-EReader_041613_0.pdf, page 5.

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Scope 3 is defined as *'any emissions that occur as a consequence of your organisation's activities but that aren't owned or controlled by your organisation'*[3]

Currently, the only mandatory Scope 3 reporting is 'energy use and emissions from business travel in rental cars or employee-owned vehicles (where they pay for the fuel)'[4], but there is strong encouragement to go further.

Large food businesses and retailers are already focusing on voluntary Scope 3 data collection from their food suppliers and agricultural supply chains, with a view to reporting broader Scope 3 data annually. This is because agriculture, and particularly ruminant livestock production, is in the spotlight because of overall greenhouse gas emissions. It is anticipated that this will become mainstream across processors and retailers in the years ahead, even if it is not mandatory under legislation, and so all food and farming businesses need to be mindful that supply chains will be asking for energy and carbon data as it becomes a competitive issue in the future.

This is because Scope 3 represents a massive section of a company's total emissions. For example, Kraft Foods identified that 90% of its emissions fell under Scope 3 and estimates suggest it will account for between 80% and 97% of total emissions for a large business[5].

Which emissions are we focusing on?

There are six major greenhouse gases that are recognised: carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, and sulphur hexafluoride, with carbon dioxide responsible for the bulk of emissions with methane and nitrous oxide also being important in the agricultural context.

In the UK, agriculture was responsible for 10% of total emissions in 2018[6] with 70% of total nitrous oxide, 49% methane and 1.6% carbon dioxide[7] emissions coming from agriculture. It is calculated that there has been a 16% reduction in the emissions in the industry from 1990 to 2018[8].

Nitrous oxide emissions largely stem from emissions from agricultural soils, with 56%[9] of the total 70% in 2018 thought to stem from agricultural soils. Agricultural emissions of nitrous oxide are largely associated with manure and nitrogen (N) fertiliser application with nitrous oxide being generated because of a microbial process within soil on which it is applied, this accounts for direct emissions. Indirect emissions are caused by leaching or 'run-off' from the area of application.

Agriculture is estimated to be responsible for 49% of the UK's total methane emissions in 2018[10]. Most agricultural methane emissions come from enteric fermentation which is the digestive process where both ruminant and non-ruminant livestock break-down plant matter, with the methane being the by-product. The decomposition of manures under anaerobic conditions also contributes to agriculture's methane emissions, with storage and application affecting emission rates.

UK agriculture's total carbon dioxide emissions predominately relate to fuel and electricity usage, as well as the manufacture and production of feeds and fertiliser. Soil cultivation can also affect carbon emissions.

Nitrous oxide is regarded as the most potent greenhouse gas as it absorbs more energy than methane, which in turn absorbs more than carbon dioxide. To arrive at a standardised measurement of the three gases, the system of GWP_{100} (100-year Global Warming Potential) has come into common usage and values published by the IPCC. This system converts these gases into a common metric of Carbon Dioxide Equivalent (CO_2e), which estimates how much energy gases will be absorbed over 100 years.

1) https://www.gov.uk/government/publications/academy-trust-financial-management-good-practice-guides/streamlined-energy-and-carbon-reporting#who-needs-to-report-and-where

2) Greenhouse Gas Protocol, 'Corporate Value Chain (Scope 3) Accounting and Reporting Standard', https://ghgprotocol.org/sites/default/files/standards/Corporate-Value-Chain-Accounting-Reporing-Standard-EReader_041613_0.pdf pp. 5

3) https://www.neechamber.co.uk/our-members/news/secr-your-2021-checklist

4) https://www.neechamber.co.uk/our-members/news/secr-your-2021-checklist

5) https://secrhub.co.uk/scope-3-emissions-your-frequently-asked-questions/

6) https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/862887/2018_Final_greenhouse_gas_emissions_statistical_release.pdf

7) https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/941991/agriclimate-10edition-08dec20.pdf

8) https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/862887/2018_Final_greenhouse_gas_emissions_statistical_release.pdf

9) https://naei.beis.gov.uk/overview/pollutants?pollutant_id=5

10) https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/941991/agriclimate-10edition-08dec20.pdf

CO_2 Equivalent of GHGs[11]

Gas Name	Symbol	1 kg in CO_2 equivalence
Carbon Dioxide	CO_2	1 kg CO_2
Methane	CH_4	25 kg CO_2
Nitrous Oxide	N_2O	298 kg CO_2

A modified calculation of the GWP_{100} has been developed called GWP*[12] which recalculates emissions reflecting that certain greenhouse gases (GHGs) are short-lived and 'break-down' over time and therefore cannot be treated as an equivalent to CO_2 as in the GWP_{100} calculation. Methane does not have a worsening effect on the climate but in fact declines over time, and so using the GWP* metric improves the overall carbon assessment of agriculture given the proportion of methane emissions attributed to agriculture.

Currently most carbon assessment tools use the GWP_{100} metric for their calculations. There is a movement to see GWP* recognised as a more accurate metric but will require global agencies to adjust the advice published now for over 10 years.

Data

Irrespective of the tool used the most important factor is the capturing and the subsequent availability of accurate, timely and specific farm data. It is essential that all farms start to understand the data required to ascertain their carbon impact and utilise pre-existing data sources where possible.

It is understanding, at farm level, the role that accurate data plays and that effective carbon calculations and therefore reductions require precise data in the first instance.

Data readiness on ruminant livestock farms requires careful consideration due to the multiple data sources and sometimes fractured supply chains. Utilisation of pre-existing data sources needs to be exploited with farm carbon calculating tools making use of such sources.

Dairy farms are largely in a 'stronger' position due to multiple data points, benefiting from more frequent data gathering along with a stream-lined supply chains, particularly those on an aligned contract. However, red meat livestock supply chains have the potential for being more challenging due to the amount of data already collected and available on farm, the fragmented nature of the supply chain, the fact that ruminants often move from farm-to-farm prior to slaughter.

11) https://ec.europa.eu/eurostat/statistics-explained/index.php/Glossary:Carbon_dioxide_equivalent#:~:text=A%20carbon%20dioxide%20equivalent%20or,with%20the%20same%20global%20warming

12) Allen, M.R., Shine, K.P., Fuglestvedt, J.S. et al. A solution to the misrepresentations of CO_2-equivalent emissions of short-lived climate pollutants under ambitious mitigation. npj Clim Atmos Sci 1, 16 (2018). https://doi.org/10.1038/s41612-018-0026-8

Types of GHG assessment

There are three main types of GHG assessment: enterprise level, project level and product level.

Enterprise level assessments measure the carbon impact of the entire business operation itemising emissions from all activity. Project level assessments quantify the carbon emissions, or, more commonly, the sequestration of specific projects. Product level assessments focus on the entire life cycle of a particular product or service from its extraction or formation through to its disposal.

In terms of ruminant agriculture, the most common two assessments that are available are the enterprise (whole farm) level and product level.

Enterprise or whole farm assessments measure the carbon impact of the entire farm business itemising emissions from all business operations, also taking into account any farm level sequestration (where applicable). This form of calculation is particularly important for those businesses with mixed farming activity ensuring that all emissions and mitigation are taken into account. This approach also has the potential for ruminant farmers to understand any opportunities for farm-based carbon credits as they have an understanding of their total farm carbon balance and whether they are in a carbon negative position or not.

For ruminant farmers, the product level GHG calculations focus on the emissions of CO_2e per unit of output, so by litre of milk or kilogramme of meat produced. Understandably there can be challenges within certain ruminant supply chains where animals are not bred and finished by the same business, where multiple outputs occur over the life of an animal i.e., beef from dairy cull cows, wool from sheep.

It is an important consideration when choosing a suitable tool to determine a farm's carbon footprint what needs to be measured, and whether both the whole farm impact as well as the product emissions need to be calculated.

Carbon assessment tools

Carbon assessments are most commonly undertaken in two ways; one by data gathering companies who work with the farmer to collate and verify the necessary data then input it into their own carbon calculator, and secondly online self-input tools where the farmers undertake the entire process themselves. However, there are new tools available that incorporate carbon assessments as part of a broader farm management software package.

There are multiple tools available globally offered for free, for a fee, used in a specific supply chain or as part of a specific membership. This assessment has focused on the tools that satisfy three criteria; firstly, those that are broadly available being either free to use or for a fee as part of a comprehensive package; secondly, those that are applicable to agriculture in the UK; and thirdly, those that include ruminant livestock systems.

We have identified the main players using industry knowledge, web-based searches and previous studies[13]. In terms of data collection companies using their own tools, specific information regarding some of these tools is more limited given the nature of the businesses and their commercial offer. These tools tend to be focused on providing a carbon footprinting service for the processor, retailer, or consultant rather than on an individual farmer basis.

In addition, we have also identified the core tools that are readily available online and suitable for UK farms. All four of the online tools identified have free versions available for individual farmers to access and calculate their own carbon footprint, with some of them offering a more advanced version for a small fee. They may also be used by third parties under a payable licence which can include the data gathering process as well as the calculation.

There is also a new tool that forms part of a farm business management programme, incorporating a carbon calculator as part of the package.

Another option, although with limited access, is tools privately developed and used within the supply chain. Arla have been investing in this space for nearly 15 years, appreciating its importance to the sector and supply chain at large. The Arla Climate Check programme uses a digital reporting tool where farmers submit their data, with the data then verified by an external adviser. Arla have pioneered this programme with their farmer members, representing a large proportion of UK dairy farms already undertaking carbon footprinting. Arla's Climate Check tool is based on ISO (14044) standards for life cycle assessment and follows the International Dairy Federation (IDF) guidelines on carbon footprint methodology, while emissions from animals, manure and soils are based on IPCC (Intergovernmental Panel on Climate Change) methodology.

It is likely that the more structured ruminant livestock supply chains will centralise carbon footprinting to ensure unity of carbon calculation tooling, focusing on the methodology rather than the desired outcomes.

13) https://www.climatexchange.org.uk/media/3584/farm-based-carbon-audits-final.pdf & https://www.nfuonline.com/nfu-online/environment/carbon-calculators-review-member-briefing-14012020/

Self-input vs data gathering

Whilst self-input offers a flexible and cost-effective method of calculating on-farm carbon emissions it must be noted that there is the potential for data error or inaccuracy when farmers are completing without support, some retailers have found the results of self-entry systems variable and have moved back to independent data collection.

However, the use of online calculators does give the supply chain 'control' regarding the data and calculations. Tools offering greater integration or utilisation of existing data creates opportunities for all ruminant livestock farmers to increase the accuracy and effectiveness of self-input carbon calculation.

It is also key to recognise the importance of starting to measure carbon emissions at farm level across the ruminant sectors and therefore farmers must not be dissuaded by the pitfalls for self-entry.

What are the standards?

PAS 2050:2011 is an independent and widely recognised standard providing requirements and guidelines on specific issues relevant for carbon footprints, including land-use change, carbon uptake, biogenic carbon emissions, soil carbon change, and green electricity. The standard was first introduced in 2008 then revised in 2011, with the aim of providing a consistent internationally applicable method for quantifying product carbon footprints.

It is a specification for assessing product life cycle GHG emissions, prepared by BSI British Standards and co-sponsored by the Carbon Trust and the Department for Environment, Food and Rural Affairs (Defra) that was developed with significant input from international stakeholders and experts across academia, business, government, and non-governmental organisations.

IPCC (2019) Tiers 1 and 2 are accredited methodological approaches that give set parameters for the calculations. The IPCC 2006 methodology was updated in 2019.

It is generally accepted that carbon footprinting tools should follow the PAS2050:11, however it is important to note that even tools following identical standards may deliver different outcomes.

What other data can feed in?

Calculators may also adopt pre-existing datasets that work with the standards to calculate the carbon footprint. The Global Feed LCA Institute (GFLI) is an independent animal nutrition and food industry institute who develop and publish an Animal Nutrition Life Cycle Analysis (LCA) database.

The GFLI database consists of the LCA of raw materials from various regions in the world ensuring that all life cycles stages are captured up to the delivery of a feed stuff on farm. The GFLI's methodology is built on four reference documents to adhere to globally standardised guidelines of FAO and EU standards, namely the FAO LEAP feed guidelines (2016), LEAP feed additives guidelines (2020), Feed PEF database methodology (2017), and Feed PEFCR (2018).

It is not a prerequisite that all tools link with the GFLI but there is an increasing movement of tools towards its incorporation. It must be noted that the GFLI is a working database, and in many respects it relies on the information provided by feed companies, particularly in relation to compound feed. It is striving to include more comprehensive data in relation to regional information, minerals, additives and co-products.

The Tools

Farm Carbon Toolkit

The Farm Carbon Toolkit has been working with farmers for over a decade in relation to on-farm GHG emissions. It is a farmer led project grant funded from EU funds (via Agritech Cornwall) and is run as a community interest/not for profit enterprise. There is a distinct focus on soils, with the organisation also running the Soil Farmer of the Year competition. The tool is marketed as giving farmers an idea on their emissions, directing them to areas of potential improvement rather than a definitive guide.

The tool current boasts over 2,500 users and claims that users are rapidly increasing as awareness grows. Many of the directors of the business have links to the organic sector which possibly explains a clearer focus on the sequestration or carbon balance of the farm.

The tool is evolving with a number of updates in the 5.1 version in 2021[14]. There appears to be a focus on upgrading and developing the tool in line with scientific progression.

The tool provides a whole farm calculation including the carbon balance.

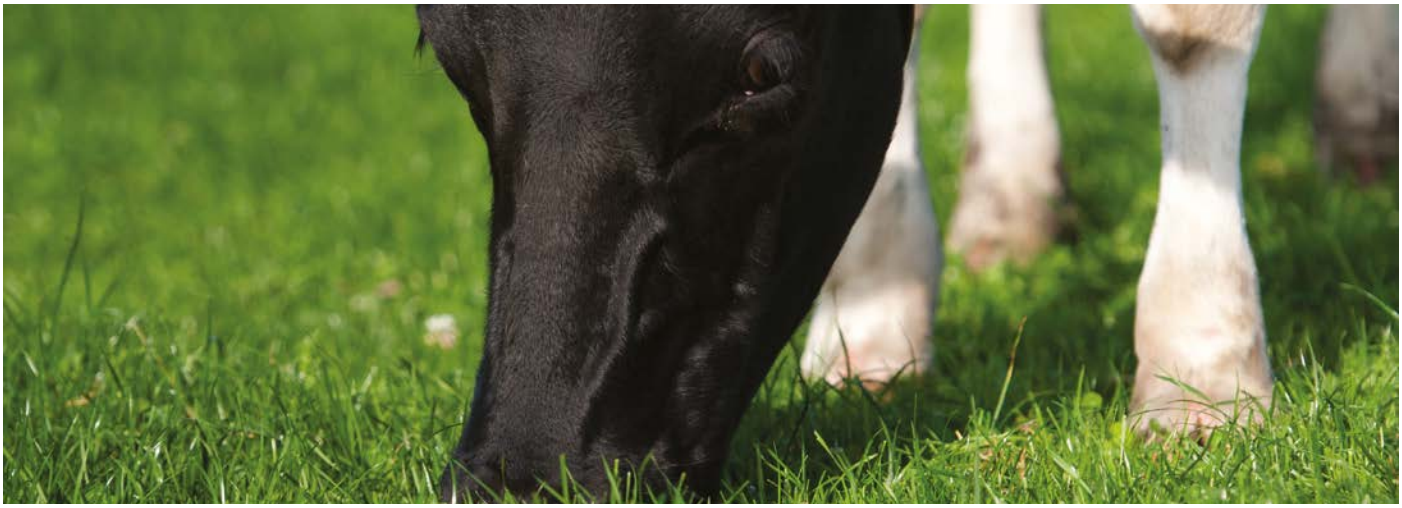
The tool is free for farmers to use as individuals and easy to sign-up online. The tool is available for commercial use enabling third party data collection with different packages available with training available to support consultants as part of the package.

Compliance with standards

The calculator covers Scopes 1, 2 and 3 for farm businesses covering both direct and indirect emissions, it covers Tiers 1 and 2 of the IPCC Livestock calculations.

The Farm Carbon Toolkit is partially compliant with the PAS 2050 standard; it is compliant with the methodology of PAS 2050 but takes a much broader approach as it includes Scope 3 (indirect emissions) and carbon sequestration neither of which are PAS 2050 compliant. They believe that the wider scope of the calculator means the Farm Carbon Toolkit is more comprehensive and accurate for the user combining the different elements.

The tool has started to integrate GWP* but waiting until the metric is more widely agreed to implement further within the tool's calculation.



14) https://farmcarbontoolkit.org.uk/sites/default/files/downloads/calculator_changes_2021.xls

What data is required?

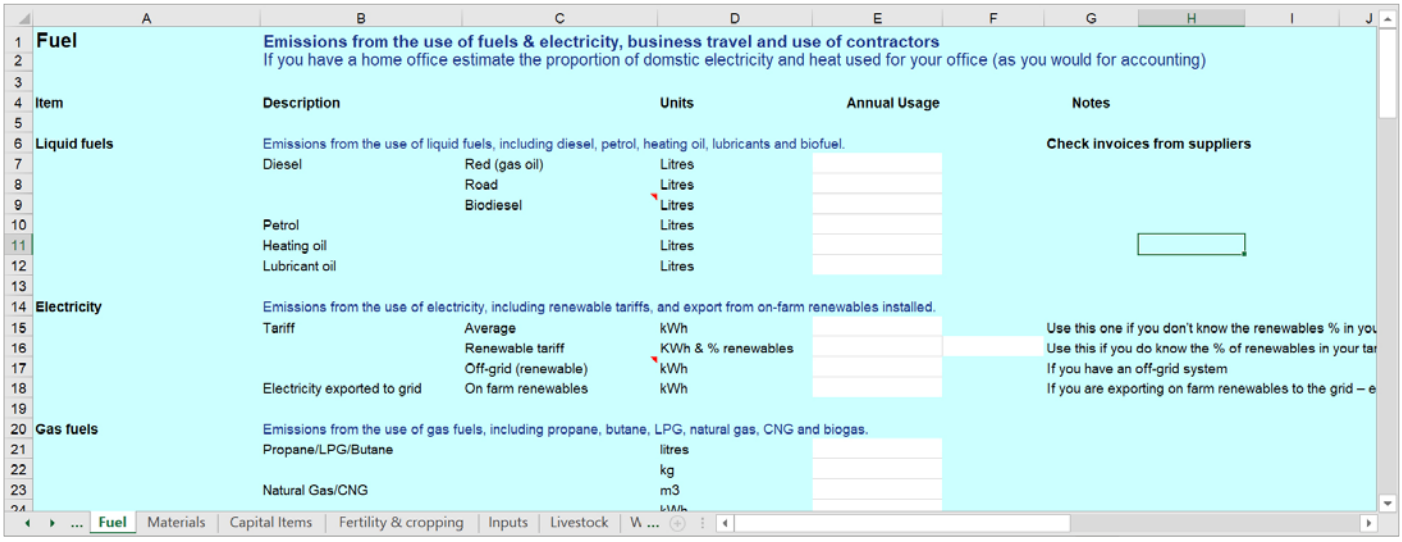
There are nine sections that require data entry:

- Fuel
- Materials
- Inventory
- Crops
- Inputs
- Livestock
- Waste
- Distribution
- Sequestration

Data input

The tool is user-friendly and suggests that data may be inserted between 30 minutes and two hours provided that the relevant information has already been gathered.

There is an Excel spreadsheet tool available as a useful resource for farmers to gather the data required[15].



	A	B	C	D	E	F	G	H	I	J
1	**Fuel**	**Emissions from the use of fuels & electricity, business travel and use of contractors**								
2		If you have a home office estimate the proportion of domstic electricity and heat used for your office (as you would for accounting)								
3										
4	**Item**	**Description**		**Units**	**Annual Usage**		**Notes**			
5										
6	**Liquid fuels**	Emissions from the use of liquid fuels, including diesel, petrol, heating oil, lubricants and biofuel.					**Check invoices from suppliers**			
7		Diesel	Red (gas oil)	Litres						
8			Road	Litres						
9			Biodiesel	Litres						
10		Petrol		Litres						
11		Heating oil		Litres						
12		Lubricant oil		Litres						
13										
14	**Electricity**	Emissions from the use of electricity, including renewable tariffs, and export from on-farm renewables installed.								
15		Tariff	Average	kWh			Use this one if you don't know the renewables % in you			
16			Renewable tariff	KWh & % renewables			Use this if you do know the % of renewables in your tar			
17			Off-grid (renewable)	kWh			If you have an off-grid system			
18		Electricity exported to grid	On farm renewables	kWh			If you are exporting on farm renewables to the grid – e			
19										
20	**Gas fuels**	Emissions from the use of gas fuels, including propane, butane, LPG, natural gas, CNG and biogas.								
21		Propane/LPG/Butane		litres						
22				kg						
23		Natural Gas/CNG		m3						
24				kWh						

... | Fuel | Materials | Capital Items | Fertility & cropping | Inputs | Livestock | W ...

15) https://calculator.farmcarbontoolkit.org.uk/

Results

The tool provides a summary of GHG emissions, sequestration, and farm total carbon balance.

The tool generates 'live' results as data is entered comparing emissions generated with emissions offset as the tool is populated with farm data, once complete a series of reports are available to view online or download as a pdf, which can be shared with a third party. It calculates the farm's annual footprint, expressed as a carbon dioxide equivalent, although it also shows the breakdown between the three different GHGs. The live results element enables farmers to use the assessment as a decision-making tool.

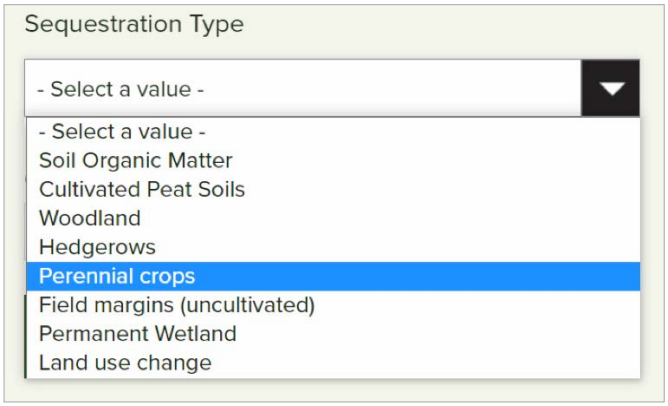
The results show total carbon emissions and carbon sequestration, expressed as tonnes of carbon dioxide equivalent (CO_2e), percentage of total emissions/sequestration, and the carbon balance of the farm business. The user can compare the results of different items.

The Farm Carbon Toolkit offers a consultancy service in line with the tool covering interpretation of the results, data verification, carbon reduction strategy and on-farm soil analysis.

What else does the tool offer?

The tool incorporates an assessment of soil carbon sequestration, using the Soil Carbon Project (a collaborative project between FCCT, Duchy College, Rothamsted Research (North Wyke) and the University of Plymouth) with 90 farmers to validate the calculations, which are based on IPCC guidance. This addition to the calculator enables it to create an indication of the business' carbon balance.

The model also includes the audit of green infrastructure in relation to sequestration[16].



Conclusion

The Farm Carbon Calculator offers a cost-effective solution for farmers to start calculating their emissions impact. The programme works for livestock farmers, working for dairy, beef, and lamb well, giving a whole farm picture of carbon emissions, including any off setting. The 'live' results function acts as a decision-making tool making it easy for users to pin-point areas that require improvement.

In terms of livestock efficiency, measures that are particularly important to ruminant agriculture are not captured in the tool including mortality and fertility. These areas have the potential to offer valuable insight into how carbon efficiency can be improved on UK livestock farms.

16) https://calculator.farmcarbontoolkit.org.uk/

Cool Farm Alliance Tool

The Cool Farm Alliance Tool was originally developed by the Sustainable Food Lab, University of Aberdeen and Unilever but now sits under the Cool Farm Alliance, a community interest group.

It remains strongly aligned to corporate business with some members of its executive being from PepsiCo, Syngenta, and Unilever.

The calculator gives individual carbon footprints by farm product rather than a whole farm assessment with results in carbon dioxide equivalent including a detailed breakdown by category and GHG.

The Cool Farm Tool is designed to help farmers choose management options that improve their environmental performance and to track and measure improvement over time. The results the tool generates can be reported to CDP (global environmental disclosure system) to provide carbon disclosure for agricultural supply chain emissions however if claims are to be made to consumers regarding the results, third party verification is required.

The tool currently boasts over 10,000 users both corporate and individual farmers.

The tool is evolving in line with the developing science and is regularly updated. The corporate membership model continues to fund the tool's development.

The tool allows farmers to access up to five free products assessments with a fee triggering for anymore.

Commercial packages are available where businesses become a 'partner' which enables consultancies and corporates to access the tool on behalf of farmers in their supply chain/clients. A third-party data collection can be used to collect farm data with these packages.

Compliance with standards

The Cool Farm Toolkit seeks to be aligned with various standards and protocols but is not necessarily 'compliant' with the standards. The calculator claims that it is "agnostic of standards" believing that they conflict in some areas.

The calculator can support a business' assessment for Product Life Cycle Accounting (LCA) and Reporting Standard (GHG Protocol for products) as well as other GHG protocol standards. However, it is not a LCA tool and does not replace a full assessment.

What data is required?

Crop data

- Harvested yield and marketable yield product weights
- Growing area
- Fertiliser applications: type and rate
- Number of pesticide applications
- Energy use (kWh and fuel use)
- Optional: transport: mode, weight of product and distance

Livestock data

- Herd or flock size
- Feed
- Manure management
- Energy use (kWh and fuel use)
- Transport of feed and other inputs

Dairy data

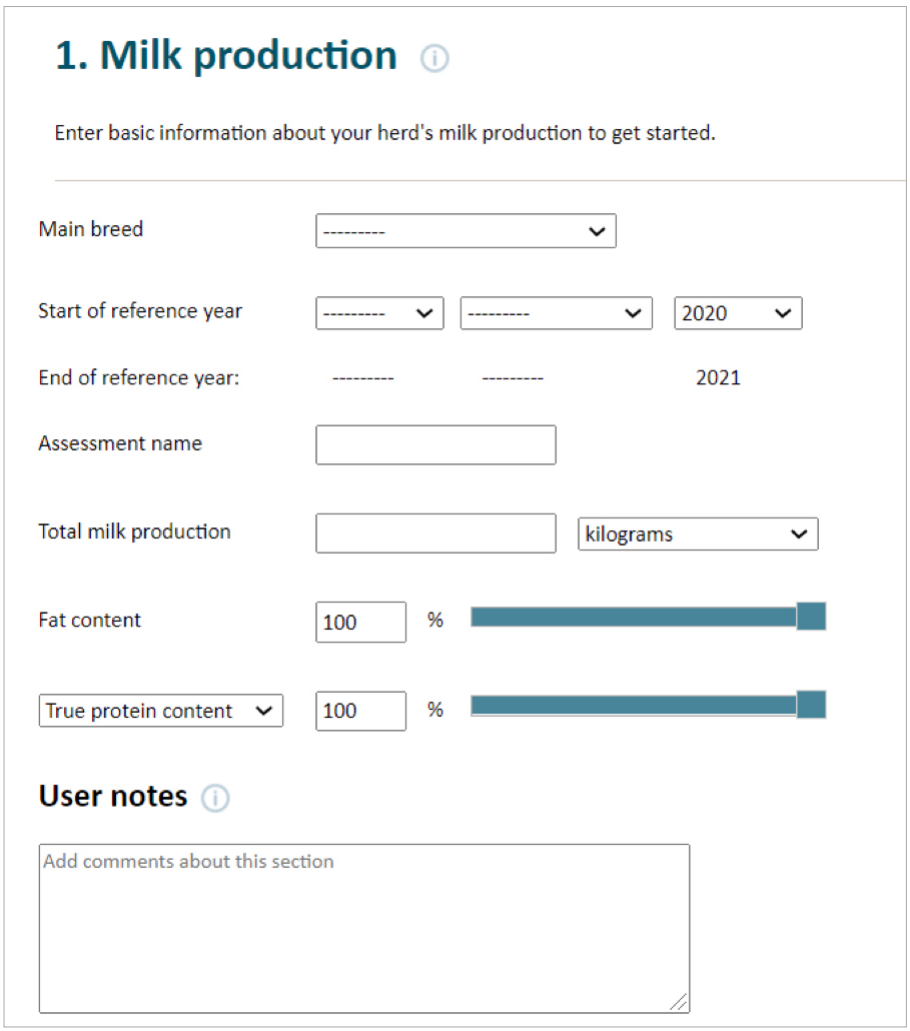
- Total milk production, fat content, protein content
- Grazing
- Feed
- Manure management
- Energy use (kWh and fuel use)
- Transport of feed and other inputs

Data input

The data input is straight-forward and very user-friendly with useful guidance regarding the process. They estimate that it takes about an hour for data entry provided that accurate records are available, but this is by each farm product, so more time would be required for mixed enterprises.

Some useful data in terms of dairy is required in the tool, the feed can be split out by group choosing dry matter (DM) intake per animal or average over the herd.

It requests precise detail regarding milk quality and breed providing a focus on productivity[17]:



17) https://coolfarmtool.org/

Detailed information regarding grazing groups can also be uploaded onto the tool, these would require good grazing records to complete[18].

3. Grazing

Please provide the information to estimate the amount of grazing time, total days and average hours per day during the grazing period and the select the grazing type and grass quality.

Category	Days	Hours / day	Grazing type	Grazing quality
Dairy calves 0-1 year for replacement of dairy cows	0	0	Confined pastur	High
Heifers 1 year until first calving	0	0	Confined pastur	High
Milk cows lactating dairy cows	0	0	Confined pastur	High
Dry cows non-lactating dairy cows	0	0	Confined pastur	High
Nursing / suckling cows	0	0	Confined pastur	High

The grazing element of the tool does not incorporate carbon sequestration, nor does it recognise rotational grazing. The grazing element focuses on grass quality with a link to digestive efficiency and therefore its impact on enteric fermentation.

The tool deals with different 'products' independently, however after creating the footprint for a crop in the crop section you can use it as a feed option in the livestock sections.

18) https://coolfarmtool.org/

Results

The results generated provide a breakdown of GHG emissions in CO_2e across the different inputs focusing on farm management options and costs.

The tool provides a comprehensive, user-friendly results dashboard breaking down the results for each section (feed, transport, energy, grazing, fertiliser, manure management and enteric fermentation) so they can be compared. The comparison function enables the user to create "what-if" scenarios indicating how GHG emissions can be improved by implementing more sustainable practices, e.g., applying different quantities of nutrients.

The results under the livestock modules combine some financial results in terms of costs per litre/kilogramme of protein for each element of the assessment.

Data can be shared but it requires a 'group code' which activates certain member-only features such as data export and data aggregation. It also includes the ability to gather and export the results of multiple farmers. The business requiring access to individual farmer data would be responsible for having the necessary data sharing agreement with the farmer.

What else does the tool offer?

The tool offers two 'bolt on' assessments alongside the GHG assessment. The biodiversity tool enables users to focus on activity and landscape on their farm that may aid biodiversity, the tool is relatively simplistic and does not offer the ability to input detail regarding specific on-farm biodiversity but does offer a good starting point. The other 'bolt on' is a water assessment which allows farmers to quickly assess their water footprint although this assessment is really focused on the arable sector, and not ruminant agriculture.

Notably the tool does not use carbon sequestration as it claims that the science is not quite there yet.

Conclusion

Easy to use professional tool with some impressive corporate partners. It does request some detail that helps to give a more definitive guide including separate options for certified soya and the milk quality information for the livestock modules. The focus on individual farm products rather than a whole farm approach can be more challenging for livestock farms and their, sometimes, mixed nature. Similarly, to the Farm Carbon Calculator it does not adequately account for productivity elements that are important to ruminant agriculture and impact carbon emissions such as fertility and mortality.

Agricultural Resource Efficiency Calculator (AgRECalc)

Agrecalc combines the on-farm knowledge of SAC Consulting and the research and academic credentials of Scotland's Rural College (SRUC). The tool was initially used for the Scottish Beef Efficiency Carbon Scheme and so has a good grounding in livestock agriculture.

It is designed to capture whole farm data but can allocate resources between enterprises or by product, so it can present results as a whole farm, by enterprise or by product type.

The tool currently has over 4,000 active users predominantly farmers but also some supply chains and Government.

All subscriptions are reinvested into the tool's development. The tool has evolved and is updated regularly, its most recent major update introduced a carbon sequestration in soils module.

Agrecalc offers a complimentary version for farmers and non-commercial use which enables users to assess their carbon performance and undertake basic benchmarking, an upgraded version is available for a nominal fee.

A 'partnership' membership is available for consultants, food supply chains, retailers, governments, and other corporate bodies with flexible licence options. The package offers an Access portal where the relevant farm client data can be accessed, it also allows businesses to create groups, compare within groups, and export results.

The Agrecalc tool offers a variety of ways in which data may be submitted in addition to farmers completing the process themselves. A data collection service is offered via SAC as well as Agrecalc collecting data online by sharing data collection forms with the farmer or a consultant to use and gather the data. The Agrecalc team can then perform the actual data input into the tool.

Compliance with standards

The tool conforms to IPCC Tier I and Tier II calculations for all livestock types and with PAS 2050:11 for supply chain standards.

What data is required?

Land and crops:

- Inorganic and imported organic manure
- Crop residues
- Embedded emissions associated with purchased inorganic fertiliser
- Lime
- Pesticides

Livestock:

- Storage and application of organic manure
- Ruminant enteric fermentation
- Manure management
- Purchased feed
- Bedding

Energy and waste:

- Energy use
- Waste disposal

The tool also captures forestry and soil carbon sequestration along with renewable energy production.

Data input

The data input process is more complex than the other two tools and therefore requires more time, however the complexity largely involves the greater detail required (e.g., feed component detail) which arguably establishes a more meaningful overall result. It is likely that farmers would need support at the data entry stage to give the best results.

Each section provides useful notes outlining the information that farmers need to input.

Land & Crops

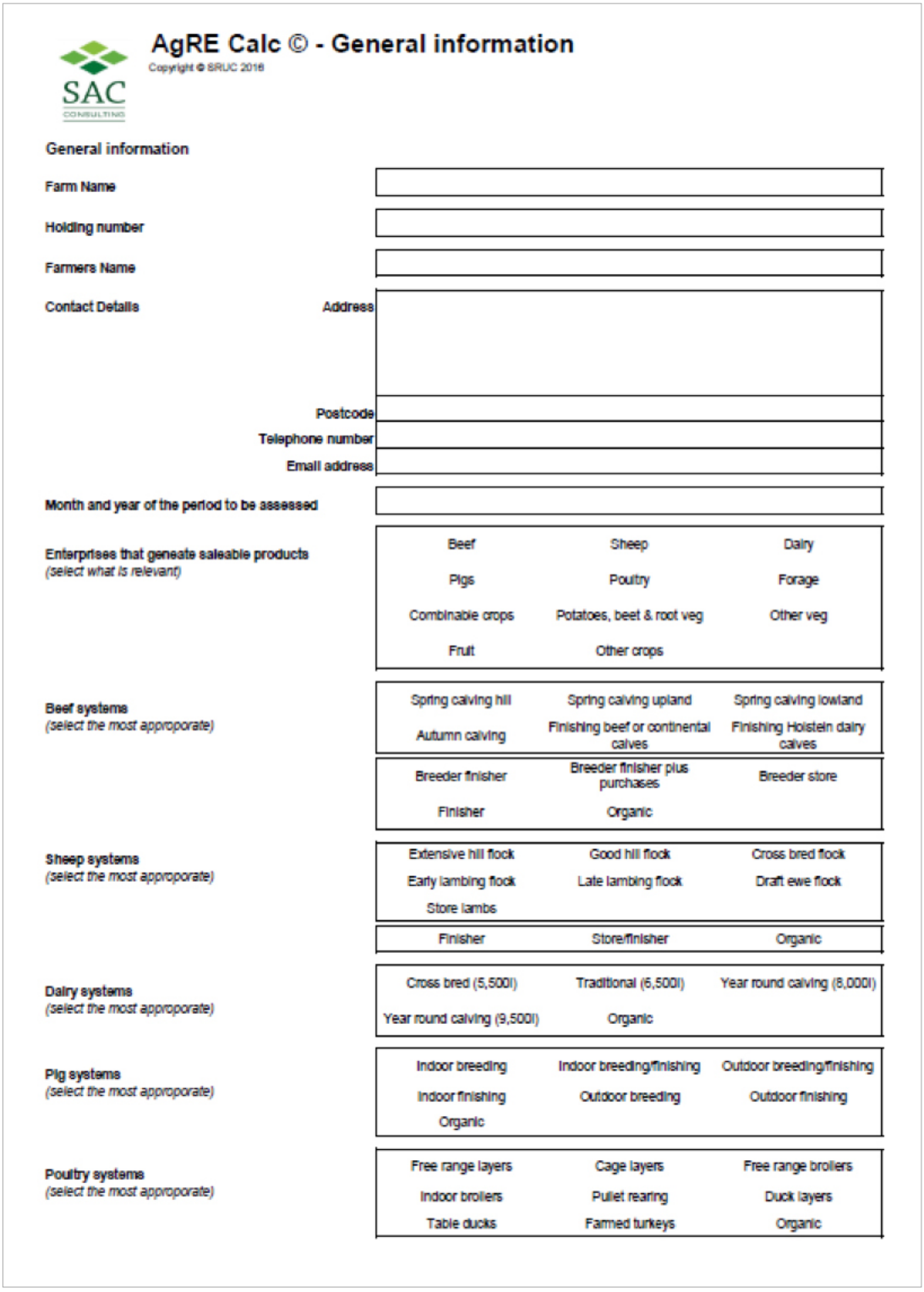
Quickjump to another report

The information collated in this section is used to calculate direct and indirect N_2O emissions from the application of nitrogen fertiliser (inorganic and imported organic manure) and from crop residues, and CO_2 emissions from embedded emissions associated with purchased inorganic fertiliser, lime and pesticides.

Enter data from the 12 month period being assessed into the relevant boxes. Various crops can be found by scrolling down the page. If you wish to open or close a crop group, click on the relevant subheading. Once you have finished entering data move onto the next tab, auto-save will save your data or you can also manually save your data by using the save button at the bottom of each page.

As you work through the various sections some boxes maybe highlighted in red this indicates what data must be entered or if totals are not 100%.

There are also data collection sheets that are helpful in the data gathering process:



AgRE Calc © - General information

SAC CONSULTING

General information

Farm Name		
Holding number		
Farmers Name		
Contact Details	**Address**	
	Postcode	
	Telephone number	
	Email address	
Month and year of the period to be assessed		

Enterprises that generate saleable products *(select what is relevant)*	Beef	Sheep	Dairy
	Pigs	Poultry	Forage
	Combinable crops	Potatoes, beet & root veg	Other veg
	Fruit	Other crops	
Beef systems *(select the most appropriate)*	Spring calving hill	Spring calving upland	Spring calving lowland
	Autumn calving	Finishing beef or continental calves	Finishing Holstein dairy calves
	Breeder finisher	Breeder finisher plus purchases	Breeder store
	Finisher	Organic	
Sheep systems *(select the most appropriate)*	Extensive hill flock	Good hill flock	Cross bred flock
	Early lambing flock	Late lambing flock	Draft ewe flock
	Store lambs		
	Finisher	Store/finisher	Organic
Dairy systems *(select the most appropriate)*	Cross bred (5,500l)	Traditional (6,500l)	Year round calving (8,000l)
	Year round calving (9,500l)	Organic	
Pig systems *(select the most appropriate)*	Indoor breeding	Indoor breeding/finishing	Outdoor breeding/finishing
	Indoor finishing	Outdoor breeding	Outdoor finishing
	Organic		
Poultry systems *(select the most appropriate)*	Free range layers	Cage layers	Free range broilers
	Indoor broilers	Pullet rearing	Duck layers
	Table ducks	Farmed turkeys	Organic

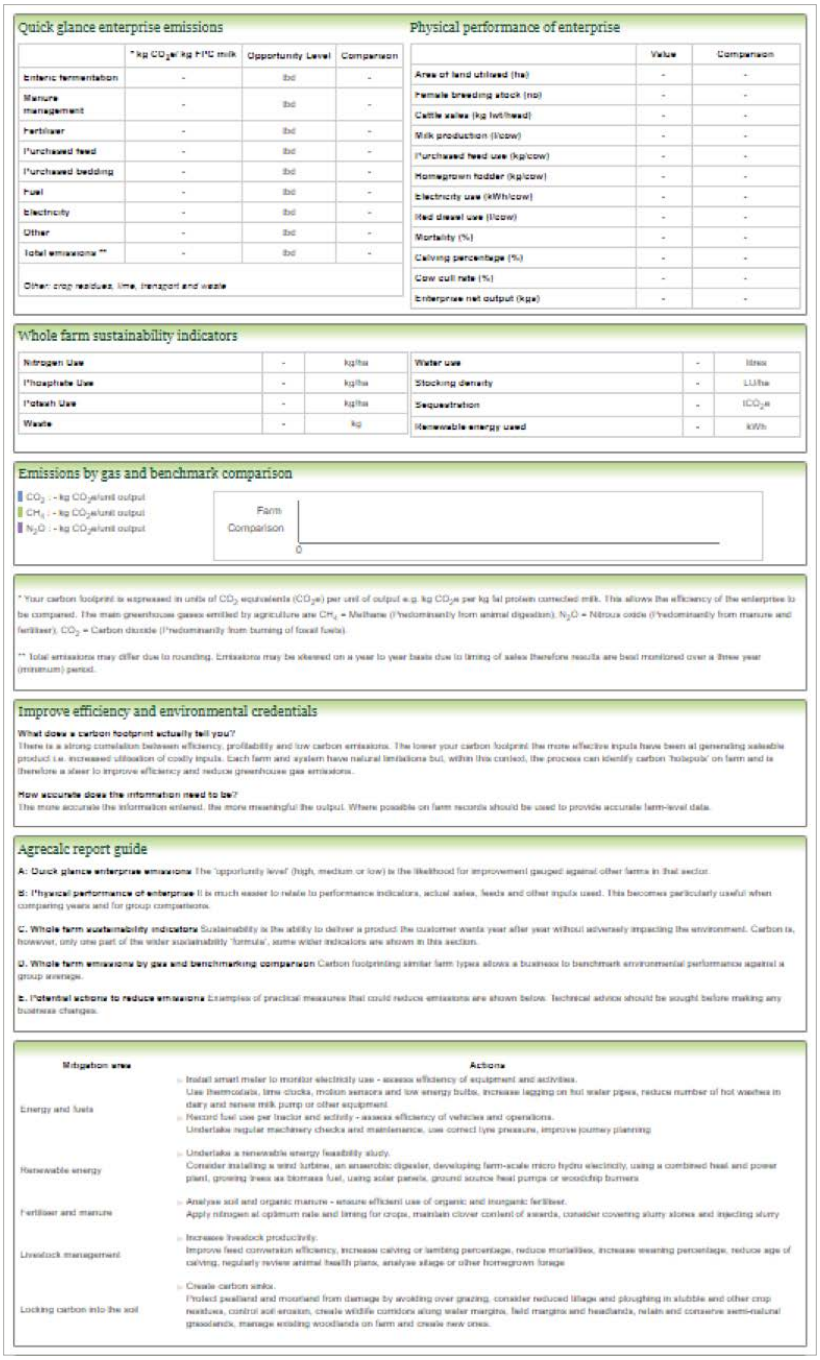
Recognising the need for quality data entry all data is verified prior to being used in the benchmarking function.

Results

The tool generates total farm GHG emissions breaking them down according to crop and livestock species and type of GHG.

There is no 'live' results function on the complimentary package, but the tool produces detailed and direct reports highlighting potential areas of improvement which are easily accessible.

The upgraded packages (including corporate) enable the user to access more sophisticated data analysis, including benchmarking and aggregating data. The corporate package also has access to a portal enabling data to be modelled accordingly, there appears to be a degree of flexibility in ensuring that the data package suits the needs of the corporate partner[20].



Quick glance enterprise emissions

	* kg CO_2e/ kg FPC milk	Opportunity Level	Comparison
Enteric fermentation	-	tbd	-
Manure management	-	tbd	-
Fertiliser	-	tbd	-
Purchased feed	-	tbd	-
Purchased bedding	-	tbd	-
Fuel	-	tbd	-
Electricity	-	tbd	-
Other	-	tbd	-
Total emissions **	-	tbd	-

Other: crop residues, lime, transport and waste

Physical performance of enterprise

	Value	Comparison
Area of land utilised (ha)	-	-
Female breeding stock (no)	-	-
Cattle sales (kg liv/head)	-	-
Milk production (l/cow)	-	-
Purchased feed use (kg/cow)	-	-
Homegrown fodder (kg/cow)	-	-
Electricity use (kWh/cow)	-	-
Red diesel use (l/cow)	-	-
Mortality (%)	-	-
Calving percentage (%)	-	-
Cow cull rate (%)	-	-
Enterprise net output (kgs)	-	-

Whole farm sustainability indicators

Nitrogen Use	-	kg/ha	Water use	-	litres
Phosphate Use	-	kg/ha	Stocking density	-	LU/ha
Potash Use	-	kg/ha	Sequestration	-	tCO_2e
Waste	-	kg	Renewable energy used	-	kWh

Emissions by gas and benchmark comparison

CO_2 : - kg CO_2e/unit output
CH_4 : - kg CO_2e/unit output
N_2O : - kg CO_2e/unit output

Farm
Comparison
0

* Your carbon footprint is expressed in units of CO_2 equivalents (CO_2e) per unit of output e.g. kg CO_2e per kg fat protein corrected milk. This allows the efficiency of the enterprise to be compared. The main greenhouses gases emitted by agriculture are CH_4 = Methane (Predominantly from animal digestion), N_2O = Nitrous oxide (Predominantly from manure and fertiliser), CO_2 = Carbon dioxide (Predominantly from burning of fossil fuels).

** Total emissions may differ due to rounding. Emissions may be skewed on a year to year basis due to timing of sales therefore results are best monitored over a three year (minimum) period.

Improve efficiency and environmental credentials

What does a carbon footprint actually tell you?
There is a strong correlation between efficiency, profitability and low carbon emissions. The lower your carbon footprint the more effective inputs have been at generating saleable product i.e. increased utilisation of costly inputs. Each farm and system have natural limitations but, within this context, the process can identify carbon 'hotspots' on farm and is therefore a steer to improve efficiency and reduce greenhouse gas emissions.

How accurate does the information need to be?
The more accurate the information entered, the more meaningful the output. Where possible on farm records should be used to provide accurate farm-level data.

Agrecalc report guide

A: Quick glance enterprise emissions The 'opportunity level' (high, medium or low) is the likelihood for improvement gauged against other farms in that sector.

B: Physical performance of enterprise It is much easier to relate to performance indicators, actual sales, feeds and other inputs used. This becomes particularly useful when comparing years and for group competitions.

C. Whole farm sustainability indicators Sustainability is the ability to deliver a product the customer wants year after year without adversely impacting the environment. Carbon is, however, only one part of the wider sustainability 'formula', some wider indicators are shown in this section.

D. Whole farm emissions by gas and benchmarking comparison Carbon footprinting similar farm types allows a business to benchmark environmental performance against a group average.

E. Potential actions to reduce emissions Examples of practical measures that could reduce emissions are shown below. Technical advice should be sought before making any business changes.

Mitigation area	Actions
Energy and fuels	Install smart meter to monitor electricity use - assess efficiency of equipment and activities. Use thermostats, time clocks, motion sensors and low energy bulbs, increase lagging on hot water pipes, reduce number of hot washes in dairy and service milk pump or other equipment. Record fuel use per tractor and activity - assess efficiency of vehicles and operations. Undertake regular machinery checks and maintenance, use correct tyre pressure, improve journey planning.
Renewable energy	Undertake a renewable energy feasibility study. Consider installing a wind turbine, an anaerobic digester, developing farm-scale micro hydro electricity, using a combined heat and power plant, growing trees as biomass fuel, using solar panels, ground source heat pumps or woodchip burners.
Fertiliser and manure	Analyse soil and organic manure - ensure efficient use of organic and inorganic fertiliser. Apply nitrogen at optimum rate and timing for crops, maintain clover content of swards, consider covering slurry stores and injecting slurry.
Livestock management	Increase livestock productivity: Improve feed conversion efficiency, increase calving or lambing percentage, reduce mortalities, increase weaning percentage, reduce age of calving, regularly review animal health plans, analyse silage or other homegrown forage.
Locking carbon into the soil	Create carbon sinks. Protect peatland and moorland from damage by avoiding over grazing, consider reduced tillage and ploughing in stubble and other crop residues, control soil erosion, create wildlife corridors along water margins, field margins and headlands, retain and conserve semi-natural grasslands, manage existing woodlands on farm and create new ones.

20) https://www.agrecalc.com/

The results report identifies areas of strength and areas for potential improvement with detailed targeted guidance given according to areas of emission reduction[21].

		Whole Farm	Beef	Sheep	Dairy
		kg CO_2e	kg CO_2e	kg CO_2e	kg CO_2e
CARBON DIOXIDE					
	Direct CO_2	-	-	-	-
	Indirect CO_2	-	-	-	-
	Total CO_2 from energy & waste	-	-	-	-
METHANE					
	Total CO_{2e} from methane	-	-	-	-
NITROUS OXIDE					
	Total CO_{2e} from nitrous oxide	-	-	-	-
Total CO_{2e} emissions from farming		-	-	-	-
Sequestration by forestry	(kg CO_{2e})	-			
Net emissions from land use		-			
Whole farm CO_2e emissions per kg of farm output	($KgCO_2e$/kg output) (2)	-			
Product CO_2e emissions					
Meat	Total $KgCO_2e$		-	-	-
	($KgCO_2e$/kg lwt)		-	-	-
	($KgCO_2e$/kg dwt)		-	-	-
Wool	Total $KgCO_2e$			-	
	($KgCO_2e$/kg wool)			-	
Milk	Total $KgCO_2e$				-
	($KgCO_2e$/kg FPC milk) (3)				-
Eggs	Total $KgCO_2e$				
	($KgCO_2e$/kg eggs)				
Forage, grain, seeds, roots	Total $KgCO_2e$				
	($KgCO_2e$/kg crop)				
Straw	Total $KgCO_2e$				
	($KgCO_2e$/kg straw)				
Emissions per LU equivalent	($KgCO_2e$/LU)	-	-	-	-
Emissions per hectare	($KgCO_2e$/ha)	-	-	-	-
Farm and enterprise output	(Kg)	-	-	-	-

(1) - Power for farming activity (excludes personal and household demand)

(2) - Beef, sheep, dairy, pig & poultry meat expressed per net kg dwt of cold carcase; milk expressed per kg FPC milk, poultry eggs expressed per kg, crops and straw expressed per kg

(3) - Fat protein corrected (FPC) milk

21) https://www.agrecalc.com/

Practical Measures To Improve Efficiency And Reduce Emissions

Energy and fuels

Install smart meter to monitor electricity use, assess efficiency of equipment and activities, use thermostats, time clocks, motion sensors and low energy bulbs, increase lagging on hot water pipes.

Record fuel use per tractor and activity, assess efficiency of vehicles and operations, undertake regular machinery checks and maintenance, use correct tyre pressure, improve journey planning.

Renewable energy

Undertake an energy audit to investigate the scope for renewable activities, such as wind, solar or hydro-electric power, anaerobic digesters, ground source heat pumps, biomass.

Fertiliser and manure

Prepare a farm nutrient management plan to identify opportunities for better utilisation of organic and inorganic fertiliser, analyse soil and organic manure, apply nitrogen at optimum rate and timing for crops, maintain or increase clover content of swards or other legume crops.

Livestock management

Carry out technical benchmarking of farm performance to highlight scope for improvements, increase calving or lambing percentage, reduce mortalities, increase weaning percentage, reduce age of calving, regularly review animal health plans, analyse silage or other homegrown forage.

Locking carbon into the soil

Protect peatland and moorland from damage by avoiding over grazing, consider reduced tillage and ploughing in stubble and other crop residues, control soil erosion, create wildlife corridors along water margins, field margins and headlands, retain and conserve semi-natural grasslands, manage existing woodlands on farm and create new ones.

22

What else does the tool offer?

The calculator handles livestock more comprehensively than the other non-specialist tools, including productivity metrics and more detailed emissions for different feed compositions, which are particularly useful metrics for livestock farms, targeting key areas for carbon efficiency.

All packages provide a benchmarking function, with the upgraded packages offering more advanced benchmarking options.

A new carbon soil sequestration module has recently been integrated into the tool and is now a fully operational part of Agrecalc, it claims to be the first tool to use the accredited IPCC methodology for soil carbon sequestration.

The calculator constructs and runs scenarios for carbon mitigation solutions according to results.

Conclusion

Although a more complex data entry process than the other tools the level of detail and comprehensive way Agrecalc handles livestock appears to produce meaningful results that can focus farmers for real change.

Agrecalc's ability to use performance metrics that translate into productivity and impact the carbon footprint make it well suited to UK livestock farms.

The bespoke nature of the package available to corporate businesses enables them to tailor the data requirement according to need.

22) https://www.agrecalc.com/

Solagro Carbon Calculator

Solagro is a French agri-environmental consultancy who have developed a carbon calculator on behalf of the Joint Research Centre of the European Commission. The tool differs from the other self-input tools in that it takes the form of an Excel spreadsheet that calculates the footprint rather than an online interface. The carbon calculator spreadsheet is available for download once you create an online account. The calculator along with very detailed guidance are free to access.

Compliance with the standards

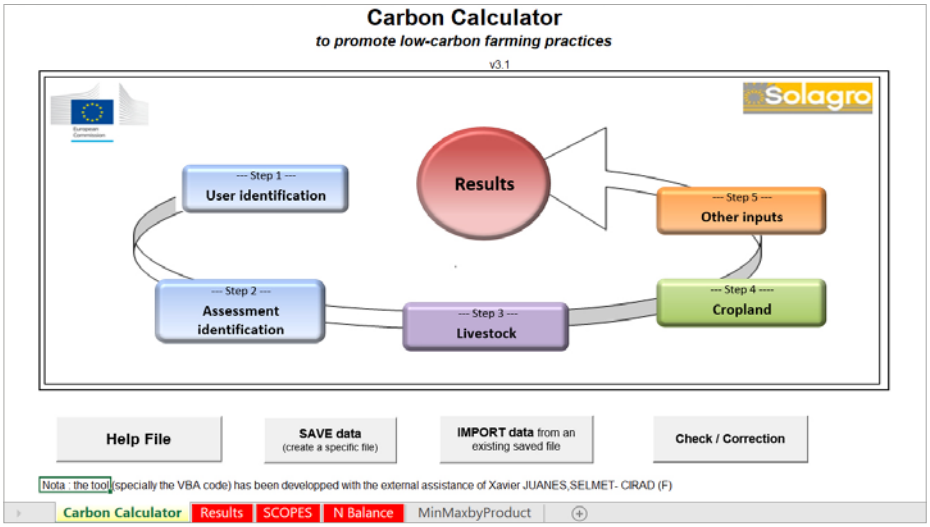
The tool complies with PAS 2050:11 and uses IPCC Tier I and Tier II calculations for all livestock.

What data is required?

- Livestock numbers
- Feed
- Manure management
- Forage/cropping
- Energy
- Land use change
- Buildings
- Machinery
- Cooling and refrigeration

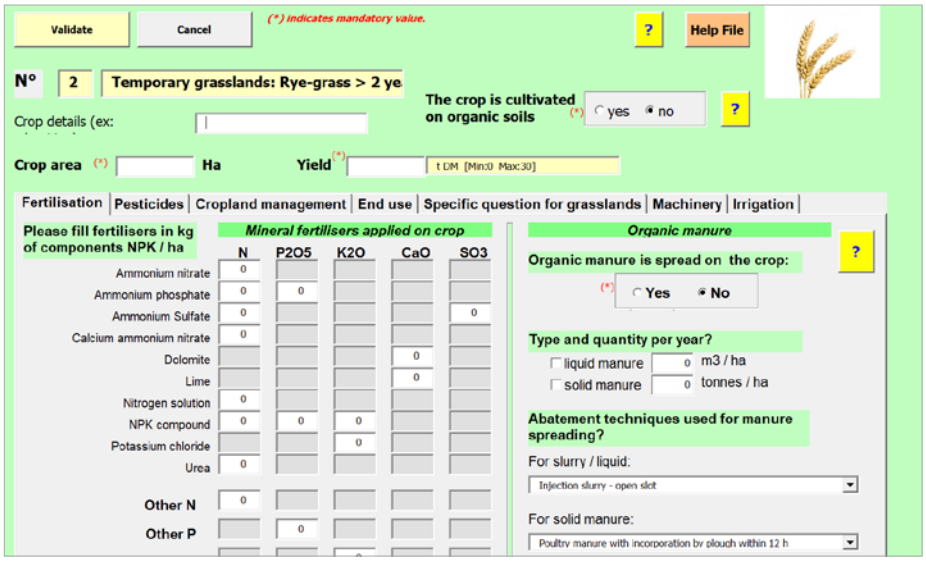
Data input

Data is inputted via a MS Excel spreadsheet and whilst the sections are detailed and the process logical in a step-by-step format it could be more challenging for those who are not familiar with Excel, particularly as error messages are regular.



23

The tool requires a considerable level of detail allowing the user to have confidence in the results however there is no technical support available other than the written guidance so if users are experiencing difficulty they are on their own.



24

There are some pre-populated sections that provide useful data using existing datasets, for example, soil.

23) https://solagro.org/nos-domaines-d-intervention/agroecologie/carbon-calculator
24) https://solagro.org/nos-domaines-d-intervention/agroecologie/carbon-calculator

Results

The report generated provides both a whole-farm result and for each product, each of which it compares to the global minimum, average and maximum. It also gives you a break-down of GHG emissions by gas (CO_2, CH4, N2O and HFC) for the farm.

For each product it highlights the 'top five' GHG sources, it also generates an action plan giving the user a top 10 mitigation actions (e.g., agroforestry) that are automatically generated out of a possible 16 with details of the impact they would have on the carbon footprint if adopted and the financial benefit of the user includes the optional financial data requested by the tool.

What else does the tool offer?

The tool requests information regarding 'a natural elements' function to capture data on hedgerows in order to calculate their sequestration potential.

The tool also includes a tab for demonstrating the farm's nitrogen balance using the inputted data. It also breaks down the emissions by Scopes 1, 2 and 3.

The tool provides more broad environmental indicators including water usage, energy consumption and ammonia volatilisation.

Conclusion

Less user-friendly given the Excel format, some proficiency in Excel would be required to use this tool effectively.

It appears that the tool itself was last modified in 2018 with the methodological guidelines updated in 2016. It is not clear what has been updated.

Given the nature of the tool there is no clear roadmap for development or updating given the non-commercial nature of the tool.

Nevertheless, the tool offers a detailed and credible carbon footprint at farm level.

Integrated Data and Carbon Footprint Collection Services

Due to the integrated nature of the service provided by data collection companies with combined carbon footprinting tools precise details regarding all of the tools are not widely available in comparison to the online tools.

We have identified three service providers who offer professional data capture services designed to gather carbon footprint information to use with their in-house tool to generate farm GHG emissions.

These tools are most commonly used by processors and retailers rather than directly by individual farmers.

Promar International (Genus plc).

Promar International is part of the Genus Group, with Promar providing consultancy to farmers, processors, and retailers. Promar have been involved in the carbon calculation scene for a number of years having developed their tools with the Carbon Trust in 2011. The tools are predominantly used by processor clients for their supplying pools in the pig, beef, and dairy sectors.

Promar offer consultancy in relation to the carbon footprint results and help drive change at farm level.

Promar are able to offer their corporate customers a complete approach to understanding their emissions covering Scopes 1, 2 and 3 reporting supported by third parties.

Compliance with standards

The tools are PAS 2050:11, IDF guide to standard LCA methodology and IPCC Tier I and Tier II compliant.

The models are also independently assured and validated by the Carbon Trust every two-to-three years. Promar's tools were first accredited by the Carbon Trust in 2012. The tools are due to be re-accredited in the summer of 2021.

Plans are underway to link-up with the GFLI database for feed inputs in the future.

What data is required

- Feed
- Fuel
- Fertiliser
- Energy
- Livestock
- Cropping
- Manure management
- Land availability
- Land inputs

Data input

There is a flexible approach to how the data is collected and is very much dependent on the corporate client's requirements.

Promar can offer a data collection service via Promar/Genus staff collecting data at farm level. They can also support farmers to provide data independently and are increasingly capturing data remotely using a portal with an ambition to expand the scope of the portal data capture in the future. They are able to do remote data capture for farms using certain farm software packages with the data then being verified with the farmer.

When using data collectors at farm level there is a focus that the support and advice given can aid the process in subsequent years.

Promar are increasingly working with their customer's farm liaison teams training them to collect the data.

All data collected is verified by the Promar team to ensure accuracy.

There is an ambition to further utilise API links from pre-existing data sources as the capability of data sources improves.

Results

The results generation and presentation is also a bespoke process according to customer requirements often further broken-down to farmer pool requirements. The results can be delivered directly back to the producing pools or to the processor for them to do.

The results can be presented in various ways and can include benchmarking within a pool to enable farmers to understand their emissions compared to others in their supplying pool. The results can aggregate data by system using the wider Promar data set to establish benchmarks if necessary.

The results enable the customer to establish a baseline both at farm and pool level allowing progress to be tracked on an annual basis.

There are options for the tool to provide two, five- or 10-years focus providing targeted actions and linkage to broader impacts, including policy change, with the results also sign-posting towards how the carbon footprint may be improved.

Promar are able to offer dual reporting presenting the carbon emissions in both GWP_{100} and GWP*, again this depends on whether the customer wants to understand the carbon impact in both metrics. The reporting of the emissions using the GWP* calculation is not accredited by the Carbon Trust.

What else does the tool offer?

The tool has an array of bespoke measures that can be applied to create a more rounded sustainability review giving the corporate customer full flexibility according to their requirements.

Promar can capture data in relation to biodiversity, water management and sequestration in soils and trees.

Conclusion

Promar's approach to carbon footprinting and broader sustainability understanding is very flexible. Their tooling enables customers to create a bespoke package from data capture to results designed to add value to their business.

Promar is one of only two tools suitable for the UK ruminant sector that is independently accredited by the Carbon Trust.

Intellync

Intellync is part of the AB Agri umbrella, with Intellync being formerly known as AB Sustain. They are a business who specialise in supply chain management and insight working directly with processors and retailers. The Intellync service is targeted to processors and retailers rather than an individual farm basis.

Intellync have been involved in carbon footprinting for a number of years and cover multi species in their tooling including beef, sheep, dairy, poultry (four models), pig (three models), duck, turkey and arable.

Intellync do not undertake consultancy in relation to carbon footprinting; they provide the results with the intention that they will then be interpreted at farm level by a specialist.

Carbon footprint can be generated by both product and whole farm.

Compliance with the standards

The tools are PAS 2050:11, and IPCC Tier I and Tier III (enteric methane) compliant.

The tools were previously accredited by the Carbon Trust for more than 10 years but no longer carry the accreditation, this is largely due to the number of tools Intellync have and the requirement for each individual tool to be accredited.

What data is required

- Feed
- Fuel
- Fertiliser
- Energy
- Livestock
- Cropping
- Manure management
- Land availability
- Land inputs (N, P & K)
- Water

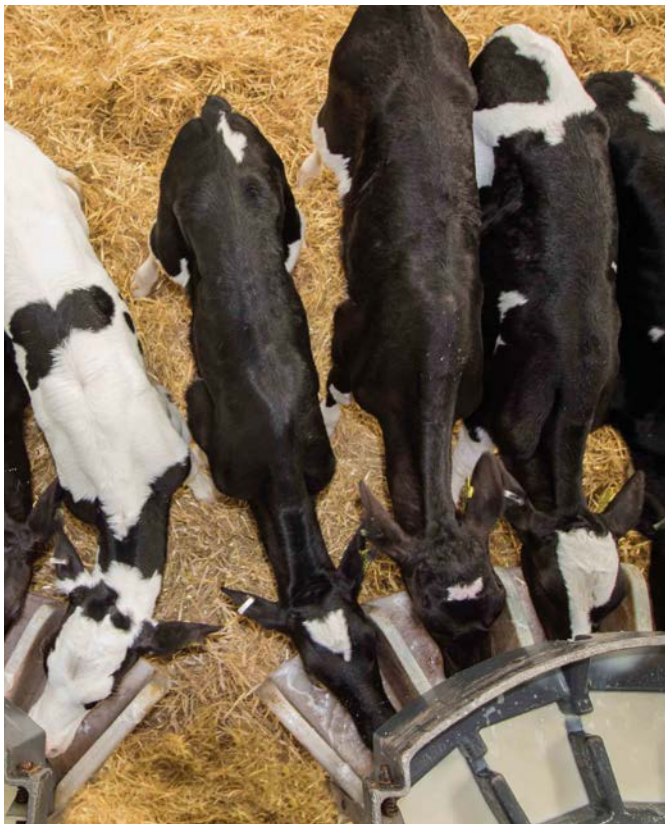
Data input

Intellync offer three different methods of data collection. They can use their professional and skilled data gathering team entering the data via a cloud-based portal.

The data can be self-entered, this can be done by the farmer, by the processor's field staff or by a third party such as a consultancy firm.

Intellync can also use API links to extract data automatically. At present this tends to be limited to the pig and poultry sectors with the ruminant sector not quite as advanced in terms of available data and API linkage. As an indication a poultry business with available data via API links can produce a carbon footprint within minutes.

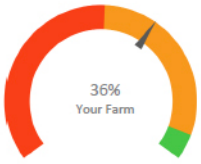
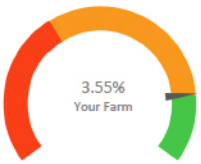
Intellync have a three-step quality control process to ensure that the data entered is accurate. The data is firstly checked at the point of data collection when their own team is collecting data, it is verified again once it is submitted via the portal. The data then has a final quality control check once the carbon reports are generated.



Results

The results report is clear and well-presented, with Intellync's mantra of *calculating an accurate footprint in an easy and convenient manner* being reflected in their report's layout. It provides a useful benchmarking facility allowing the individual farm to be benchmarked against the group average.

Farm Performance - How do you compare against Industry Averages

Avg. daily feed (kg/litre)	Replacement Rate	Butterfat	Protein	kg CO_2e /litre
Group Average: 1744	Group Average: 33%	Group Average: 4.2%	Group Average: 3.39%	Group Average: 1236
				
Lowest 10% 548 / Highest 10% 3581	Lowest 10% 20 / Highest 10% 40	Lowest 10% 3.83 / Highest 10% 4.67	Lowest 10% 3.14 / Highest 10% 3.67	Lowest 10% 897 / Highest 10% 1874

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25) Intellync carbon audit example report

The intention is that a farmer will use the report with an advisor, and that the report in isolation should not trigger change but that it works alongside specialist advice at farm level to enact meaningful decarbonisation.

The report sets out key performance metrics linked with carbon efficiency and productivity assisting the end user to find clear areas of focus for improvement.

Key Performance Metrics in Your System Compared to the Group Average

Inputs for last production cycle	Group average	Lowest 10% of group farms	Your performance	Highest 10% of group farms
Last Production year 2020				
Cows in herd	269	74	205	948
Milk Yield Per Cow (Litres)	5855	3613	10779	8076
Annual Milk Production (Litres)	1,664,489	394,398	2,209,721	6,529,254
Butterfat (%)	4.20%	3.83%	4.17%	4.67%
Protein (%)	3.39%	3.14%	3.55%	3.67%
Calving Interval (Days)	387	424	-	364
Replacements				
Cows Left Herd (%)	24%	47%	22%	7%
Replacement rate (%)	33%	78%	36%	12%
Heifer calving age (Months)	26	31	-	24
Cows Left Herd (%)	24%	47%	22%	7%
Dairy Herd Feeding				
Concentrates use @ 86% DM (Kg/cow)	1696	3517	3663	542
Concentrates use @ 86% DM (kg/litre)	0.30	0.53	0.34	0.12
Other purchased Feed @ 86% (Kg/cow)	48	255	15	0
All Purchased feed @86% DM equivalent (Kg/cow)	1744	3581	1954	548
Forage				
Nitrogen fertiliser use (kg N / ha)	187	357	165	66
Stocking Rate (cows / ha)	1.85	3.07	1.99	0.91
% of forage area as permanent pasture	67%	100%	12%	11%
Housing & Manure				
Dairy Cow Housing Period (Months)	6.0	11.4	10	3.6
Bedding Use (tonnes straw / cow)	0.87	2.63	0.51	0.09
% of total manure as slurry	88%	96%	80%	74%

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The reports can also benchmark by specific groups within a pool, for example they can benchmark by system such as spring block calving.

The results can be delivered via the benchmarking report, pdf data export and Excel data export.

26) Intellync carbon audit example report

What else does the tool offer?

The calculator also accounts for carbon sequestration from permanent pasture, with other areas under review for future development.

The tool calculates nitrogen and phosphorus loading values from feeds fed and fertilisers.

Emissions Loading

Environmental Impact Potential	Nitrogen loading	Phosphorus loading
Feed (kgs)	6,293	9,652
Fertiliser (kgs)	0	0
Total (kgs)	6,293	9,652

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The report offers dual reporting presenting results both in GWP_{100} and GWP*.

Carbon Footprint

Global Warming Potential	GWP 100 FOOTPRINT	GWP 10 FOOTPRINT
CO_2e kgs/litre	950	760
Permanent pasture sequestration (tons)	5	5
NET CO_2e kgs/litre	950	760

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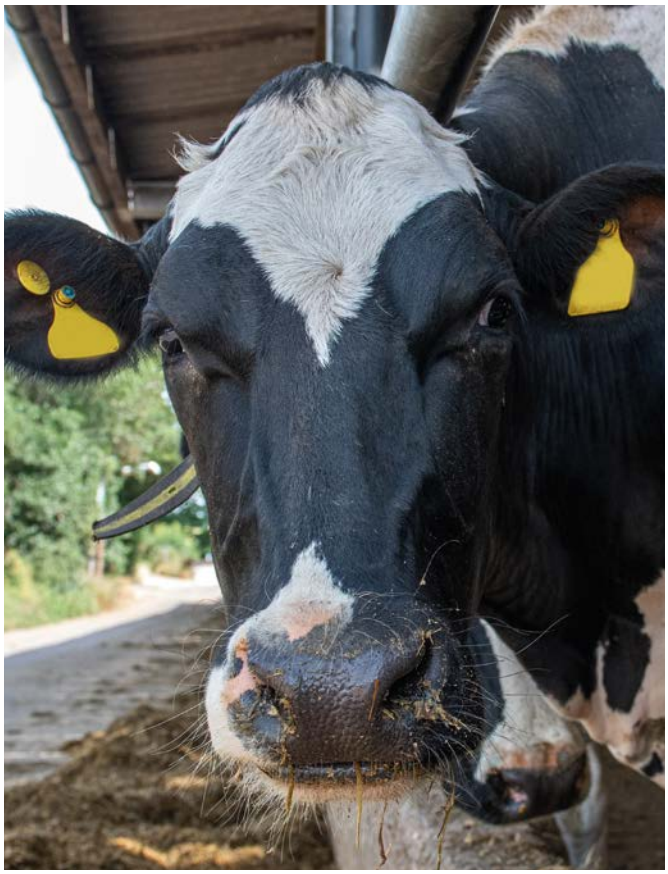
Conclusion

Intellync offer a solution to capture carbon emissions data across multi species. They offer a professional and slick service that enables the supply chain to understand their carbon impact.



27) Intellync carbon audit example report

28) Intellync carbon audit example report

Alltech E-CO_2

Alltech E-CO_2 is part of the broader global Alltech agri-business. The Alltech E-CO_2 carbon assessment tool is one of only two farm focused carbon assessment tools that are accredited by the Carbon Trust. The tool offers an environmental assessment that includes carbon, water utilisation and biodiversity.

The assessment captures whole farm data providing a detailed benchmarking report, together with practical advice to improve farm carbon efficiency. The tool is suitable for both arable and livestock enterprises obtaining data on animal production, health, feed, fertiliser, water, energy, and resource use. Both full and swift assessments are available, with the swift version offering a more concise environmental snapshot that can sit alongside an existing farm audit.

Results are delivered via reports with access to an online portal. Alltech E-CO_2 also offer consultancy in terms of carbon efficiency based on the results.

Alltech E-CO_2 also have a free-to-use online 'what if' tool which creates a simplistic modelling of your farm's performance, both financially and as an emitter, and compares it to a 'what if' scenario. It does not serve as a comprehensive assessment but is a useful tool.

Other Carbon calculators

This is a rapidly developing marketplace with new calculators applicable to UK ruminant agriculture bringing more than just carbon footprinting to the farm sustainability agenda.

Sustell™, Royal DSM

The globally renowned nutrition company, Royal DSM (DSM), launched its sustainability tool in 2021. DSM have a long track-record in life-cycle analysis.

The tool provides a holistic sustainability analysis for animal protein producing businesses.

The current tool covers dairy, broilers, layers, and pigs with the beef and aquaculture modules currently under development. All modules have the same functionality.

DSM have a clear and robust road map of IT development and upgrades for the tooling, ensuring that the calculator remains relevant and follows scientific developments.

Compliance with standards

Sustell™ uses the Blonk Consultants' APS-Footprint tool as its calculation engine, ensuring the independence of the analysis. The dairy module currently uses the following standards and calculation methods:

- ISO 14040/44 series
- ILCD handbook (JRC-IES & European Commission, 2010)
- PEFCR for feed for food producing animals (European Commission, 2018a)
- PEFCR for dairy products (European Commission, 2018b)
- PEFCR for red meat
- Environmental performance of large ruminant supply chains (FAO LEAP, 2016a)
- Nutrient flows and associated environmental impacts in livestock supply chains (FAO, 2018)
- Environmental performance of feed additives in livestock supply chains (FAO, 2019)
- The IDF guide to standard LCA methodology for the dairy sector (2010)
- EF2.0 LCIA Method. It identifies 16 different impact categories and differentiates impact on climate change due to fossil emissions, biogenic emissions, and land use and transformation
- Climate change – kg CO_2 eq
- Ozone depletion – kg CFC11 eq
- Ionising radiation – kBq U-235 eq
- Photochemical ozone formation – kg NMVOC eq
- Respiratory inorganics – disease inc.
- Non-cancer human health effects – CTUh
- Cancer human health effects – CTUh
- Acidification terrestrial and freshwater – mol H+ eq
- Eutrophication freshwater – kg P eq
- Eutrophication marine – kg N eq
- Eutrophication terrestrial – mol N eq
- Ecotoxicity freshwater – CTUe
- Land use – Pt
- Water scarcity – m3 depriv.
- Resource use, energy carriers – MJ
- Resource use, mineral and metals – kg Sb eq

The following Tier models and sources are used for excretions and emissions:

Excretions and emissions	Baseline method: PEFCR Dairy 2018
N Excretion (N_E)	IPCC Tier 2
Total ammonia nitrogen excretion (TAN_E)	EMEP/EAA
Volatile solids excretion (VS_E)	IPCC Tier 2
CH_4 enteric	IPCC Tier 2
CH_4 manure	IPCC Tier 2
Direct N_2O emissions	IPCC Tier 2
Indirect N_2O emissions	IPCC Tier 2
NH_3 emissions	EMEP/EAA Tier 2
NO_x emissions	EMEP/EAA Tier 2
NMVOC emissions	EMEP/EAA Tier 2
$PM_{2.5}$ and PM_{10} emissions	EMEP/EAA Tier 2

What data is required

The tool recommends that farm-level data spanning a one-year period is used within the tool.

- Feed – input as compound feed or single ingredient[29]. Data on digestibility, energy intake, crude protein and silage intake are also required
- Water
- Bedding
- Energy[30]
- Herd composition
- Manure management system and storage
- Other inputs such as annual average temperature, time spent grazing, time spent in buildings and housing type required
- Inputs for total milk production, protein and fat content are required
- Total liveweight to slaughter also required

The functional unit for milk output used is 1kg Fat-Protein Corrected Milk (FPCM), corrected to 4% fat and 3.3% protein[31].

29) APS-Footprint tool contains a compound feed module where a feed formulation can be defined. The default ingredient list is based on Agri-footprint 5.0 database.

30) National grid process data in Agri-footprint 5.0 database are used for electricity modelling

31) As calculated in PEFCR dairy guidelines (European Commission, 2018

Data input

The data input process uses an online interface, using pre-defined elements where appropriate i.e., compound feed. There is a support service via the Sustell™ Expert Centre for bespoke compound feed development and feed related parameters such as digestibility and energy intake if required.

Primary data is used for farm-level data input with background processes based on Agri-footprint 5.0 and the GFLI database.

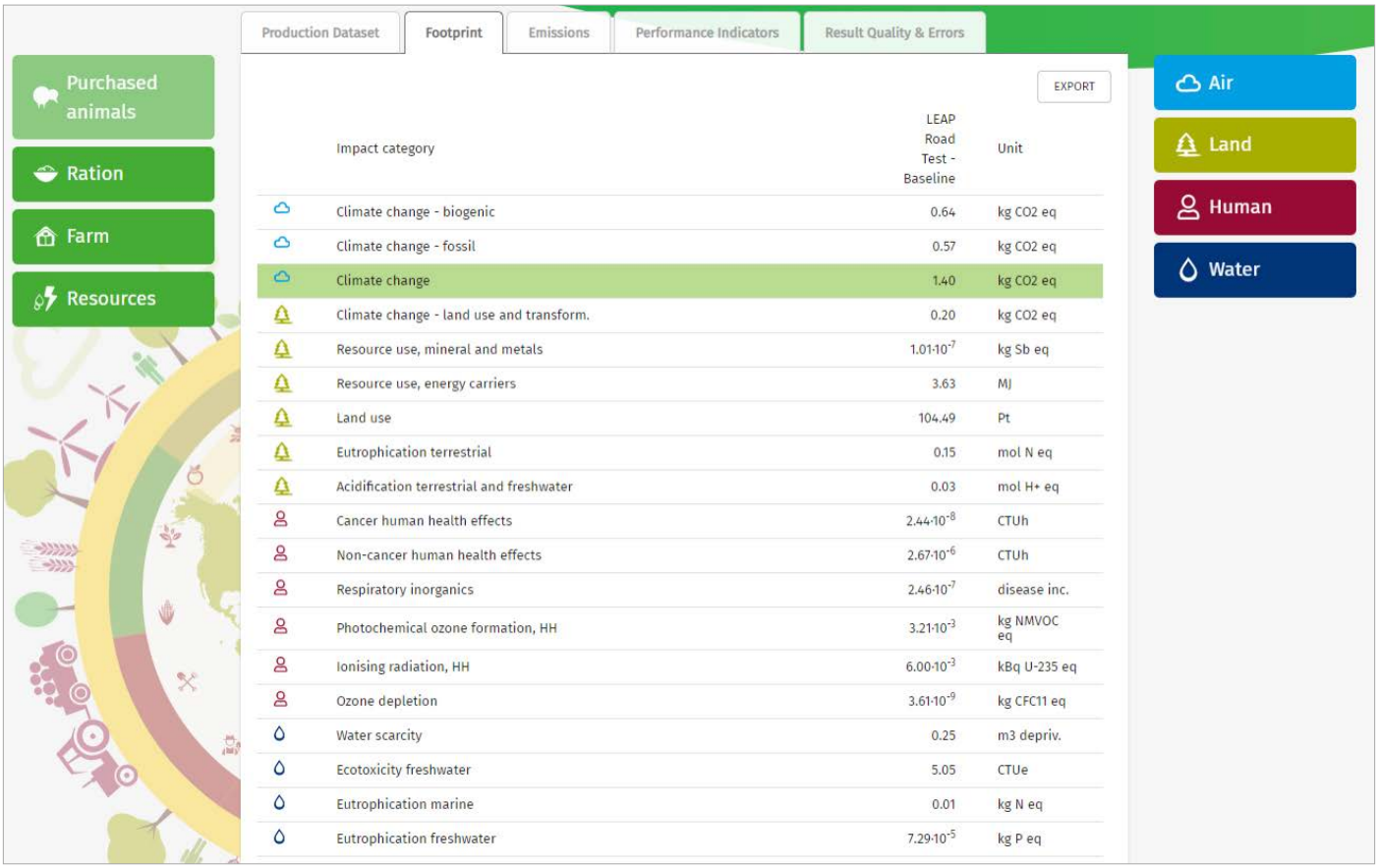
The interface is user-friendly calculating the environmental impact automatically as data is entered.

The Sustell™ Expert Centre verifies the data inputted at farm level to aid accuracy.

There is future ambition to automate data entry utilising API links with existing data sources and data holders.

Results

Sustell™ generates a comprehensive user-friendly results analysis giving both the carbon footprint and the environmental impact across the additional categories per 1kg FPCM. There is an export function enabling results to be downloaded in an Excel format.



Impact category	LEAP Road Test - Baseline	Unit
Climate change - biogenic	0.64	kg CO2 eq
Climate change - fossil	0.57	kg CO2 eq
Climate change	1.40	kg CO2 eq
Climate change - land use and transform.	0.20	kg CO2 eq
Resource use, mineral and metals	$1.01 \cdot 10^{-7}$	kg Sb eq
Resource use, energy carriers	3.63	MJ
Land use	104.49	Pt
Eutrophication terrestrial	0.15	mol N eq
Acidification terrestrial and freshwater	0.03	mol H+ eq
Cancer human health effects	$2.44 \cdot 10^{-8}$	CTUh
Non-cancer human health effects	$2.67 \cdot 10^{-6}$	CTUh
Respiratory inorganics	$2.46 \cdot 10^{-7}$	disease inc.
Photochemical ozone formation, HH	$3.21 \cdot 10^{-3}$	kg NMVOC eq
Ionising radiation, HH	$6.00 \cdot 10^{-3}$	kBq U-235 eq
Ozone depletion	$3.61 \cdot 10^{-9}$	kg CFC11 eq
Water scarcity	0.25	m3 depriv.
Ecotoxicity freshwater	5.05	CTUe
Eutrophication marine	0.01	kg N eq
Eutrophication freshwater	$7.29 \cdot 10^{-5}$	kg P eq

32

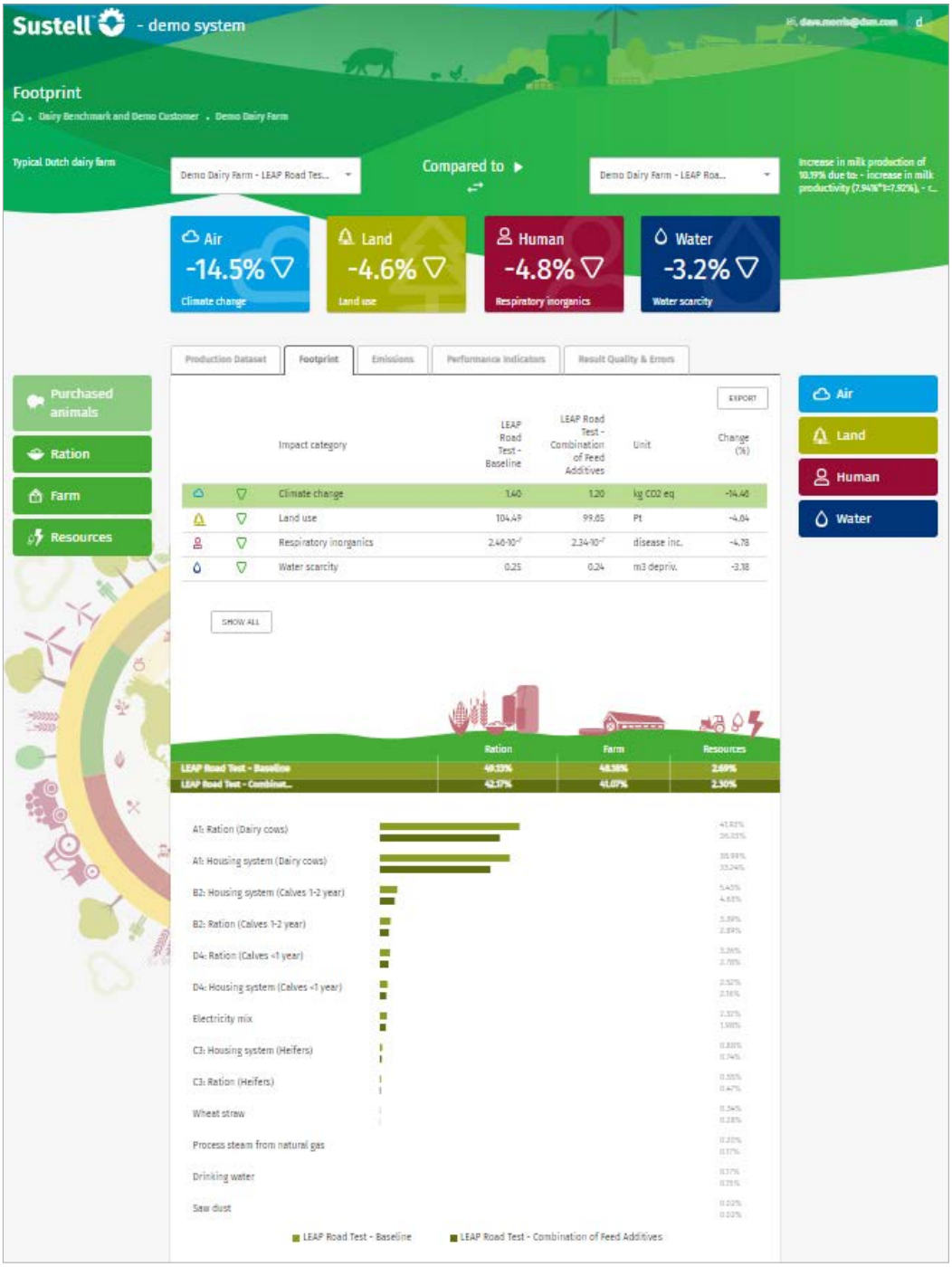
32) Courtesy of Sustell™

The results can be interpreted to show contribution from purchased animals, ration, farm related emissions and energy use:

33

33) Courtesy of Sustell™

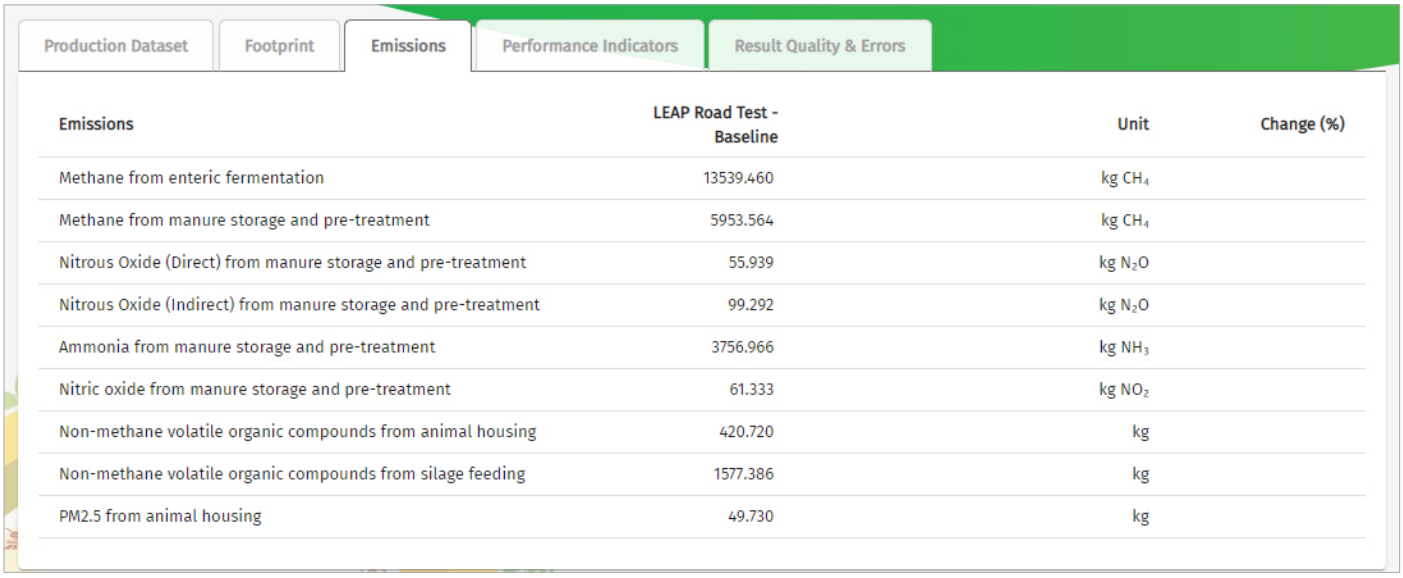
Results can also be shown in terms of the impact to air, land, human health, and water as part of the footprint.



34

34) Courtesy of Sustell™

The results report also presents emissions by source, enabling farmers to fully comprehend the different emissions from certain activities, and target areas for improvement.



Emissions	LEAP Road Test - Baseline	Unit	Change (%)
Methane from enteric fermentation	13539.460	kg CH_4	
Methane from manure storage and pre-treatment	5953.564	kg CH_4	
Nitrous Oxide (Direct) from manure storage and pre-treatment	55.939	kg N_2O	
Nitrous Oxide (Indirect) from manure storage and pre-treatment	99.292	kg N_2O	
Ammonia from manure storage and pre-treatment	3756.966	kg NH_3	
Nitric oxide from manure storage and pre-treatment	61.333	kg NO_2	
Non-methane volatile organic compounds from animal housing	420.720	kg	
Non-methane volatile organic compounds from silage feeding	1577.386	kg	
PM2.5 from animal housing	49.730	kg	

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The tool enables farmers to see 'what good looks like' running multiple scenarios enabling effective business decision-making identifying what the business needs to do to be more sustainable and highlighting targeted investment. Interventions against the current farm baseline can be calculated, e.g., increased milk productivity and fertility, allowing users to understand the impact this has on the environmental footprint.

What else does the tool offer?

The tool offers a holistic approach to sustainability, calculating much more than carbon footprint. Sustell™ covers 19 environmental impact categories[36] including eutrophication of water ways, acidification of water, respiratory inorganics, and water scarcity. The broad approach of the sustainability tool enables farmers to view decarbonisation alongside other key sustainability considerations, in particular other emissions to air and water, in line with both current and future compliance.

Conclusion

DSM have utilised their experience in LCA and visibility of the animal protein industry to create a holistic sustainability tool not only focusing on carbon footprinting but the broader environmental impact of agriculture.

The tool is user-friendly with the reports providing plentiful information, data, and decision-making tools for farmers to make targeted decarbonisation and sustainability changes on farm.

The company's IT development roadmap for future developments encourages confidence in the tool ensuring that it is both applicable at farm level and aligned to scientific developments.

35) Courtesy of Sustell™

36) In accordance with PEFCR for dairy products (European Commission, 2018b)

Sandy, Trinity AgTech

Trinity AgTech are new players in the carbon calculating space and market themselves as 'game changers' in terms of farm data and carbon calculation. The tool has been carefully crafted over the previous three years steered by both industry and scientific experts, with a scientific board of over 30 leading scientists from 15 institutions from the UK and abroad. Their newly launched tool[37] offers a one-stop shop for farm business data management with an integrated carbon footprinting tool.

The company are in the process of developing five different tools aimed across the supply chain and in accordance with developing demand.

Trinity AgTech and its scientific board are built for ongoing advancement of Sandy and ensuring that it is at the very cutting edge of evolving science. The Sandy software is designed to be a significant force in driving applied science in its research and development. Trinity AgTech has on its scientific board over 30 leading scientists from 15 institutions from the UK and abroad, placing it in a uniquely powerful position to achieve this.

Compliance with standards

Sandy reports to the main carbon standards: PAS2050, GHG protocol for product carbon footprints, and GHG protocol for corporate footprints.

The tool includes upstream emissions with built in data uncertainty reporting allowing flexibility on allocation methods to adhere to the various standards.

IPCC Tier II calculations are used throughout Sandy for livestock emissions, in addition to:

- Tier II for ruminant manure management as well as enteric fermentation
- A separate feed module to calculate the nutritional value of rations and grass, and to inform livestock emissions accordingly
- The feed module includes geographical sourcing for feeds, including whether or not they can be certified as land use change free
- IPCC (2019) methodology throughout

37) Official soft launch as of 10th June with full data integration from 1st July 2021

What data is required

The system is modelled holistically, meaning the user provides headline performance indicators like outputs, purchases and live weights rather than a direct stock take, aligning itself more to models followed within the LCA scientific literature yielding what could arguably be more of an accurate footprint with less effort from the user. It also acts as a self-checking system, preventing the user from supplying contradictory information or mis-scoping the footprint through imprecise data.

Sandy also collects information on manure management strategy, ration definition, pasture treatment, and fuel usage; in essence everything required to do a full product carbon footprint for the livestock system.

Data input

The carbon tool itself utilises data from other aspects of the software (for example, farm management section) to feed into the carbon calculator, it integrates data from other farm activities and enterprises, including arable and perennial cropping systems, anaerobic digestion, buildings, and transport. The software utilises existing farm data via API links from external sources of data (e.g., RPA), as well as utilising any other on-farm software and internet of things (IoT) devices plus satellite field and crop analytics. Trinity AgTech is committed to maintaining and continuously expanding this connectivity.

The quantity of data imported into the software largely depends on other systems and programmes the farm uses but reduces the need to duplicate data entry. Data can also be manually inputted, especially for specific detail in relation to the carbon calculation with the tool having useful data insights to help the user input the data.

The carbon section highlights data that is required and is therefore mandatory for the calculation and also data that is encouraged and allows greater accuracy. The tool focuses on data assurance and quality having built-in checks, and also requires users to attest accuracy of their key input data if the report is to be used for external purposes. There is default data input using calculated assumptions where any data gaps exist, the tool usefully provides a 'data completeness' score indicated as a +/- % of accuracy according to the amount of assumptions made versus actual inputted data.

Results

Sandy's carbon footprint results are presented in a clear, simple and interrogatable format; the user can view results at the farm level, at enterprise level, and at field level. Result can be displayed either using the GWP_{100} or GWP* with a simple drop-down option changing the calculation metric.

The user can view breakdowns by gas and by source at each level. Results also include emissions sources and sinks such as soil carbon and agroforestry.

Sandy also includes an optimisation-driven net-zero journey; this takes the user's system as described by the carbon footprinting module and applies it to an optimisation algorithm which chooses the most cost-effective routes to net-zero emissions for the user's specific system, including establishing a timeframe for change.

In terms of benchmarking Sandy uses a proprietary Monte Carlo-based algorithm to footprint the user against their own "best self"; essentially considering what is possible on the user's systems, and the extent to which they can improve in line with industry best practice.

A user's carbon footprint results are directly available to Sandy's Provenance module; this allows the user to attach a verified carbon footprint to their product and to export this as desired. This process is fully under the user's control.

All of Sandy's carbon footprinting modules calculate upstream emissions as a default. By default, Sandy's downstream system boundary is the farm gate, but the modules provide the user with utility modules which can be applied to downstream emission calculation (e.g., transport) if required.

What else does the tool offer?

The tool is more than a carbon tool and includes carbon in a holistic whole farm business approach with a fully integrated system of connectivity and artificial intelligence and machine learning capabilities.

This system comprises of:

- Sustainability tools
  - Spatial biodiversity assessment
  - AI/ML-driven water protection and nutrient use efficiency modelling
  - Agroforestry scenario planning
- Farm Management tools
  - Crop health and nutrient management
  - Field accessibility and management
  - Yield forecasting and pasture management
  - Livestock feed management
  - Livestock health and welfare
- Financial resilience tools
  - Arable and livestock system financial management
- Opportunities
  - Optimisation-driven insights (e.g., net-zero, biodiversity improvement)
  - Investment and action plans
- Farm utilities
  - Field-level weather forecasting and analysis
  - Financial, productivity and livestock health benchmarking
  - Procurement
  - Provenance

The tool has a function called 'Alex' that enables users to submit feedback, ask real time questions and request a new feature.

Conclusion

Sandy's carbon footprinting module sits within a rich suite of on-farm tools, offering a fully integrated farm sustainability system. This tool has the potential to stream-line ruminant carbon footprinting through the utilisation of pre-existing data sources.

The net-zero function allows farmers to set targets and timeframes towards working against net zero.

Conclusion

It is clear that the requirement for ruminant farmers to start measuring their carbon impact is increasing pace from supply chain drivers, consumers and from producers' own interest in understanding their carbon footprint.

The acceleration and voluntary adoption of understanding the impact of Scope 3 emissions for supply chains will further drive the need for UK ruminant farms to calculate carbon effectively and accurately. There are also potential opportunities within the supply chains for 'insetting' any carbon credits generated within the primary source, but for this to happen carbon footprints at farm level need to be undertaken.

The potential financial implications in relation to calculating carbon footprints, and reducing them, for the supply chain highlight the need for verified and credible on-farm carbon calculations. The increased focus on Scope 3 emissions commitments to net-zero and other external pressures to decarbonise will require food and drink supply chains to have an accredited carbon calculation for on-farm emissions. It is unlikely that having a figure will be sufficient, businesses will need to demonstrate that their total carbon impact figures are reliable with the possibility of assurance schemes encroaching on the carbon calculation space.

The likelihood that a financial value will be associated with a product's carbon footprint has the potential to fast-track the requirement for robust and accurate carbon footprinting data.

One of the current barriers for calculating carbon emissions is that the science is rapidly developing with some conflict between carbon calculators, academics and industry in relation to how certain elements are calculated, for example, in relation to carbon sequestration in soils. However, there are broader risks with not starting the process and it is likely that further legislation and regulation will come sooner rather than later, in addition to supply chain pressure.

Quality precise data remains the stumbling block with the availability of consistent accurate data at farm level being a challenge. It is clear that the future must focus on utilising pre-existing farm data sources, using technology where available. Until farm data capture is universally reliable and accurate it is unlikely that a 'level playing field' in terms of understanding farm level carbon emissions will exist in that inaccuracies in carbon emissions data will exist. Nevertheless, problems with farm data should not postpone the use of carbon calculation at farm level.

All tools help identify areas where greater carbon efficiency can be gained, the targeted results aid UK ruminant farmers to make informed decisions regarding GHG mitigation on their farm and start to decarbonise the ruminant livestock sector.

Fundamentally there needs to be some commonality (beyond the standards) across all recognised and suitable tooling at farm level to ensure that carbon emission calculations can be compared across calculators, as things stand, results generally differ from one tool to another. The divergences in results across calculators hinders the ability to effectively compare the results both within a species and cross-sector.

In addition, not all tools targeting the ruminant sector capture productivity metrics in relation to the livestock, disregarding information in connected to an animal's overall productivity including age of first calving and calving interval is critical in understanding its overall carbon efficiency. This link and the fact that it demonstrates the efficient use of resources strongly correlates with reduced production costs per kg of output therefore improving profitability of the farm business.

It is imperative that businesses opt for the tool that is most appropriate for both their needs and objectives and that they understand any limitations within the tool, and how to account for those limitations at farm level.

The key is that UK ruminant livestock farmers start to calculate their carbon impact no matter which tool is used, farmers need to start to see carbon footprinting as a management tool to aid effective business decision-making and not an administrative burden.

Appendix 1

Business Name	Farm Carbon Toolkit	Cool Farm tool	AgreCalc	Solagro Carbon Calculator
Website	https://calculator.farmcarbontoolkit.org.uk/	https://coolfarmtool.org/	https://www.agrecalc.com/	https://solagro.org/nos-domaines-d-intervention/agroecologie/carbon-calculator
Farmer or supply chain	Farmer & supply chain	Farmer & supply chain	Farmer & supply chain	Farmer
Free	Yes, for individual farmers	Yes, for individual farmers	Yes, for individual farmers	Yes
Data collection & entry	Online farmer submission but data can be provided by consultants or data collection business	Online farmer submission but data can be provided by consultants or data collection business	Online farmer submission but data can be provided by consultants or data collection business	Downloadable MS Excel spreadsheet
Sectors Covered	All UK ruminant sectors covered	All UK ruminant sectors covered but with a particular focus on crops, and global farm systems	All UK ruminant sectors covered	All UK ruminant sectors covered
Livestock Focus	Livestock built in but productivity metrics not considered	Livestock integrated to lower degree. Detailed livestock data entry not available	Comprehensive livestock productivity elements	Livestock built in but productivity metrics not considered
Sequestration	Yes - soil	No	Yes - soil & woodland	Yes - hedgerows
PAS2050:11 compliant	Yes but includes elements that are not currently certified	"agnostic of standards" linkage with PAS2050	Yes	Yes
Ease of data input	Easy to use, good real time visuals	Easy to use. API for data extracting available on advanced packaging	Most detailed of self-input but easy provided the data is available	More challenging as based on an Excel spreadsheet
Verification of data	Unclear how data is validated	Unclear how data is validated	Verification available in versions beyond the complimentary version	No, but a correction function will check blanks, decimals, etc
Type of assessment	Whole farm but does break down by kg of output	Product only	Whole farm, enterprise & product	Whole farm & product
Other Comments	• Looking to integrate GWP* • Can offer consultancy and support to farmers and supply chain • Focus on soils	• Limited livestock productivity metrics • Bolt-on biodiversity module • Bolt-on water assessment	• Basic benchmarking in complimentary version	• Nitrogen balance • Ammonia volatilisation • Water consumption • No comprehensive updates • No technical support

Business Name	Alltech ECO2	Promar	Intellync (AB Agri)	Sustell™, Royal DSM	Sandy, Trinity AgTech
Website	https://www.alltech-e-co2.com/	https://promar-international.com/	https://intellync.com/	https://www.sustell.com	https://www.trinityagtech.com/
Farmer or supply chain	Supply chain	Supply chain	Supply chain	Supply chain	Farmer & supply chain
Free	No	No	No	No	No
Data collection & entry	On farm/virtual assessment	Data collector (Promar or client), farmer portal entry or hybrid approach	On farm/virtual assessment and/or preloaded farmer data input	Online farmer entry supported by pre-defined elements where appropriate	Online farmer entry plus data accessed using API links where available
Sectors Covered	All UK ruminant sectors covered	All UK ruminant sectors covered	All UK ruminant sectors covered	Dairy, broiler, layer, swine with the beef model currently under development	All UK ruminant sectors covered
Livestock Focus	Comprehensive livestock productivity elements	Comprehensive livestock productivity elements	Comprehensive livestock productivity elements	Comprehensive livestock productivity elements	Comprehensive livestock productivity elements
Sequestration	No	Yes	Yes - permanent pasture	Carbon sequestration is not included, in-line with PEFCR for dairy products	Yes - soil & agroforestry
PAS2050:11 compliant	Yes	Yes	Yes	Yes	Yes
Ease of data input	Flexible approach.	Flexible approach between assessment and farmer input	Flexible approach between assessment and farmer input	Easy to use, support from Sustell™ Expert Centre if required	Easy to use, utilisation of existing data including API links
Verification of data	Data verified through data collection	Data verified through data collection and processing	Data verified through data collection, input into portal and on reporting	Data verified by Sustell™ Expert Centre	Utilisation of existing data, option to understand accuracy of results due to use of default values.
Type of assessment	Whole farm & product	Whole farm & product	Whole farm & product	Product	Whole farm, enterprise & field level
Other Comments	• What if tool • Operate a full carbon or "swift" tools depending on requirements • Offers wider carbon consultancy and links to financials	• Calculations available in both GWP_{100} and GWP* • Flexible/bespoke approach • Multiyear impact actions	• Calculations available in both GWP_{100} and GWP* • Nitrogen and phosphorus loading values from feeds fed and fertilisers	• Holistic sustainability tool • 19 environmental impacts covered	• Holistic sustainability tool • Biodiversity assessment • Broader farm management software package • Calculations available in both GWP_{100} and GWP*