

 Soil Association  
**producer  
support**

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Carbon footprinting on farms

Information sheet

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Soil Association  
Producer Support  
South Plaza, Marlborough Street,  
Bristol, BS1 3NX  
**T** 0117 914 2400  
**F** 0117 314 5001  
**E** [producer.support@soilassociation.org](mailto:producer.support@soilassociation.org)  
**W** [www.soilassociation.org/Farmersgrowers.aspx](http://www.soilassociation.org/Farmersgrowers.aspx)

Identifying the carbon footprint of a farm business is the first vital step in being able to quantify the contribution that farm is making to climate change. A carbon footprint calculation identifies the quantity and source of carbon dioxide, methane and nitrous oxide emitted from the farm, highlighting areas where improvements or changes can be made to reduce greenhouse gas emissions.

## Background to carbon calculations

There are two approaches to carbon footprinting – whole farm approach and life cycle analysis.

- **Whole farm approach** measures a farm’s overall annual GHG emissions and is a useful calculation for individual farm benchmarking purposes. These calculations highlight ‘hot spots’ or areas where GHG reductions might be made. It’s important to note that these calculations are estimates only and so only give an indication of footprint.
- **Life cycle analysis** measures the GHG emissions associated with a specific product. The calculation shows GHG emissions per unit of product, e.g. per kg of grain or litre of milk. This method of calculation can be used to highlight emissions within the life cycle of a product. The Carbon Trust has developed a life cycle analysis methodology for the UK called **PAS (Publicly Available Specification) 2050** [1].

The underlying mechanism which carbon calculators use is based on two simple components,

- a database of standard figures for emissions and sequestration
- farm specific information/data.

These figures are multiplied together to give the total emissions associated with each parameter considered by the calculator, e.g. the quantity of diesel used on farm is multiplied by the standard emissions figure for diesel – the result indicates the total emissions from diesel use on the farm. The totals for each parameter are then added together giving a total emissions result for the farm or enterprise.

The majority of calculators report the results in ‘**carbon dioxide equivalents**’ or **CO<sub>2</sub>e**. This is to allow the impact of the gases to be directly compared. Carbon dioxide (CO<sub>2</sub>), methane (CH<sub>4</sub>) and nitrous oxide (N<sub>2</sub>O) all have different **global warming potential** (GWP) – their potential to absorb and re-emit heat within the atmosphere, maintaining global temperature. A kilogram of N<sub>2</sub>O has the capacity to emit 310 times the amount of heat compared to 1 kg of CO<sub>2</sub> and is therefore equal to 310kg CO<sub>2</sub>e. Methane has 21 times the GWP of CO<sub>2</sub>, 1 kg is therefore equal to 21 kg CO<sub>2</sub>e [2].

1 kg CO <sub>2</sub> = 1 kg CO <sub>2</sub> e
1 kg CH <sub>4</sub> = 21 kg CO <sub>2</sub> e
1 kg N <sub>2</sub> O = 310 kg CO <sub>2</sub> e

**Table 1. GWP defined by IPCC 2006**

Some calculators may report results in ‘**carbon equivalents**’ (**CE**). This is still calculated based on GWP but the result is converted to carbon only.

**To convert CE to CO<sub>2</sub>e you multiply CE by 12/44 (or 3.67)** [3].

The total emissions from a farm in CO<sub>2</sub>e is a useful indication of a farm's footprint however it is important to know the quantities of each GHG to be able to identify the source of emissions so that measures can be taken to reduce them.

There are a number of different calculators available for farmers and growers to use – several are free while others are privately owned and can be used through a consultant. The footprinting tools vary significantly due to the standard data they use and parameters and boundaries they take into account. It's therefore very important to know the background to the calculator you chose to use so that you can better understand the result it produces.

## Scopes and boundaries

The **boundaries** of a calculation determine what aspect of production the calculation is assessing – whether it's a single enterprise or the whole farm; whether it takes into account operations solely within the farm gate or whether this is expanded to take into account transport and packaging beyond the farm gate for example. You can choose what boundaries to use when doing your calculation - it is important to define this before you start so that emissions are allocated accurately.

If you chose to carry out the footprint calculation for one farm enterprise then you need to be careful that any farm specific input data you use is attributable to that enterprise only – e.g. fuel usage – only count fuel which is used for operations related to the enterprise being assessed. It's often difficult to allocate usage and data accurately with mixed farming systems where enterprises are integrated and rely on each other; this is often why a whole farm approach is simpler and more accurate.

The **scope** of a calculation is slightly different to the boundary – scope defines the breadth of data that the calculation takes into account. Within carbon calculating there are three widely recognised 'scopes' which have been defined by the World Business Council for Sustainable Development (WBCSD) and the World Resource Institute [4].

- **Scope 1** - direct emissions from sources that are owned or controlled by the company, e.g. CO<sub>2</sub> emitted as a result of diesel used in tractors and farm machinery, gas for heating, land use change; N<sub>2</sub>O from manure application; CH<sub>4</sub> from enteric fermentation.
- **Scope 2** – emissions associated with the generation of purchased electricity used on the farm
- **Scope 3** – indirect emissions associated with the production, processing and distribution of inputs into the farming system, e.g. seed, bought in grain and compound feed, fertilisers, pesticides, etc. This also includes embedded emissions in machinery, building materials and farm infrastructure.

Scope 3 data is sometimes included in whole farm calculations often just in part – some calculators may factor in emissions from fertiliser production but won't factor in emissions from seed production or imported feed production and distribution. This is because it is suggested that emissions should be allocated at each level of production and distribution so that they are the responsibility of the party involved at any particular level. This means that the farmer at the end of the chain of production does not accumulate responsibility for emissions higher up the chain and is only responsible for emissions associated with their own activities

The lack of scope 3 data within the 'whole farm' approach is often perceived as not showing the 'complete picture' when it comes to carbon footprinting, however it is important that the factors taken into account within a calculation are those which can be managed directly by the farmer, i.e. fuel use on farm or livestock management, so that they can be managed effectively to make positive changes and so that a farmer does not

take responsibility for emissions out of the farm's control. It is important however, to recognise and be aware of emissions involved in other aspects of the food production chain and make choices accordingly to reduce the global impact of agriculture on GHG emissions but not to take direct responsibility for them. For example, it should be recognised that imported feedstuffs will carry a higher carbon footprint due to transport distances, and/or the method of production in other countries. These emissions will not always be reflected in the 'destination' farms carbon footprint, but measures should be taken to make careful choices on imported inputs to the farm system where possible.

## Standard emissions data

The datasets used within the various calculators vary significantly because of differences in the quality of data used and how emissions are estimated.

The Intergovernmental Panel for Climate Change (IPCC) has published guidelines on the methods that should be used for estimating greenhouse gas emissions by sources and removal by sinks. These guidelines are known as '**2006 IPCC Guidelines**' and are recognised and agreed globally [5].

There are 3 'tiers' of data recognised by the 2006 IPCC Guidelines,

- **Tier 1 data** – this data is country specific but based on global activity, it is the default factor for an emission source and contains a lower level of accuracy as figures are more general – e.g data used for emissions from a dairy cow is universal.
- **Tier 2 data** – this data is country/region or farming system specific and therefore more accurate and applicable.
- **Tier 3 data** – this is high resolution data, possibly farm specific and is therefore the most accurate form of data.

There is currently no industry standard input data but the majority of calculators in the UK are based on 'tier 1' data. It is particularly important to know what level of data is used in a calculation if the results are to be compared with others so that like is compared with like and all sources of emissions are accounted for as accurately as possible.

## Carbon calculators

### CALM

<http://www.calm.cla.org.uk>

The Carbon Accounting for Land Managers (CALM) calculator was developed by the Country, Land and Business Association (CLA). It is a free, web-based calculator which is relatively straightforward and simple to use. The calculator uses a drop down menu format which requires data to be input into each relevant field. Provided the data required is readily available, the calculation takes less than an hour to complete.

The calculator has been designed as a monitoring tool, enabling farmers to assess the carbon balance of their farm. It produces a 'whole farm' report which indicates the level and type of emissions attributable to different areas of the farm system enabling the user to identify 'hotspot' areas where improvement could be made. The calculation results indicate the total annual emissions for the farm business in tonnes CO<sub>2</sub>e as well as a breakdown of N<sub>2</sub>O, CO<sub>2</sub> and CH<sub>4</sub> emissions.

Scope 1	Fuel and energy use (on farm and contracted) Livestock Manure management/storage Cropping areas, history and yields Incorporated crop residues Lime Manure/fertiliser applications Exported straw Carbon sequestration by woodland Land use changes
Scope 2	Electricity production
Scope 3	Production of imported artificial fertilisers

## CFF Carbon Calculator

<http://www.cffcarboncalculator.org.uk>

The CFF (Climate Friendly Food) Carbon calculator is was developed in 2009 and updated in 2010. It is a free, web-based farm management tool which enables the identification of a farm's total annual emissions. The calculator is simple and easy to use, requiring basic computing skills. It takes about an hour to complete provided the data needed is to hand. The calculator is designed primarily for organic farmers and therefore doesn't currently have the capacity to include N fertilisers in the calculation.

The CFF carbon calculator uses a broader scope to a whole farm calculation than other available tools, taking into account sequestration and embedded emissions (i.e. in farm machinery and building/infrastructure materials) to a greater extent. The calculator's database uses data from over 30 sources including IPCC 2006 and Defra GHG Conversion factors. A report is produced displaying the results of the calculation which indicates the level and type of emissions attributable to the various areas of the farming system. The result indicates the annual whole farm emissions in CO<sub>2</sub>e as well as total emissions of CH<sub>4</sub>, N<sub>2</sub>O and CO<sub>2</sub>.

Scope 1	Fuel and energy use (on farm and contracted) Livestock Manure management/storage Cropping areas, history and yields Incorporated crop residues Lime Fertility and biomass inputs Carbon sequestration by woodland, soils, wetland, uncultivated areas and farm habitats Land use changes
Scope 2	<ul style="list-style-type: none"> <li>• Electricity production</li> </ul>
Scope 3	<ul style="list-style-type: none"> <li>• Production of imported fertility</li> <li>• Embodied energy in building materials, vehicles, consumables and infrastructure.</li> </ul>

	<ul style="list-style-type: none"> <li>• Off-farm processing</li> <li>• External distribution systems</li> </ul>
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## CPLAN

<http://www.cplan.org.uk>

The CPlan tool is available in two versions. CPlan v.0 is a simple calculator which can be used free of charge while CPlan v.2 is more complex and carries a charge per calculation as the calculation forms the basis of a paid consultancy.

**CPLAN v.0** is a simple system taking into account emissions under the farmer's direct control. The calculator is very straightforward to complete and it takes a matter of minutes to complete the calculation if the individual farm data is available. The results are presented in a table showing the allocation of emissions to each area of inputted data – **Note: results data is shown as carbon equivalent, multiply by 3.67 to convert to CO<sub>2</sub>e.**

**CPLAN v.2** is a more flexible calculator allowing the user to enter more exact data on factors such as woodland, landuse change and nitrogen content of fertilisers. In addition the user can choose between using standard national emissions for the sheep, dairy and beef cattle on the farm or a more complex model which allows the user to input herd/flock specific information regarding diet, livestock weight and manure management enabling a more farm specific calculation. Another advantage of being able to input farm specific information is that you can perform hypothetical calculations with regards to livestock management – trying out different data to reflect changes in management to see how changes would impact on emissions.

The resulting report is very detailed providing a breakdown of CO<sub>2</sub>, CH<sub>4</sub> and N<sub>2</sub>O as well as presenting the results as CE and CO<sub>2</sub>e. It also shows upper and lower bounds to take into account the uncertainty within the calculations using IPCC recommended methodology. CPLANv.2 is available following registration as a member. There is a charge per calculation of approximately £30, credits can be purchased on the website using secure PayPal services. The data entered into CPLAN via the web is guaranteed 100% secure and not sold or given to any third party.

	CPlan v.0	CPlan v.2
Scope 1	<ul style="list-style-type: none"> <li>• Energy and fuel use</li> <li>• Livestock manures</li> <li>• Livestock enteric fermentation</li> <li>• Incorporated crop residues</li> <li>• Fertiliser inputs</li> <li>• Woodland and organic soil carbon sequestration</li> <li>• Land use change</li> </ul>	<ul style="list-style-type: none"> <li>• Energy and fuel use</li> <li>• Livestock manures (herd/flock specific data)</li> <li>• Manure storage</li> <li>• Livestock enteric fermentation (herd/flock specific data)</li> <li>• Incorporated crop residues</li> <li>• Fertiliser inputs</li> <li>• Woodland and organic soil carbon sequestration</li> <li>• Land use change</li> <li>• Soil changes</li> </ul>
Scope 2	<ul style="list-style-type: none"> <li>• Electricity production</li> </ul>	<ul style="list-style-type: none"> <li>• Electricity production</li> </ul>

## Cool Farm Tool

<http://www.growingforthefuture.com/content/Cool+Farm+Tool>

The Cool Farm Tool was developed by the University of Aberdeen, commissioned by Unilever and is currently being used in a multi-company project on agricultural climate change mitigation coordinated by The Sustainable Food Lab. This calculator is a free and open-source tool, and enables users to carry out a footprint calculation on a 'product' or enterprise basis. The tool allows the user to select variables that they can influence to reduce their carbon footprint. For example, tillage changes - this allows a 'what if' approach, allowing farmers to see what impact changing certain practices would have on their emissions.

The Cool Farm tool is fairly straight forward to use providing the required data is readily available. Care needs to be taken to ensure energy use/field activities are allocated to each enterprise as accurately as possible. A 'whole farm' calculation requires a calculation to be done for each enterpriser which can be time consuming.

Scope 1	<ul style="list-style-type: none"><li>• Fuel and energy use (on farm and contracted)</li><li>• Livestock enteric fermentation</li><li>• Livestock manure management/storage</li><li>• Cropping areas, history and yields</li><li>• Soil management practices</li><li>• Incorporated crop residues</li><li>• Lime</li><li>• Fertility and biomass inputs</li><li>• Carbon sequestration by woodland</li><li>• Land use changes</li></ul>
Scope 2	<ul style="list-style-type: none"><li>• Electricity production</li></ul>
Scope 3	<ul style="list-style-type: none"><li>• Production of imported artificial fertilisers</li><li>• Primary processing</li><li>• Primary distribution</li></ul>

	<b>CALM</b>	<b>CFF</b>	<b>CPLAN v.0</b>	<b>CPLAN v.2</b>	<b>COOL FARM TOOL</b>
Cost of use	Free	Free	Free	£30/calculation	Free
Ease of use (1= easy/5=most difficult)	3	3	2	3	4
Methodology	IPCC Tier 1	Own	IPCC Tier 1 + UK National data	IPCC Tier 1 + UK National data	IPCC Tier 2
Scope	1, 2 & some 3	1,2 & some 3	1 & 2	1& 2	1,2 & some 3
Emissions from fuel & electricity	x	x	x	x	x
Emissions from livestock	x	x	x	x	x
Emissions from crop management	x	x	x	x	x
Sequestration	x (outline)	x (detailed)	x (outline)	x	x
Primary processing		x			x
Transport/distribution		x			x
Result units	CO <sub>2</sub> , CH <sub>4</sub> , N <sub>2</sub> O & CO <sub>2</sub> e Whole farm balance	CO <sub>2</sub> , CH <sub>4</sub> , N <sub>2</sub> O & CO <sub>2</sub> e Whole farm balance	CE Whole farm balance	CO <sub>2</sub> , CH <sub>4</sub> , N <sub>2</sub> O. Ceq & CO <sub>2</sub> e Whole farm balance	CO <sub>2</sub> , CH <sub>4</sub> , N <sub>2</sub> O & CO <sub>2</sub> e per ha & per tonne

A more detailed 'case study' comparison of the above tools is also available on our website.

Other carbon calculation tools are available through private consultancy services, these include:

### **OCIS Public Goods Tool**

The OCIS Public Goods Tool was developed by the Organic Research Centre to assess the impact of farming systems on wider society. The tool assesses the provision of 11 'public goods' by a farm and calculates a score for each based on farm specific data. The 'public goods' were chosen to account for a range of social, environmental and economic areas, including: soil management; biodiversity; landscape and heritage; water management; manure management and nutrients; energy and carbon; food security; agricultural systems diversity; social capital; farm business resilience; and animal health and welfare.

The results of the assessment are presented on a radar diagram enabling farmers to see on which areas they perform well and which areas could be improved. Additional bar charts give more detailed information so that specific activities can be identified to work on to improve the score in the future.

A full report on the OCIS Public Goods Tool development can be found [here](#). For more information on accessing the Public Goods Tool please contact the Organic Research Centre.

### **EASI**

[http://www.organicresearchcentre.com/manage/authincluds/article\\_uploads/Research/Resources/Brief%20summary%20of%20EASI.pdf](http://www.organicresearchcentre.com/manage/authincluds/article_uploads/Research/Resources/Brief%20summary%20of%20EASI.pdf)

The Energy, Emissions, Ecology and Agricultural System Integration (EASI) Programme began in 2007 led by the Organic Research Centre and aims to provide practical information to farmers and landowners on ways to increase their overall energy efficiency, reduce their carbon footprint and develop their potential to produce on-farm energy, in a sustainable, ecological way. The EASI Tool has been developed as part of the programme and takes the following into account;

- The efficiency of the different farm enterprises in terms of energy in/energy out;
- Energy use relative to benchmark figures;
- Potential energy yield from such areas as farm woodlands, animal manures and slurries;
- Carbon footprint of the entire farm and each enterprise;
- Carbon sequestration and carbon storage.

A report is produced following the calculation which details areas where the farm could save money and reduce its carbon impact and/or generate energy.

The EASI tool can be accessed through the Organic Research Centre, please contact Laurence Smith for more information at [laurence.s@organicresearchcentre.com](mailto:laurence.s@organicresearchcentre.com)

## Footprints4Food

<http://www.footprints4food.co.uk/>

Footprints4Food Ltd provides cost effective environmental footprinting services, specialising in fresh produce carbon and water footprinting. They have extensive experience in the fresh produce sector and are therefore able to benchmark against industry average figures. The calculations are completed by experts from Bangor University to follow PAS 2050 and Intergovernmental Panel on Climate Change (IPCC) 2006 guidelines.

## Climate Friendly Food Carbon Accounting toolkit

[http://www.climatefriendlyfood.org.uk/carbon\\_toolkits](http://www.climatefriendlyfood.org.uk/carbon_toolkits)

Climate Friendly Food is a not for profit social enterprise, set up in 2008, that tackles climate change through agroecological farming, particularly field-scale veg, market gardening, orchards and other perennials. They certify low-carbon growers, through farmer-to-farmer inspection, and aim to increase carbon awareness and community resilience.

Climate Friendly Food has an online carbon accounting toolkit for farmers and growers. The toolkit included accounting tools for both growers and gardeners on a range of scales.

The CFF Carbon calculator is a sister organisation to Climate Friendly Food.

## References

[1] **Guide to PAS 2050 – how to assess the carbon footprint of goods and services.** Carbon Trust; DEFRA; BSi. [Online : <http://www.bsigroup.com/en/Standards-and-Publications/How-we-can-help-you/Professional-Standards-Service/PAS-2050/> ]

[2] **UK Greenhouse gas inventory method and compilation - global warming potentials.** Department of Energy and Climate Change. [Online: [http://www.decc.gov.uk/assets/decc/statistics/climate\\_change/1\\_20100121130353\\_e\\_@\\_listgreenhousegases.xls](http://www.decc.gov.uk/assets/decc/statistics/climate_change/1_20100121130353_e_@_listgreenhousegases.xls) ]

[3] **Conversion factors.** *Carbon Trust.* [Online: <http://www.carbontrust.co.uk/cut-carbon-reduce-costs/calculate/carbon-footprinting/pages/conversion-factors.aspx> ]

[4] **Types of emissions.** *Carbon Trust.* [Online: <http://www.carbontrust.co.uk/cut-carbon-reduce-costs/calculate/carbon-footprinting/pages/organisation-carbon-footprint.aspx> ]

[5] **2006 IPCC Guidelines for National Greenhouse Gas Inventories, Vol 4.** *Intergovernmental Panel on Climate Change.* [online: <http://www.ipcc-nggip.iges.or.jp/public/2006gl/index.html> ]

## Other useful resources

**Atmospheric emissions reports.** *National Atmospheric Emissions Inventory* [online: <http://naei.defra.gov.uk/reports.php> ]

**Carbon footprinting for farm businesses.** *Better Organic Business Links – Tony Little, Organic Centre Wales; Laurence Smith, Organic Research Centre, Elm Farm.* June 2010 [Online: [http://www.organiccentrewales.org.uk/uploads/carbcalcfull\\_report\\_a4.pdf](http://www.organiccentrewales.org.uk/uploads/carbcalcfull_report_a4.pdf) ]

**Calculating farm scale greenhouse gas emissions.** *Jan Dick, Pete Smith, Ron Smith, Allan Lilly, Andrew Moxey, Jim Booth, Colin Campbell, Drew Coulter.* June 2008. [Online: <http://www.cplan.org.uk/Calculating%20GHG%20Report.pdf> ]

**DEFRA GHG Conversion Factors.** *Department for Environment, Food and Rural Affairs.* [online <http://archive.defra.gov.uk/environment/business/reporting/conversion-factors.htm> ]

**Farming Futures Factsheets.** [online: <http://www.farmingfutures.org.uk/resources/factsheets> ]



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