Instant expert: food

The greenhouse gas emissions associated with our food consumption amount to around a fifth of our total household emissions.

KEY MESSAGES

Understanding the food supply chain, and assessing each stage in an item of food's journey from its original state to our plate, can help us to make lower-carbon choices. The stages are:

- Agriculture and fertiliser: how the food is produced up to the farm gate. Included deforestation, land use change.

- Manufacturing and packaging: processing that happens after the farm.

- Transportation: how far the food travels from the farm (or place of production) to a retail distribution centre such as a supermarket.

- Retail and catering: where we acquire the food.

- Home and waste: how we get the food home and what we do with it.

There are savings to be made at each stage. The most significant changes we can make to lower the greenhouse gas (GHG) emissions associated with the food we eat are to:

- Reduce consumption of meat and dairy products, particularly beef, lamb and cheese.
- Eat food that is in season and food that is produced locally.
- Plan meals and shopping trips to minimise waste.

INSTANT EXPERT CRIB NOTES

Assessing the environmental impact of food production and consumption is very complicated. For each item of food that reaches our table, there are often many stages in the journey from its original state on a farm, in the sea, or in a factory. A pint of milk is a relatively simple example; a cook-chill ready-prepared prawn curry is a very much more complex one. Calculating the environmental impact of each item of food is laborious and can be inexact. Not all food is tracked meticulously, so the origin of all the ingredients is not always clear. This is particularly true of processed food, so measurements can be inaccurate or incomplete. However, repeated studies have shown similar measurements which lead to some very clear guidelines. This document attempts to explain the conclusions of these studies and to give some general guidelines for how to reduce the GHG emissions associated with the food we consume.

When describing the carbon footprint of an item of food the measurement is usually expressed as CO_2e per kg of food. The abbreviation CO_2e stands for the amount of carbon-dioxide emissions and will include other green house gas emissions such as methane and nitrous oxide.

FACT BOX

- It is important always to talk about GHG emissions not just CO_2 as methane (CH_4) and nitrous oxide (N_2O) contribute substantially to GHG emissions.
- Estimates suggest that food consumption accounts for up to 29% of our GHG.[1]
- Breaking down the 19% figure for overall food consumption, the GHG emissions associated with each stage of the food supply chain can be divided into:

44% Agriculture and fertiliser
18% Manufacturing and packaging
12% Transportation
13% Retail and catering
11% Home and waste disposal

- A Dutch study quoted in *Cooking up a Storm*[2] breaks down the GHG emissions of our diet as follows:

28% Meat, meat products and fish
23% Dairy
15% Potatoes, fruit and veg
15% Drinks and sugar products
3% Oils and fats
3% Other

Compiled Summer 2011

[1] *Systematic review of greenhouse gas emissions for different fresh food categories*, Clune et al (2017) Journal of Cleaner Production, Vol 140 (2017) 766-783.
[2] *Cooking up a Storm*, Garnett, T. (2008), p4. http://www.fcrn.org.uk/sites/default/files/CuaS_Summary_web.pdf [Accessed 30 Aug 2011], p8.

The food supply chain

When looking at the GHG emissions associated with our food consumption, it is important to consider the whole food chain – 'from plot to plate' or 'from fork to fork'. Very often, advice focuses on a particular feature of our diet such as 'food miles' or 'local food'. But taken in isolation, this advice is not always helpful when attempting to reduce the carbon footprint of our food.

Agriculture and fertiliser

Agriculture is the beginning of the journey for most of the food we eat. From the GHG emissions figures for each stage of the food chain, it's clear that agriculture and fertiliser contribute disproportionately to emissions. This is due mainly to two factors:

i. 'Enteric fermentation of ruminants'. This is a technical term describing a particular feature of the digestive systems of cows and sheep which causes them to belch and fart methane (CH_4). Breaking down the grass and other feed that ruminants need to produce milk or grow to a sufficient size to be slaughtered for meat entails a complicated digestive process, and methane gas is a by-product of this. Methane is also produced from manure (depending on how it is stored, methane or carbon dioxide is released into the atmosphere). There is a fuller explanation of both aspects of methane production in Chris Goodall's book, *How to live a low-carbon life*.[3]

ii. Nitrous oxide emissions. Nitrous oxide (N_2O) is emitted when nitrogen-based fertilisers are applied to land. It is a very powerful greenhouse gas – more so even than methane and carbon dioxide.[4]

Other studies which back up the price we pay in environmental terms for our meat and dairy industries suggest that livestock farming is responsible for 18% of the world's GHG emissions.[5]

Finally, **land use change** is a significant factor when looking at the GHG emissions associated with agriculture. As more and more of the world adopts a western diet – typically meat and dairy rich – more land is needed to provide this food, meaning land that was previously forest is now used for grazing livestock or for producing crops to feed them. This has a double effect: the forest is no longer sequestering carbon[6]; and the livestock are producing methane (or fertilisers have been applied to crops, thus releasing nitrous oxide). A figure quoted in *How low can we go?*[7] suggests that 18% of global GHG emissions arise from land use change and depletion of forests.

Manufacturing and packaging

The next stage in the food chain is the journey from the farm to the factory or distribution centre. This will vary hugely depending on the food type. For example, a study at Manchester University[8] calculated that the GHG emissions for a single portion of a ready-prepared, cook-chill lamb curry was 4.3kg CO_2e. This can be broken down as follows: ingredients 65%; manufacturing 18%; packaging 4%; transport 2%; and retail 16%. The report also suggests that preparing the food at home can reduce GHG emissions by 20% as the need for refrigeration is reduced. In *Cooking up a Storm* it is suggested that keeping food chilled contributes some 3-3.5% of the UK's overall GHG emissions.[9] This covers all stages of the food journey, from manufacturing to our homes. So although figures suggest that manufacturing and packaging contribute only 18% of food's GHG emissions, the studies quoted above provide some important indications of where we can make savings. In particular processed and cook-chill food will have a much higher figure than, for example, fresh, seasonal ingredients and dried, simply-packaged pulses.

Transportation

Most of the GHG emissions associated with transportation are from CO_2 emissions from fossil fuels used by lorries, boats and particularly aeroplanes. A study by DEFRA (Department for Environment, Food and Rural Affairs)[10] suggests that transporting food accounts for 25% of all HGV vehicle kilometres in the UK. In general, the shorter the distance an item of food has travelled, the lower the GHG emissions. However, there are important exceptions to this. There is a more in-depth discussion of food miles below.

Retail and catering

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[3] *How to live a low-carbon life* Goodall, C. (2010), p195-196. Earthscan, London.
[4] *Cooking up a Storm* Garnett, T. (2008), p4. p4. http://www.fcrn.org.uk/sites/default/files/CuaS_Summary_web.pdf [Accessed 30 Aug 2011]
[5] *Livestock's long shadow* (2006) Food and Agriculture Organization of the United Nations. ftp://ftp.fao.org/docrep/fao/010/a0701e/a0701e.pdf [Accessed 31 August 2011]
[6] For more information about how carbon sequestration works see http://en.wikipedia.org/wiki/Carbon_sink#Forests [Accessed 5 September 2011]
[7] *How low can we go?* A study conducted for WWF-UK and the Food Climate Research Network. (2009), p11. http://assets.wwf.org.uk/downloads/how_low_can_we_go.pdf [Accessed 31 August 2011]
[8]Reported as an example of a carbon calculating tool developed at the University of Manchester. http://www.manchester.ac.uk/aboutus/news/display/?id=5738 [Accessed 31 August 2011]
[9] *Food refrigeration* Garnett, T. What is the contribution to greenhouse gas emissions and might emissions be reduced? (2007).
[10] The Validity of Food Miles as an Indicator of Sustainable Development, (2005), p3 DEFRA, London http://archive.defra.gov.uk/evidence/economics/foodfarm/reports/documents/foodmile.pdf [Accessed 5 September 2011]

Supermarkets use huge amounts of energy for transportation and refrigeration. To some extent, this part of the food chain is out of our hands and requires government intervention.[11] But we can make a difference by choosing to buy – and therefore, creating a demand for – local, seasonal produce. We have become used to 'an eternal Mediterranean summer' – the availability of a very wide range of fruit and vegetables at all times of the year, distorting our expectations about food availability. Shelves are kept fully stocked, and food that is past its 'sell by' date is discarded. Some local initiatives like the Oxford Food Bank[12] mitigate this by distributing unwanted supermarket food to local charities. As well as making a difference through our food choices, we can also create pressure to reduce waste by asking questions about what happens to unwanted goods.

Home and waste disposal

This part of the journey looks at how food arrives in our homes – and what we do with it.

The figures for food shopping online are not completely clear, but there is evidence that by shopping with some supermarkets – such as Ocado and Waitrose, who use a model that allows you to choose a delivery time when there is already a van delivering nearby – you can save energy. What is clear, however, is that frequent trips in a car to the supermarket do use energy. The Carbon Calculator[13] suggests that by using online shopping we could save 700kg of CO_2 a year, and by reducing our shopping trips to the supermarket from three to one each week, we could save 600kg of CO_2 a year.

Cooking also uses energy. Figures suggest that gas cooking produces fewer emissions than electric, but this depends on the source of the electricity – if it is generated from renewable sources, then electricity is better. Simple measures we can take to cut emissions include:

- Batch bake: if the oven is on, try to cook several things at once.
- When boiling water in pans on the hob, keep the lid on. According to the Carbon Calculator, 'covering pans can reduce energy needed to heat the contents by 90%, and thus reduce the carbon being emitted.'[14]
- Cook food at home rather than buying processed food, particularly food that needs to be kept at a constant chilled temperature.

Finally, we look at food waste. It is estimated that we throw away around 8.3 tonnes of food a year,[15] meaning all the energy expended in producing the food is wasted. The WRAP website http://www.wrap.org.uk/[16] provides huge amounts of advice on how to minimise waste. This is mostly the subject of a separate workshop, but these are the basic ideas:

- Plan meals for the week ahead and make a list before you go shopping.
- Use leftovers to make new meals.
- Compost any uncooked fruit and vegetable peelings, tea bags, and coffee grounds.

[11] *Green to the core? How supermarkets can help make greener shopping easier* Allder, J. & Yates, L. (2009). http://www.direct.gov.uk/prod_consum_dg/groups/dg_digitalassets/@dg/@en/documents/digitalasset/dg_182322.pdf [Accessed 5 September 2009]
[12] http://www.oxfordfoodbank.co.uk/ [Accessed 5 September 2011]
[13] http://www.carboncalculator.co.uk/reductions_transport.php [Accessed 9 September 2011]
[14] http://www.carboncalculator.co.uk/reductions_food.php [Accessed 9 September 2011]
[15] http://www.lovefoodhatewaste.com/ [Accessed 9 September 2011]
[16] Also the Love Food Hate Waste site provides lots of useful tips. http://www.lovefoodhatewaste.com/ [Accessed 5 September 2011]

STRATEGIES FOR REDUCING OUR FOOD CARBON FOOTPRINTS

Reducing meat and cheese consumption

The figures for the GHG emissions associated with the production of beef, lamb and cheese are substantially higher than for other foods. So the first step that we can take to reduce our food-related GHG emissions is to eat less beef, lamb and cheese. A very recent study[17] attempts to correlate the protein content with the GHG emissions of various foods. This suggests that meat substitutes such as tofu and quorn would be lower-carbon replacements for meat protein, as would pulses such as chickpeas, lentils and beans.

For example, replacing spaghetti bolognese made with a modest amount of beef mince and using locally-grown carrots and onions, with a cook-chill prawn curry, would not reduce the GHG emissions and may even increase them. Similarly, replacing beef and lamb with large amounts of cheese would have little effect. However, reducing the amount of beef, lamb and cheese in a meal and using more field-grown vegetables and pulses would make a measureable difference.

For many people, the idea of eating less meat and cheese is difficult. If you do have a household of carnivores then it may be worth looking at the choice of meat: for example chicken and pork have a lower footprint than beef and lamb. The figures for pork are about half that of beef and lamb, with chicken slightly lower still. Other factors which could be considered are whether the meat is local, thus reducing refrigeration and transport and whether it is organic. There is more about organic food production later.

To conclude, eating meat is not incompatible with a lower-carbon diet per se, but the amount and type of meat you eat can have a significant impact on the overall carbon footprint of your diet.

Eat seasonal food and local food

What's seasonal? Apples are a good example of how adapting our choices to the season can make a big difference to our household emissions. When apples are in season in the UK – roughly from September to January – then British apples will have a very low carbon footprint. However, outside these months, any British apples will have been kept in a cold store, which requires substantial amounts of energy. During these months, apples from, say, New Zealand are in season, and although they travel a long distance to arrive at our plate, the GHG emissions associated with shipping are less than that of cold storage. The carbon footprints of apples are as follows:[18]

- Picked from a tree in your garden: 0g CO_2
- Local and seasonal: 10g CO_2
- Average: 80g CO_2
- Shipped, cold-stored and inefficiently produced: 150g CO_2

Local food that has been grown and harvested in season is likely to have a low carbon footprint. Locating pick-your-own and vegetable box schemes is a good place to start. Even better, food that you grow yourself will have the lowest environmental cost. A Scottish paper[19] suggests that each standard-size allotment plot will save one tonne of CO_2 per year.

Farmers' markets provide an easy way for us buy local, seasonal food. In general (and it is usually possible to check), produce sold at farmers' market will have been provided by local farmers. For instance, the East Oxford farmers' market states that they actively look for producers within a 30 mile radius. Farmers' markets also provide an excellent opportunity to meet farmers and find out more about where our food comes from.

There are many guides to what's in season, for example in *How bad are bananas?*. There are regional differences, as crops tend to be ready to harvest earlier the further south you go.

Plan what you eat and shop less often

There are several small changes we can make that will help:

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[17] Protein efficiency per unit energy and per unit greenhouse gas emissions: Potential contribution of diet choices to climate change mitigation, Gonzalez, A.D., Frostell, B, Carlsson-Kanyama, A. (2011), Food Policy, 36, p 562-570. http://www.sciencedirect.com.libezproxy.open.ac.uk/science/article/pii/S030691921100090X#bibl001 [Accessed 5 September 2011] NB requires access to academic journals.

[18] *How bad are bananas?* Berners Lee, M. (2010), p26. Profile Books, London.

[19] http://www.sags.org.uk/docs/ReportsPresentations/CarbonReductionBriefing.pdf [Accessed 5 September 2011]

- Plan a weekly menu and make a list before you shop. Figures from the WRAP (Waste and Resources Action Programme) 'Love food hate waste' campaign[20] suggest that cutting out food waste would have the same environmental benefit as taking one in four cars off the road. The topic of food waste will be covered in much more detail in a later workshop.
- Use vegetable box deliveries and farmers' markets. There are many excellent vegetable box schemes; some are provided nationally and some by local farmers. Schemes which deliver boxes of vegetables to local drop-off points within easy walking or cycling distance, rather than providing a door-to-door service, will reduce the food's carbon footprint even further. Farmers' markets can be another source of local, seasonal food.
- Shopping online and reducing car trips to the supermarket will also help reduce your carbon footprint.

Mythbusting

Is organic better?

There is substantial evidence that organic farming methods produce fewer GHG emissions. This is achieved in part by enriching the soil so that it will hold more carbon. For example, the Soil Association argues that: 'The widespread adoption of organic farming practices in the UK would offset 23% of UK agricultural emissions through soil carbon sequestration alone.'[21] Also, better soil structure means that less water is needed for plants. Finally, organic farming does not permit the addition of nitrogenous fertilisers, reducing nitrous oxide emissions.

However, there is evidence that farming organically reduces yields so more land is needed to produce the same amount of food. Further evidence suggests that the use of GM (genetically modified) crops and intensive farming mean that less land is needed to produce more food.[22]

This is clearly a complicated issue. There is a very balanced summary in Carbon Commentary[23] – a website which provides a critical appraisal of the issues in the move to a low-carbon economy – which concludes that further study is needed. In the meantime, it is suggested that we should eat less meat and dairy products and more plant-based food; that raw food is better than cooked; that processed food, particularly if it needs refrigeration, should be replaced by foods that can be kept at ambient temperature, and in general that we should buy local, seasonal food which is not from supermarkets. What is undoubtedly the case is that hothouse-grown, unseasonal fruit and vegetables (whether grown organically or not) will have a high GHG impact. There is a more detailed discussion of this issue in the next section.

Food miles

The issue of food miles is also difficult. Initially our understanding was that the further that food travels, the higher the carbon footprint. However, this has now been shown not to be the case. An article in the 'Ethical Living' section of *the Observer*[24] in March 2008 goes some way to explain this:

In brief, it is important to analyse the whole journey of any item of food, not just the distance it has travelled. The article uses the example of apples and lettuces. In both cases, British apples and lettuces are usually available in supermarkets all year round. However, apples are only picked from the trees in the autumn and early winter. Any UK apples bought at other times will have been kept in cold stores which consume energy and thus produce CO_2. So by the summer, it is better to buy apples from New Zealand where they will have been grown naturally and then transported here by ship. Similarly, in winter, UK lettuces will have been grown in heated polytunnels, whereas lettuces from Spain will have been grown in the field. The emissions associated with transportation will be lower than those associated with cooling the apples or warming the lettuces.

Finally, a word about prawns and shrimps – which illustrates why food miles do sometimes matter! Several studies and articles[25] have described how prawns caught off the coast of Scotland are transported in chilled container ships to China for shelling, and then back again to the UK. The message from this is to replace prawns with other, more sustainably-produced seafood.

Which is better: dried or tinned chickpeas?

The Observer article mentioned above also includes a classic example of how complicated it can be to make a good choice. On a supermarket shelf, a tin of chickpeas has a much higher carbon footprint than its dried neighbour – there

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[20] http://www.lovefoodhatewaste.com/about_food_waste [Accessed 5 September 2011]
[21] Soil Carbon and organic farming. (2009), p 4. http://www.soilassociation.org/LinkClick.aspx?fileticket=BVTfaXnaQYc%3d&tabid=574 [Accessed 5 September 2011]
[22] http://www.pnas.org/content/107/26/12052.full.pdf+html[Accessed 5 September 2011]
[23] http://www.carboncommentary.com/2007/09/15/7 [Accessed 5 September 2011]
[24] http://www.guardian.co.uk/environment/2008/mar/23/food.ethicalliving [Accessed 30 August 2011]
[25] http://www.bbc.co.uk/bloom/actions/prawns.shtml [Accessed 5 September 2011]

is more processing involved, the tins are much heavier to transport, and producing the tins themselves will have a carbon cost. However, once you include the carbon emitted when cooking the dried chickpeas at home, the dried chickpeas end up with a higher footprint. Unless, that is, you use a pressure cooker or your house is powered by renewable energy!

Home cooking or ready meals?

As mentioned before, a study from Manchester University calculated that a lamb curry ready meal had a carbon footprint of 4.2kg CO_2 e, compared with a home-cooked version which had a 20% lower carbon footprint. This was mostly due to eliminating the refrigeration stage. The figures are not always completely clear-cut: if a ready-meal was not chilled and was then heated in a microwave it may well have a lower footprint than a similar meal prepared from scratch and cooked in an electric oven.

Some conclusions

Arguably a low-carbon (or low GHG emission) diet is not necessarily more expensive than a healthy British diet – but may be more time-consuming to prepare, and for many people this could be a real barrier to making changes. Planning a weekly menu, cooking in bulk and freezing the extra portions will definitely help.

FURTHER INFORMATION

More useful information which considers GHG emissions as well as carbon footprint:

How bad are bananas? Mike Berners Lee

How to live a low-carbon life Chris Goodall.

The papers *Cooking up a storm* and *How low can we go?* referenced in the footnotes are particularly useful and informative. Both come from the Food Climate Research Network, based at the University of Surrey, whose studies are extremely useful in providing an understanding of the issues surrounding the food we eat and the cost in environmental terms.

Finally *Animal Vegetable Miracle* by Barbara Kingsolver is a life-affirming and entertaining account of a family's attempt to feed themselves from locally-produced food.