Understanding the Carbon Footprint of our Food

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Introduction

If you pick up a pack of potato crisps you may notice a black footprint logo alongside the nutrition information and ingredients list. This represents the 'carbon footprint' of the product. The snack sector may seem an unlikely pioneer in environmentally friendly consumption, however, this footprint logo is a practical application of 'nutritional ecology'. This final article of the three-part Sustainable Eating Series aims to explain what the carbon footprint is and how we can best use it to help restore our planet's health.

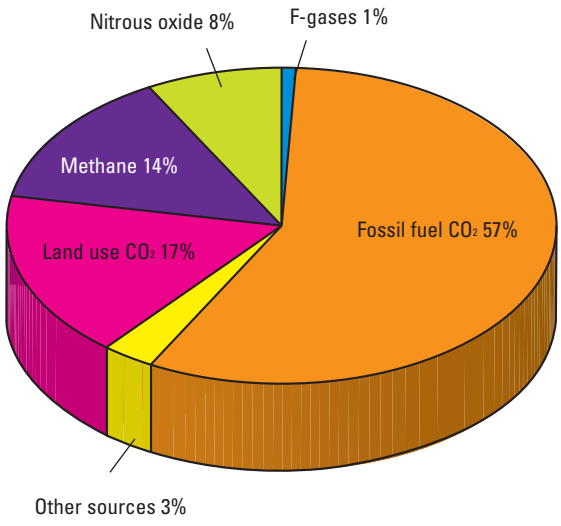
What is carbon footprint?

The carbon footprint is a measure of the amount of greenhouse gases (GHG) produced by our activities in relation to carbon dioxide (CO_2) or carbon (see **Figure 1**). All activities caused by mankind from building our homes, using our cars to flying on holiday can be the subject of carbon footprinting. The carbon footprint on food is an estimate of all the emissions caused by the production (e.g. farming), manufacture and delivery to the consumer and the disposal of packaging. To put the crisps example into context, a 1.4L petrol car emits about 160g CO_2 per kilometer. So a carbon footprint of 80g CO_2 for a standard packet of crisps is about the same as driving a typical petrol powered car half of a kilometer.

Greenhouse gasses & global warming

Greenhouse gases trap heat in the atmosphere. The world is getting warmer and this is highly likely to be due in increases in greenhouse gas concentrations in the atmosphere, particularly **CO_2**, **methane** and **nitrous oxide**. Concentrations have increased markedly as a result of human activities since 1750 and now far exceed pre-industrial values. Human driven emissions rose by 70 per cent between 1970 and 2004.

Figure 1: Global Man-made Greenhouse Gas Emissions Related to their Global Warming Potential



Source: taken from the IPCC Fourth Assessment Report

Methane emissions come mainly from agriculture. Ruminants (e.g. cattle and sheep) emit methane in digesting forages, and the gas is released from manures. **Nitrous oxide** is emitted from the nitrogen cycle in soils and emissions are increased by fertilisation of crops and grassland. The growth of global agriculture to feed an increasing population with more meat and dairy consumption is a major driver behind the increased release of methane and nitrous oxide. Converting natural vegetation to agriculture, for example clearing forest for pasture, is a major driver behind deforestation emissions.

Measuring the carbon footprint

Carbon footprints are generally measured using Life-Cycle Assessment (LCA) or derivatives of LCA. LCA, also called 'cradle-to-grave analysis', estimates all the emissions and resource use from the very beginning of the production process (e.g. mining) through to manufacture, use and disposal. Carbon footprints derived from LCA can guide consumers in choosing more climate friendly products. Conducting the LCA is particularly valuable in that it reveals emission 'hotspots' in the processing and delivery process, helping manufacturers identify ways to save energy.

Food and greenhouse gas emissions

We are familiar with the idea that using our cars, heating our homes, powering our factories and so on cause GHG emissions. There are other much more damaging GHGs than CO_2 from fossil fuels, particularly from farming. When these emissions from agricultural soils and animals are added to the CO_2 from processing, manufacture, and so on, food accounts for a large proportion of all emissions. World wide, agriculture is directly responsible for about 14 per cent of all GHG emissions and these are dominated by **nitrous oxide** from fertilised soils and **methane** from farm animals. Land use change, dominated by deforestation for food production, plays an even bigger role at about 17 per cent. So the carbon footprint of a litre of milk includes the emissions from the production of feeds, emissions of methane from the digestion processes and from manure, and even the nitrous oxide from the soil increased by urine from cattle.

Greenhouse Gases from Farming

The gases from agriculture are particularly damaging. The effect of one kilogram of methane on the climate in 100 years is 25 times greater than CO_2. On the same timescale, nitrous oxide is 298 times more damaging than CO_2. To make a very complex picture a little simpler, estimates express combinations of these gases in term of CO_2 equivalents.

Food and our personal carbon footprints

Cranfield University research for Defra provided detailed LCAs of the major UK farm products (see **Figure 2**), demonstrating that the carbon footprint of British meat and milk is higher than plant-based foods. It is now accepted by the global scientific community that livestock products are carbon intensive. Perhaps for the first time in any country, the Cranfield team went on to estimate the total carbon footprint of UK food consumption. The research covered the full life-cycle of all major UK food supply chains, from the production of farm inputs, right through to home refrigeration and food preparation. It estimated that emissions directly from the food system amount to 20 per cent (152 million tonnes of carbon dioxide equivalent or 6.8kg CO_2 per person per day) out of a total UK carbon footprint of about 748 million tonnes (about 12 tonnes per person per year). When the indirect effects of deforestation are considered, **the proportion of the UK's carbon footprint accounted for by food increases to 30 per cent.**

Our personal contributions to the carbon footprint

On average, each person on the planet is responsible for the release of the equivalent of about seven tonnes CO_2 each year, or about 19kg per day. This is not just CO_2 from fossil fuel use, for example, to fuel our cars and central heating. Nearly half of emissions are not from fossil fuels. Methane and nitrous oxide come predominantly from food production while 17 per cent comes from deforestation which is strongly linked to agriculture. So after energy use, it can be concluded that the production of our food is the second most important driver behind man-made climate change.

More plant based eating to reduce our carbon footprint?

More than half of the emissions from food come from **farming** and **fishing** (see **Figure 3**). Of these, nearly two-thirds come from animal products which provide only about one third of the food energy in UK food. So on the basis of our food energy, **livestock products have nearly twice the carbon footprint of plant based foods.** The result is that consumers who switch to more plant-based diets generally reduce their carbon footprint, particularly if they compensate for the switch by consuming more carbohydrate rich products and in-season fruit and vegetables. Removing meat completely from the diet reduces the food carbon footprint (FCF) by 20 per cent whilst, reducing all livestock products by 50 per cent reduces the FCF by 13 per cent. We can all reduce emissions too by changing the way we store and prepare food – after farming, refrigeration in particular is a large source of emissions. See **Figure 3**.

Other ways of reducing our food GHG emissions include farming more efficiently by using less fertiliser and improving the productivity of animals. The Cranfield research considered all these options and concluded that changing consumption is central to a broader effort to reduce food-related carbon emissions.

Food carbon footprints and healthy eating

For the nutritional adviser, the question arises as to how healthy eating affects our food related carbon footprint. Unfortunately, the UK Food Standard Agency's Eatwell Plate does not quantify the desired contribution of food types. This not only makes implementation of the Eatwell Plate difficult for consumers, it makes it difficult to assess the environmental effects of the Eatwell Plate. The Eatwell Plate advises to reduce animal protein and fat whilst increasing plant fibre and fruit and vegetable intakes. From the Cranfield research, we can say with some certainty that adoption of the Eatwell Plate would generally reduce the FCF where meat and dairy consumption is reduced.

Figure 2: Greenhouse Gas Emissions from UK Production of Potatoes, Wheat, Poultry and Beef

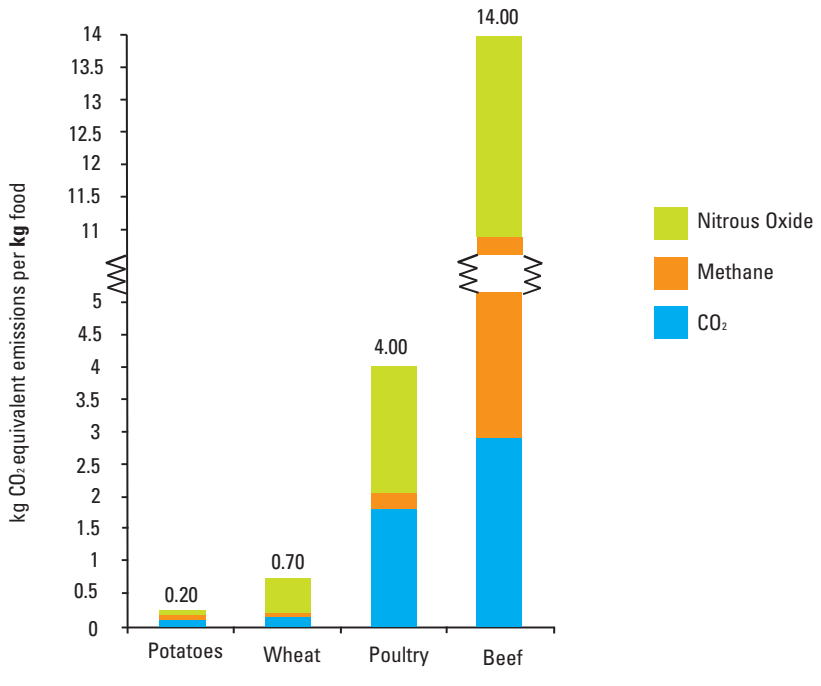
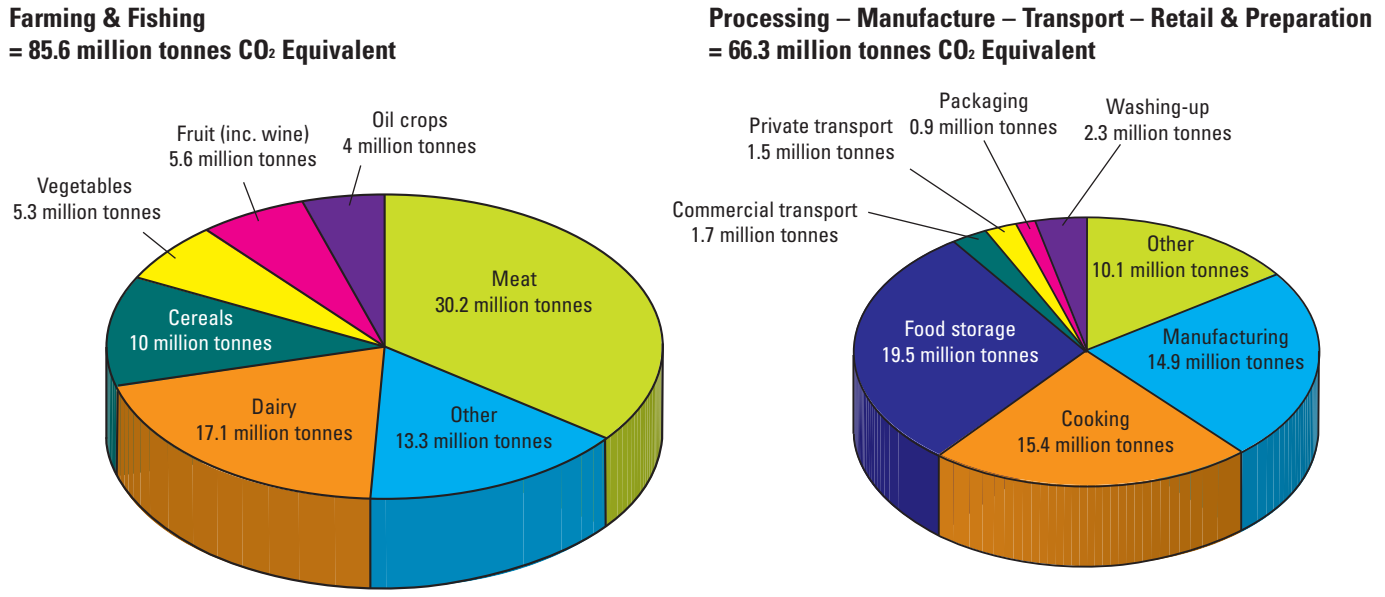


Figure 3: The UK's Food Related Carbon Footprint (152 million tonnes CO_2 equivalent)



Source: Audsley E, et al (2009). An assessment of greenhouse gas emissions from the UK food system and the scope for reduction by 2050. How low can we go? WWF UK and the Food Climate Research Network.

Climate friendly healthy eating for your patients

For the typical consumer a low carbon diet is aligned to healthy eating:

- Increased use of substitutes for butter and cheese (e.g. margarine and cheese analogues)
- Switch to low fat milk or soya milk/yogurt alternatives
- More meat free days
- Smaller portions of meat
- More starchy foods (e.g. whole grain cereals and potatoes), and seasonal fruit and vegetables.

There would be a general increase in the consumption of foods rich in complex carbohydrates – e.g. bread, pasta and potatoes balanced by a general increase in fruit and vegetables. Whole grain products are particularly climate friendly because cereal crops are efficient, have a broad role in the diet and lower processing requirements. The adoption of culinary traditions (e.g. Chinese) where meat is often used just as a condiment may play a role. And there are also European traditions, for example the Mediterranean tradition of using meat sparingly in cereal-based dishes (pasta) and the northern European tradition of basing meals on bread ('Abendbrot') and vegetable soups and stews that use meat only for flavouring.

There could be a move towards more products such as industrially fermented microbial based protein, textured vegetable protein or tofu. There is no particular need to adopt these substitutes if animal products are reduced rather than eliminated. Some consumers accustomed to high protein intake may find this a challenge. Much will depend on the food manufacturing industry and the retail and food service sector increasing the plant-based components of their products and providing attractive alternatives to meat and dairy based products.

Unlike the UK's FSA, other countries are explicit about desirable levels of components in the diet. The German Society for Nutrition recommends a weekly intake of meat of 300–600g (compared with a current average intake of about 1,100g per week in the UK). An international study concluded that: *"Particular policy attention should be paid to the health risks posed by the rapid worldwide growth in meat consumption, both by exacerbating climate change and by directly contributing to certain diseases. To prevent increased greenhouse gas emissions from this production sector, both the average worldwide consumption level of animal products and the intensity of emissions from livestock production must be reduced".* The authors go on to advocate an average intake of 630g per week, with no more than 300g as beef or sheep-meat.

In summary

Overall, the direction of travel for the consumer is clear: reducing the consumption of livestock products is central to reducing food carbon footprints and this supports healthy eating. It also opens up opportunities to address a wide range of other environmental problems affecting our countryside, air and water arising from the current high level of livestock production. Producing livestock uses scarce agricultural land. So at a global level, moderating demand in the richer countries is part of making resources available so that the world's poorest can improve their diets in a resource constrained world which will have nine billion people by 2050.

About the author...

Dr Donal Murphy-Bokern is an independent agricultural scientist based in Germany. He directs agricultural and environmental research and also works with public bodies on related food and agricultural matters. He has worked on greenhouse gas emissions from agricultural systems for about fifteen years in various roles in the UK and Germany.

Recommended further reading: **1.** Williams A, Audsley E, Sandars D (2006). Determining the environmental burdens and resource use in the production of agricultural and horticultural commodities. Defra project report IS0205. **2.** Audsley E, et al (2009). An assessment of greenhouse gas emissions from the UK food system and the scope for reduction by 2050. How low can we go? WWF UK and the Food Climate Research Network. **3.** Friel S, et al (2009). Health and Climate Change 4 – Public Health Benefits of Strategies to Reduce Greenhouse –Gas Emissions: Food and Agriculture. The Lancet Online. **4.** Garnett T (2008) Food Climate Research Network. Food, Green House Gas Emissions and Our Changing Climates. Food Climate Research Network, Centre for Environmental Strategy, University of Surrey.