Gwell Cysylltiadau Busnes Organig

BOBL

Better Organic Business Links

Carbon footprinting for farm businesses

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Better Organic Business Links – Gwell Cysylltiadau Busness Organig

The Organic Centre Wales has received £2 million funding through the Rural Development Plan for Wales 2007-2013, which is funded by the Welsh Assembly Government and the European Agricultural Fund for Rural Development, to run the Better Organic Business Links (BOBL) project over three years (2009-2012). The BOBL project is designed to support the primary producer in Wales and grow the market for Welsh organic produce in a sustainable way. The project will develop new, emerging and existing markets for organic produce whilst driving innovation, at all levels, within the supply chain. It will strive to increase the consumer demand and markets for organic produce, especially in the home market whilst also ensuring that the primary producers are aware of market demands. The project will provide valuable market information to primary producers and the organic sector in general.

Delivery of the project is divided into five main areas of work:

1. Driving innovation
2. Consumer information and image development of organic food and farming in Wales
3. Market development
4. Market intelligence
5. Addressing key structural problems within the sector

2 Executive Summary

As awareness of our impact on the environment has increased, it has become more important to measure and monitor that impact accurately. In this context, several calculators have been developed to assess the carbon footprint of farm businesses. However, there is little consistency between them in terms of either the methodology or the raw data on which the calculations are based, and this means they can give very different answers to the same question.

In general terms, this document sets out to:

- develop a better understanding of how footprinting calculators work;
- explain how and why they differ from one another;
- highlight the issues to consider when choosing the most appropriate calculator for a particular farm or purpose;
- summarise the key features of the main calculators currently in use.

The following specific points are discussed:

- the basic principle on which all calculators are based is explained;
- the different purposes for which calculators have been developed;
- the concept of emissions scopes and their relevance to footprint calculations;
- the allocation of emissions to farm enterprises and to specific products;
- the limitations of footprint calculators with respect to standard datasets, and the difficulties inconsistent methodologies and limited benchmarking data impose on making comparisons between calculators;
- descriptions of the following calculators: CALM, CPLAN; Managing Energy and Carbon; EASI, Climate Friendly Food, Footprint analysis of Blaencamel Farm; Bangor Farm Model; Agri assist Emissions Footprint Tool;
- summary of the main characteristics of these calculators in a matrix to facilitate the choice of calculator ‘at a glance’.

3 Introduction

As awareness of our impact on the environment has increased, it has become more important to measure and monitor that impact accurately and environmental footprint calculators have been developed to address this need. While some include wide range of environmental resources such as soil, water and biodiversity, however the vast majority, including those reviewed in this report, focus on **carbon footprints (Box 1).**

Box 1: What is a farm carbon footprint?
A farm carbon footprint summarises the greenhouse gas (GHG) emissions from a farm according to farm inputs and outputs.

Canolfan Hinsawdd Cymru, 2010

Calculating the footprints for farms is more complicated than for other types of business because:

- farms in general are complex systems, and organic farms often more so because they tend to be more integrated.
- in most industries, the main greenhouse gas emitted is carbon dioxide (CO2). In agriculture methane (CH4) and nitrous oxide (N2O) are much more important; only about 10% of total agricultural emissions are of CO2.1;
- farming and the land based businesses can sequester as well as emit carbon.

Several calculators have been developed specifically for farms, but inconsistencies between them, in terms of what exactly is included in the assessment and the raw data they use, can give rise to a certain amount of confusion.

The aim of this piece of work is to:

- develop a better understanding of how footprinting calculators work;
- clarify how and why they differ from one another;
- highlight the issues to consider when choosing the most appropriate calculator for a particular farm or purpose, with particular reference to organic farms;
- summarise the key features of some of the main calculators currently in use.

4 Why calculate farm footprints?

Broadly speaking there are three reasons why the footprints of farms are calculated:

- to help farmers measure, monitor and reduce environmental footprints and subsequently improve the efficiency and performance of their business;
- to inform strategy and policy development;
- as a marketing tool to help environmentally conscious consumers choose the products they buy.

Different calculators are suited for different purposes, and this has a significant impact on the scope and the methodology of the calculators. This theme will be picked up throughout the remainder of this document.

5 How carbon calculators work

5.1 The basic principle

The basic principle on which all these calculators work is very simple. There are two components:

[1] About half of all agricultural emissions are due to N_2O; 40% are due to methane; and about 10% are due to CO_2.

- a database with standard figures for emissions (or sequestration rates) associated with an individual item or process;
- farm specific information.

The calculator then multiplies these two components together to give total emissions associated with each individual parameter as illustrated in Table 1. It then adds them all together to provide an estimate of the total emissions associated with that particular farm or enterprise.

As discussed in Section 1, N_2O and CH_4 are important greenhouse gases. However, their global warming potential is different to that of CO_2 so farm footprints are measured in **CO_2 equivalents.** A kilogramme of CH_4 has the same effect as 23 kg of CO_2, and therefore has 23 CO_2 equivalents. A kilogramme of N_2O has 296 CO_2 equivalents estimated over 100 years.

We also identified in section 1 that agriculture has the potential to sequester as well as emit carbon. Some calculators attempt to take this into take account when calculating the net Global Warming Potential (GWP) of the farm.

In practice, all calculators are a good deal more complicated, but it is important to understand the underlying mechanism.

Table 1: How a carbon calculator works

Parameter	No. Units (Farm data)	Emissions per unit (Kg CO2 Eqv/ Unit)2	Total emissions (Kg CO2 Eqv)
Diesel	3,000 litres	2.31	6,930
Electricity	1,500 Units	0.53	795
Dairy cows including manure (CH4)	100 Head	2,944	294,400
Beef cattle including manure (CH4)	15 Head	1,167	17,505
Sheep including manure (CH4)	150 Head	188	28,200
Grass clover, ha (N2O)	10 ha	555	5,550
Etc, etc			
TOTAL Emissions			353,380
Sequestration – Natural woodland regeneration on arable land	10 ha	12,517	125,170
Bioenergy crop production	10 ha	4,520	45,200
TOTAL Carbon Sequestration			170,370
Net Global Warming Potential			183,010

5.2 Setting the system boundaries

When completing an assessment, a first and very important step is to very clearly define the boundaries of the system and set the **scope** of the measurement. With respect to emissions, the World Business Council for Sustainable Development (WBCSD) has defined three scopes, which have been accepted internationally (Figure 1):

- *Scope 1* refers to direct emissions from sources that are owned or controlled by the company. This includes emissions from diesel used by tractors, propane used by grain dryers, gas for heating, kerosene for boilers etc. It also includes direct emissions from soils and livestock.
- *Scope 2* is a separate category for emissions associated with the generation of purchased electricity consumed on the farm.

[2] Sources: National Atmospheric Emissions Inventory and Carbon Trust energy and carbon conversion factors. Carbon sequestration figures taken from Falloon *et al*. 2004.

- *Scope 3* refers to indirect emissions including those associated with the production, processing and distribution of inputs in to the farming system. These include seed, bought-in grain and compound feed, fertilisers, pesticides and so on.

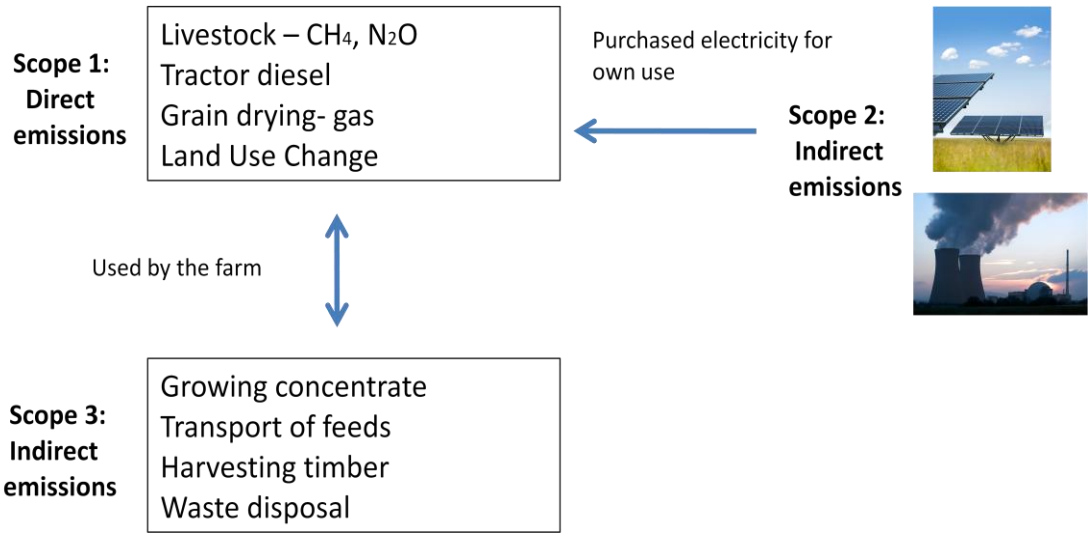

Figure 1: WBCSD Scopes for calculating carbon emissions.

It is sometimes possible to select data for the scope relevant to your purpose. In other cases, the scope is reflected in the calculator's database, so you do not make a conscious decision on the scope of the calculator. In this circumstance it is very important that you are aware of the scopes that are included in the data, and that you understand the implications for the final footprint.

5.3 Allocating emissions to enterprises

Although the total footprint of the farm is of interest, more often than not the value of the exercise is in being able to see which aspects of the business make the largest contributions to the total emissions, and to identify practical steps that can be taken to reduce those emissions, improve efficiency and make savings. To do this, it is necessary to allocate emissions to a specific enterprise. Sometimes this is easy and obvious; the energy used to cool milk is clearly a cost of dairy enterprise and it is a simple matter to work out the number of units of electricity per litre of milk.

However, it is not always so straight forward for integrated systems, typical of organic farming. The problems arise where one item or process serves more than one enterprise, or where one enterprise has more than one product. Box 2 highlights some examples of where this might occur. The emissions are usually split between the different enterprises, but there is little agreement or consistency about how this is done between calculators.

Box 2: A burden shared……

Clover rich leys build soil fertility which is exploited by a following arable or horticultural crop. They are also grazed or cut for silage, and therefore are also part of the livestock enterprise. The emissions associated with the establishment and management of the ley therefore need to be shared accordingly.

Animal manures are a cost of livestock enterprises, but an input into cropping enterprises.

Arable crops produce grain and straw. Straw is used for bedding, which means the emissions associated with its production are also a cost to the livestock. The grain is a product of the arable enterprise, and the carbon costs need to be split accordingly.

5.4 Allocating emissions to products

There is growing interest in footprinting individual products, rather than farms. This process usually accounts for all the environmental impacts associated with a product from raw material acquisition through to production, use and disposal. This approach is often referred to as a **Life Cycle Analysis** (LCA, ISO, 2006). The Carbon Trust UK have already developed an LCA methodology for the UK called PAS (Publically Available Specification) 2050[3], the guidelines for which can be freely downloaded.

One of the benefits of this detailed approach is that it can help companies identify carbon intensive 'hotspots' in their supply chain and work towards reducing their emissions (Maung, 2009). Data acquisition is however notoriously difficult when the supply chain is long. In addition to identifying potential reductions, such assessments can be used to label the environmental attributes of products in the market place. For example, companies completing a PAS 2050 compliant assessment can apply to the Carbon Trust Footprint Company to display a logo (Figure 3) on their packaging indicating their CO_2 footprint, and stating that they are taking action to reduce their impact.

Figure 3: Carbon label from Carbon Trust Footprint Company.

While LCA approaches for carbon footprinting have been questioned on the basis of cost, and the uncertain impact of carbon labelling on consumers purchasing decisions (Bolwig and Gibbon, 2009), experience suggests that these concerns are being addressed. For example, the Carbon

[3] PAS 2050: 2008. Specification for the assessment of the life cycle greenhouse gas emissions of goods and services. Published by British Standards (2008). See www.bsigroup.com/Standards-and-Publications for more information

Trust Footprint Company has footprinted over 5000 individual products, and labelled products currently available represent over £2.8bn in annual sales value (Sinden, 2010, pers comm).

Life Cycle Assessment methods could also help measure progress towards national and international greenhouse gas reduction targets and it is likely to become more common in future as the popularity of carbon labelling increases. In a further recent development, the UK Accreditation Service has recently accredited four companies (certification bodies) as being able to provide independent, third party verification of product carbon footprint results from PAS 2050. This independent validation of product carbon footprint results is a world first, and is expected to deliver further confidence in the certainty and validity of product carbon footprint results that are being made publicly available.

Despite the introduction of standards such as the PAS2050, this type of assessment can be difficult for non-experts (Bolwig and Gibbon, 2009) because of the sometimes complex calculations involved, and the need to access emissions data from a variety of sources. A number of consultancy firms in the UK have tried to address this issue through the development of PAS2050 compliant assessment calculators, for use by their team of consultants. In this country the E- CO_2 project, AB Sustain, Agri Assist and ERM have all developed calculators which can considerably reduce the amount of time needed to assess agricultural products. To date these private consultancies have tended to contact their farmer/producer clients through retailers, rather than being contacted directly. It is possible that in future producers who wish to direct market their products could make use of the services directly for example the Agri Assist calculator has been developed for use by farmers, rather than consultants. There are, however, some concerns over the application of PAS2050 to agricultural systems, for example the fact that it does not account for interactions between systems on a mixed organic farm. The debate on how such issues can be resolved effectively is currently ongoing.

6 Some problems and limitations

6.1 Quality of data

The database of emission factors and input values is the foundation on which any calculator is built and any weaknesses in the dataset will be reflected in the final results. Ideally the standard emission figures should be independently verified and widely agreed upon. In addition there is no industry standard on input data. The problem is particularly acute in two areas:

- Scope 3 emissions. This is of particular concern because these sources can account for over 40% of the total emissions from some agricultural systems (Huang et al. 2009). The current variation in input data sourcing means there is potential to be selective with the data used, in the interest of promoting one product or production system over another.
- Carbon sequestration. It is very difficult to measure carbon stocks and carbon fluctuations accurately and consistently, especially in soils. There are simply not enough relevant studies to draw on for robust data and this is a fundamental problem that will only be addressed by long term investment in appropriate research.

There is also currently a lack of advanced country and farming system specific data. Many calculators are based on Intergovernmental Panel on Climate Change (IPCC) 'Tier 1' data. This is a default factor for an emission source, for example a universal figure for a dairy cow, within any farming system. There is currently a lack of more detailed Tier 2 (country or farming systems specific) and Tier 3 (advanced country/farming system specific) data on which to base estimates. These data may be derived from existing and future studies in this area that meet the guidelines set out by the IPCC.

Making comparisons

The range of emission factors and input data required by different calculators makes it very difficult to make meaningful comparisons of farm or supply chain footprints calculated using different systems. For example some will choose to leave out scope 3 emissions altogether, whereas others will include the full life-cycle of the products being assessed. Being clear about the scope of an assessment and the tier-level of the data that is being used is important to ensuring that (a) like is compared with like and (b) all major sources of emissions are accounted for as accurately as possible. There are also potentially differences in the raw data used, and details of system used to allocate emissions to specific enterprises or products. The best way to make valid comparisons between farms or systems is to use the same calculator.

There is also a problem with finding benchmark figures that allow farmers to compare their farms to others of a similar type. This is a particular issue for the organic sector because there are not enough organic farms to make a robust dataset.

It is very important that the individual circumstances of the farm system are taken into account, and no two farms are ever identical. In addition, consumers, retailers and governments must understand that some farms will have inherently higher footprints, for example those who further from the consumer or have lower quality land. This does not imply that these farms, or farmers, are any 'worse' than other systems that do not have to operate under these limitations.

Choosing the right calculator

In the end, the choice of calculator is determined by the specific job you want it to do. The clearer you are about what the objectives of the assessment and the scope and degree of accuracy that you need, the easier you will find it to choose. Below are some of the key issues to consider when choosing a calculator, and Box 3 lists some of the characteristics that are particularly important for organic farms.

6.2 Ease of use

This includes factors such as: How easy it is to enter data; how the system takes you through each step of the calculation process; the ease of navigation between different screens or spreadsheets; and the overall 'feel' of the programme (e.g. fonts, colours, amount of information on each screen etc). Ideally the type of farm specific data should be easily available without requiring access to detailed sets of historical data, but this is discussed in more detail below.

6.3 Simplicity vs accuracy

As a general rule, systems should be as simple as possible. However, there is a certain level of complexity below which the results are unlikely to be representative of the situation on the ground. Over and above this, there is a trade-off between simplicity and accuracy.

At the very least, the calculator should be able to take account of the farm's system type, livestock enterprises and crop types.

The level of complexity will be reflected in the time it takes to complete the assessment. More complicated systems will generally require more data and therefore more time spent finding and organising the necessary records and entering the data. There is an obvious trade off between the level of detail that can be achieved for specific issues and the practicality of completing an assessment within a limited time frame (Bell and Morse, 1990).

6.4 Scopes and datasets

Make sure that the scope of footprint is appropriate for the job you want the calculator to do (see section 3.2 for more information), and that the data tiers (section 4.1) are consistent.

6.5 Interpreting the results

The results should be easy to understand and give sufficient detail to identify practical, farm specific steps to reduce the footprint of the business. They may include information such as an indication of the degree of uncertainty inherent in the calculation.

Box 3: Footprints for organic systems

The organic principles place a strong emphasis on ecology, and a strong commitment to safeguarding the environment. This means looking beyond the farm gate, and thinking about the impact of the business in the wider context, and what this implies.

Organic farmers should be interested in scope 3 emissions, which can account for up to 40% of the total emissions. These include embodied energy in inputs, machinery, buildings etc and the energy required for the transport and disposal of goods. This is a slightly contentious issue. Some argue that scope 3 emissions are less relevant to farm footprints because farmers are not directly responsible, or in a position to influence them, and in any case, the data are very inaccurate. While both these points are true, our view is that since scope 3 emissions account for such a large proportion of the total footprint, and reducing inputs across the board is one the key ways that farmers can reduce the overall environmental burden of their business significantly, they should be included.

Calculators should include all relevant aspects of the carbon cycle including sequestration, although a lack of fundamental research and robust data makes this more difficult at present

They should ideally consider emissions relative to output to allow the comparison of various enterprises in terms of production efficiency.

7 Summary of some key carbon footprint calculators

This section summarises the characteristics of the some of the calculators under the heading identified in Section 5 above. All the readily available calculators were tested by project staff, using actual farm data where it was available and model farm data where it was not. Assessments of calculators linked to consultancy services were based on discussions with, and information provided by, the companies concerned.

7.1 Carbon Accounting for Land Managers (CALM)

Developed by:	Country, Land and Business Association (CLA) Contact: Derek Holiday derek.holiday@cla.org.uk Tel: 0207 4607956
Format	Web based calculator
Availability	Free from the CLA Website (www.cla.org.uk/Policy_Work/CALM_Calculator/)
Purpose	Management tool to: assess the carbon balance of farm businesses; identify practical steps to reduce emissions and improve efficiency; identify opportunities for renewable energy projects.
Ease of use	Easy to use, based largely on drop down menus. It is an intuitive system, requiring only basic computing skills. A step by step guide takes you through the calculation process.
Complexity	Fairly simple system. The exercise takes 30–45 minutes to complete providing you have the data to hand.
Methodology	IPPC 2006
Scopes	Scope 1 and Scope 2 data is used. Optional inclusion of Scope 3 data for emissions associated with N fertiliser
Coverage	*Emissions*: Fuel and electricity use (on-farm and by contractors); fertility inputs (N fertilisers, lime imported and exported organic manures); stock; cropping areas and cropping history; tonnes harvested; straw exported; land use changes. Embodied energy in inputs is not part of the main calculation, but there is an option to include it. *Sequestration:* Area of woodland; area of organic soil (peat/fens); land use changes.
Reporting	The report is easy to understand. Practical mitigation advice is generated from a standard menu but is clear and helpful. Reports can be saved and used to monitor changes year on year.

7.2 CPLAN

Developed by:	Drew and Jan Coulter, North Deanhead, Lanarkshire and Ron Smith Contact: Drew Coulter drew@cplan.org.uk
Format	Web based calculator and consultancy; also spreadsheet calculations of LCA not publically available
Availability	Web based calculator available in two versions, CPLANvo and CPLANv2, from the website http://www.cplan.org.uk CPLANvo is a basic free calculator. CPLANv2 is more comprehensive and therefore more useful. It also reports the statistical uncertainty in the estimated emissions using standard IPCC methodology. This version requires you to register and pay a fee dependent on the number of assessments you wish to perform. CPLANv2 calculations form the basis of a paid consultancy which (a) offers farm specific mitigation advise with reports detailing the reduction of specific actions, and (b) reports results of more detailed calculations for enterprise and life-cycle analysis
Purpose	Management tool to: assess and monitor greenhouse gas balance of whole farm or specific enterprises; identify practical steps to reduce emissions; and improve efficiency. To inform policy, specifically to challenge the basis of reduction emission targets imposed by government/EU agencies by empowering farmers with detailed knowledge.
Ease of use	Very easy to use with simple format and the calculation process is clear.
Complexity	This is quite a simple system, focusing very much on direct emissions that are under the control of the farmer The CPLANv0 version takes about 15 minutes to complete, and the CPLANv2 about 30 minutes, provided you have all the information to hand.
Methodology	IPCC 2006 (Tiers 1&2 plus simplified versions of Tier 3) enhanced by UK specific models and data conformant with the UK National Inventory Reports.
Scope	Scope 2 with respect to energy (i.e. purchased electricity). Scope 1 for all other categories. Full LCA following PAS2050 and ISO/TS 14048 guidelines including Scope 3 available as part of paid consultancy.

Coverage	*Emissions*: Energy & fuel use; livestock; fertility inputs (in-organic, on-farm & bought-in manures, legumes); harvested crop residues; soil changes from management, harvested wood (carbon loss). *Sequestration*: Woodland; land use changes.
Reporting	Very simple reporting system showing total emissions associated in categories such as fuel, livestock, crop residues, etc. The basic CPLANv0 reports emissions in Carbon equivalents. CPLANv2 reports emissions of CO_2, CH_4, and N_2O as well as the combined CO_2eq and Ceq, and it also indicates the degree of uncertainty inherent in the calculation by providing upper and lower bounds of estimates. Emissions and sequestration are reported for each input line and for combined categories, eg individual cattle and sheep herds. General mitigation advice is provided in simple language and by links to external sites. Links to specific GHG reducing products also provided.

7.3 Managing Energy and Carbon

Developed by:	Centre for Alternative Land Use (CALU) Contact: Kerrin Buckler 01248 680450 k.buckler@bangor.ac.uk
Format	Paper based
Availability	Free download from the CALU Website or contact CALU. (http://www.calu.bangor.ac.uk/energybooklet.php)
What's it for?	Management tool; to reduce emissions and improve energy efficiency. Knowledge transfer/ advisory tool to stimulate discussion
Ease of use	As the only paper based system reviewed, it may be attractive to those with very limited computer skills. However, it is more cumbersome than its web or spreadsheet based counterparts. The questionnaire is well structured and the calculation process clearly explained.
Complexity	This by far the simplest system under review. It is intended as 'back of an envelope' system, designed to provide only approximate estimate energy consumption and emissions. 1-2 hours to complete.
Methodology	ADAS
Scope	Scope 2 with respect to energy (i.e. purchased electricity). Scope 1 for all other categories.
Coverage	Electricity and fuel use; livestock, crops
Reporting	The results are very broad brush and indicate a range within which the farm is likely to fall. It is then benchmarked against farms of similar types and size, based on data collected by ADAS from about 900 farms in England and Wales. Generic energy saving and emission reduction advice is provided for each enterprise through a check list system.

7.4 SAVEFuel and REfuel

Developed by:	Scottish Agricultural College (SAC) Contact: Rod McGovern 01224 711107 rod.mcgovern@sac.co.uk
Format	Excel Spreadsheets
Availability	As part of paid consultancy
Purpose	SAVEFuel is a farm management tool. REFuel assesses the potential for on-farm production of renewable energy.
Ease of use	Consultant operated
Complexity	Moderate
Methodology	Developed by SAC
Scope	Scope 1 and 2 data is included in the SAVEFuel assessment. Transport of goods and services to and from the farm is not included.
Coverage	SAVEFuel focuses very much on direct energy use and emissions on the farm. REFuel includes power from wind, hydro, solar heat, photovoltaics, energy crops and animal wastes.
Reporting	SAVEFuel calculates total emissions in for individual catagories; identifies potential savings; ranks them according to cost/benefit; and an action plan for implementation. REFuel supports technical feasibility studies provides economic assessments (including payback) of opportunities for renewable energy production.

7.5 Energy, Emissions, Ecology and Agricultural Systems Integration Programme (EASI)

Developed by:	Organic Research Centre - Elm Farm Contact: Laurence Smith laurence.s@organicresearchcente.com
Format	Excel Spreadsheets
Availability	As part of paid consultancy
Purpose	Farm management tool to: highlight areas for improvement in energy/emissions terms; understand the interactions between different enterprises on the farm; optimise the overall benefit of those interactions and assess the economic and environmental impact of on-farm renewable energy generation.
Ease of use	Consultant operated, takes between 1 and 1.5 days of consultant's time to complete for each farm. This includes a farm visit/walk-round by the consultant.
Complexity	A complex system, focusing on interactions between different enterprises on the farm.
Scope	Scopes 1 and 2 are included in the assessment. Some scope 3 data (transport and fertiliser manufacture) is also included.
Methodology	Developed by Organic Research Centre - Elm Farm
Coverage	Detailed energy use and emissions for each enterprise potential for energy production carbon storage and sequestration profile
Reporting	The calculator calculates emissions for each enterprise and produces and compares the farm's energy use to benchmark data for farms of a similar type and size. To put the results in context the assessment process also details how the energy use and emissions of the different areas compares to their energy output. This allows a cost-benefit analysis for each farm enterprise. It also includes an assessment of how any changes suggested fit into the overall farming system and thereby helps the farmer achieve the right balance of enterprises from an energy and emissions perspective. Recommendations are made that are specific to the farm, and incorporate the latest information from ORC research programme.

7.6 Climate Friendly Food

Developed by:	Climate Friendly Food Contact: Jonathan Smith and Jenny Hall jonathan@climatefriendlyfood.org.uk
Format	Web-based calculator
Availability	Free from Climate Friendly Food website (http://www.climatefriendlyfood.org.uk/carboncalc)
Purpose	Farm management tool, to encourage changes in practice to reduce carbon footprints.
Ease of use	Easy to use, based largely on drop down menus. It is an intuitive system, requiring only basic computing skills. A step by step guide takes you through the calculation process.
Complexity	Moderate. The exercise takes about 1 hour to complete providing you have the data to hand.
Scope	Scopes 1, 2 and some scope 3 data are included. Scope 3 data includes: transport of goods to and from the farm and the manufacture of building materials.
Methodology	Developed by Climate Friendly Food. It takes a life cycle approach with a stronger emphasis on sequestration than most other calculators.
Parameters	It is aimed primarily at organic farmers, and this is reflected in the input pages. The fertility section includes several options for fertility building crops and composts, but no data for N fertilisers. Specific parameters include: Fuels, electricity, transport and distribution, contractors, building materials, packaging, crop protection, office heating and lighting, vehicles and machinery, crops (including fertility building crops and green manures), composts, inputs (lime permitted fertilisers etc), livestock, imported feeds. Sequestration data for orchards, woodland, uncultivated areas, wetlands and soils is included.
Reporting	This calculator generates quite a detailed breakdown of the contributions of different parts of the business to total emissions and sequestration. Because sequestration is dealt with in more detail than in other calculators, this calculator often indicates lower net carbon balance than others of its type.

7.7 Footprint Analysis of Blaencamel Farm

Developed by:	Peter Segger, Blaencamel Farm, Aberaeron, Ceredigion peter@blaencamel.com
Format	Spreadsheet based assessment to assess emissions of Blaencamel farm, near Ceredigion
Availability	To date the calculator has only been used for Blaencamel, but could be used more widely with some adaptation.
Purpose	Identifying areas for improvement in energy/emission terms to improve farm's general resilience.
Ease of use	Easy to use – results can be produced in less than half an hour, assuming that all of the relevant information is to hand. However, good spreadsheet management skills are required.
Methodology	Developed by Mr. Peter Segger, Manager of Blaencamel farm. Peter is also a director of the Soil Association, and therefore has a strong organic focus.
Scope	Scopes 1 and 2 are included. Some Scope 3 (i.e: transport and manufacture of packing materials) is also included.
Coverage	*Emissions*: direct fuel use; Livestock emissions; Electricity (including crop storage); employee and customer transportation; Packing materials; Emissions from domestic activities; Compost production. *Sequestration:* soil carbon; woodland and hedgerow establishment; additions of compost.
Reporting	At the end of the audit the emission total is added to the sequestration value. The final figure is then divided by the sales volume to give a net kg CO_2 (e) figure (or net CO_2 (e) gain) per productive unit.

7.8 Bangor Farm Model

Developed by:	Bangor University
Format	Spreadsheet based
Availability	The calculator that has been developed has so far has only been used at the University of Bangor. Its use is currently being extended to Farming Connect Demonstration Farms in Wales.
Purpose	Management tool to assess emissions from individual holdings
Ease of use	Consultant operated system. Requires good knowledge of spreadsheets and some technical expertise to interpret the error margins effectively.
Complexity	Complex, requiring about 1 day of a consultants/researchers time
Methodology	Life Cycle Assessment (LCA), PAS 2050 compliant
Scope	Scope 1, 2 and much scope 3 data
Coverage	Emissions: Direct fuel use; electricity; direct and indirect CH4 and N2O from livestock, arable and soils; embodied emissions and transport of materials to the farm; waste disposal; direct emissions resulting from land-use change. The model has focused on livestock farms to date, however it could be applied to arable units with some adaptation. Sequestration: Soils, woodlands, individual trees on the farm and hedgerows.
Reporting	Results are presented as a detailed breakdown of the contributions of different parts of the business to total emissions and sequestration, and allocated to multiple products on the basis of revenue. Confidence intervals are included as a measure of uncertainty in the system.

7.9 Agri assist – Emissions Footprint Tool

Developed by:	Dairy Crest Direct Ltd and Agri Assist Ltd Contact: Michael Masters mmasters@edgarley.fsworld.co.uk Tel: 01458 835060
Format	Web based calculator for dairy products
Availability	Fee payable
Purpose	Management tool developed by farmers for farmers to enable measure and manage emissions techniques on farm. Interactive Webtool, providing tips and hints as farmer enters data through process to provide emissions per litre, per cow and per hectare. Farmers completing the assessment can also use the Carbon Reduction Label on their product, as long as the Carbon Trust have inspected datasets within any marketing group.
Ease of use	Companion guide provided to highlight areas where information is required to be compiled for data entry. Advise using data from Financial Year. Easy to enter data, based largely on drop down menus. It is an intuitive system, requiring only basic computing skills. Instant result provided once all data entered.
Complexity	The process takes 2 hours to complete providing you have the data to hand.
Methodology	Carbon Trust Accredited Model approved to PAS2050
Scopes	Comprehensive as determined by PAS2050.
Coverage	*Emissions*: 12 months data providing full emissions status for the dairy enterprise, including livestock numbers on farm, (ability to incorporate bought in replacements), butterfat adjusted milk production, purchased and home grown feeds used, crop inputs (ferts, herbicides/pesticides), manure usage on farm (including imports/exports), fuels used, water used, plastics use and disposal. *FWAG* – developed habitat report also generated as a result of data entry.
Reporting	The report provides contemporary comparison (energy bar charts as seen on electrical products), with results per litre, cow, hectare. Practical tips and advice is suggested during audit process. Reports can be saved and used to monitor changes year on year, plus what if scenarios can be deployed by farmer to see the emission effects of potential changes to management practices.

8 Key characteristics of calculators reviewed

	CALM	CPLAN	Man. Energy & Carbon
Developed by	CLA	D & J Coulter	CALU
Format	Web	Web & Spreadsheet	Paper
Availability	Free	1) Free (simple) 2) Pay-click-calculate (more complex) 3) Consultancy (spreadsheet not publically available)	Free
Purpose	Farm management.	Farm Management; policy development	Farm management
Ease of use	High	High	Medium
Complexity	Medium	Medium	Low
Methodology	IPCC	IPCC plus UK National	ADAS
Scope	1, 2, some 3	1 & 2 on web; 3 consultancy only	1, 2
Emissions from fuel & electricity	✓	✓	✓
Emissions from Livestock	✓	✓	✓
Emissions from soil/ crops	✓	✓	✓
Focus on organic systems	x	x	x
Sequestration	✓ (Outline)	✓ (Outline)	x
Website/ Contact Details	*www.cla.org.uk/Policy_Work/CALM_Calculator/*	*www.cplan.org.uk*	*k.buckler@bangor.ac.uk*

Key characteristics of calculators reviewed continued

	SAVEFuel/ REFuel	EASI	Climate Friendly Food (CFF)
Developed by	SAC	ORC – EF	CFF
Format	Spreadsheet	Spreadsheet	Web
Availability	Consultancy	Consultancy	Free
Purpose	Farm management	Farm management	Farm management; certification; marketing
Ease of use	Consultant operated	Consultant operated	High
Complexity	Medium	High	High
Methodology	SAC	Organic Research Centre	Climate friendly Food
Scope	1, 2	1, 2, some 3	1, 2, some 3
Emissions from fuel & electricity	✓	✓	✓
Emissions from Livestock	✓	✓	✓
Emissions from soil/ crops	✓	Limited	✓
Focus on organic systems	x	✓	✓
Sequestration	x	✓ (Detailed)	✓(Detailed)
Website/ Contact Details	*rod.mcgovern@sac.co.uk*	*laurence.s@organicresearchcente.com*	*http://www.climatefriendlyfood.org.uk/carboncalc*

Key characteristics of calculators reviewed continued

	LCA analysis of Blaencamel farm	Bangor Farm Model	Agri assist emissions footprint tool
Developed by	Peter Segger	Bangor University	Dairy Crest Direct Ltd and Agri assist Ltd
Format	Spreadsheet	Spreadsheet	Web
Availability	Free	Not publicly available	Fee payable for use of tool
Purpose	Farm management	Farm management	Farm management tool
Ease of use	Medium	Research tool	Medium
Complexity	Medium	High	Medium
Methodology	Own methodology	LCA – PAS 2050	LCA – PAS 2050
Scope	1, 2, some 3	1, 2, 3	1,2,3
Emissions from fuel & electricity	✓	✓	✓
Emissions from Livestock	✓	✓	✓
Emissions from soil/ crops	✓	Limited	✓
Focus on organic systems	✓	x	x
Sequestration	✓ (Detailed)	✓ (Detailed)	✓
Website/ Contact Details	*peter@blaencamel.com*	*www.senr.bangor.ac.uk*	*mmasters@edgarley.fsworld.co.uk*

9 References:

Bell, S, Morse S. 1990. *Sustainability Indicators – Measuring the Immeasurable?* London: Earthscan.

Bolwig, S., Gibbon, P. 2009. *Counting Carbon in the Marketplace – overview paper*. [online]. www.oecd.org/dataoecd/29/40/42886201.pdf. Accessed 31/03/10.

British Standards Institution website. 2008. *PAS 2050 - Assessing the life cycle greenhouse gas emissions of goods and services*. [online]. www.bsi-global.com/en/Standards-and-Publications. Accessed 12/09/09.

Canolfan Hinsawdd Cymru , (2010) *'Farm Carbon Footprints'* Canolfan Hinsawdd Cymru Farming Connect Climate Change Development Programme

Department of Energy and Climate Change. 2009. *The UK Low Carbon Transition Plan*. [online]. *www.decc.gov.uk › Publications.* Accessed 01/03/10.

Huang, Y., Weber, C., and Matthews, H. 2009. Categorization of Scope 3 Emissions for Streamlined Enterprise Carbon Footprinting.
Environmental Science and Technology, 43 (22), pp 8509–8515.

Maung, Z., 2008. Carbon Footprints - Made to Measure. *Ethical Corporation, Dec 2008 - Jan 2009*. pp 32-33.

ISO (International Organization for Standardisation). (2006). *Environmental management – Life cycle assessment – Principles and framework*. Geneva: ISO.