How your diet can help cool the planet - some examples

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1. Driving equivalent of omitting one hamburger per week from your diet - a worked example.

A recent article[1] in New Scientist Magazine cited the result of a Japanese study[2] that determined that beef production in Japan resulted in the emission of the equivalent of 36.4 pounds of CO_2 for every pound of beef produced.

How does that compare to driving?

The US 2006 passenger car mileage was 22.4 mi/gal[3]. Burning a gallon of gas emits the equivalent of 20.4 pounds of CO_2[4]. Putting those two numbers together (20.4/22.4), US passenger cars averaged 0.91 pounds of CO_2 equivalent per mile (of actual CO_2 plus other greenhouse gases (GHG)).

Where's the beef?

36.4/0.91 equals 40 miles of driving an average US passenger car to emit the same amount of CO_2 equivalent as producing one pound of beef to eat.

On an annual basis, then, one person reducing their beef intake by 1/2 pound (one big burger or medium steak) per week over the course of a year, 26 pounds total, would be equivalent to cutting out almost 1040 miles of driving an average US car over that same year.

2. Meal substitution - switch from red meat and dairy to chicken/fish/eggs or only vegetables one day a week.

Weber and Matthews[5] carried out a comprehensive life-cycle assessment[6] of US food production, with some interesting results. Overall, they estimated that the US annual CO_2 equivalent emissions per 2.64-person household for food production amount to about 8.1 tons/year. For comparison, a study[7] by the Rocky Mountain Institute found that personal transportation emissions for 1998 were 11 tons per household.

Our eating and driving habits have equivalent impacts on global warming! We can think of ways to drive less, but eating a lot less food isn't really an option.

Instead of eating a lot less, what we need to do is eat a lot smarter. Weber and Matthews compared the CO_2 equivalent per pound emissions for beef, pork, and dairy that resulted from their study, relative to the corresponding emissions for other food sources, and calculated that, by switching from red meat and dairy products for just one day a week, to either chicken/fish/eggs, or entirely to vegetables for that day, an average US household could reduce their annual CO_2 equivalent output by 930 or 1420 pounds, respectively, equal to driving a 25 mpg car 760 or 1160 fewer miles per year. Dropping red meat entirely in favor of chicken/fish/eggs, or a completely vegetarian diet, would have the same carbon reduction benefit (6540 or 9930 pounds) of driving that same car 5340 or 8100 fewer miles each year, respectively.

3. Animal, or vegetable?

Eshel and Martin[8] also analyzed the environmental impacts of diet and personal transportation. Much attention has been given to how driving habits and vehicle choices may affect global warming, because when you drive your car, CO_2 is obviously streaming out the tailpipe, and because cars differ so much in gas mileage. Eshel and Martin corroborate the food/transport equivalence of Weber and Matthews in terms of energy usage, pointing out that in the US, the energy we use in personal transportation is essentially equal to the energy that goes into producing the food we eat, confirming that our food choices can make as much difference in our environmental

impact as our choice of what car we drive, and how much.

Eshel and Martin also considered the relative environmental impacts of a the different food groups that go into the American diet. They found that the annual CO_2 equivalent emissions for the animal-based part of the typical American diet (providing about 28% of total calories) amount to 1.5 tons per person, or about 6% of total US (2003) emissions.

In personal transportation terms, they point out that shifting from the typical diet (with about 28% of calories from animal products) to 35%, with the meat portion consisting exclusively of red meat (beef and pork) with no poultry or fish, is equivalent to driving an SUV instead of a Camry[9]. Reducing the animal-based calorie fraction merely to 20% from 28% (keeping the same relative proportions among meat, poultry, dairy and eggs, but with more plant-based foods, overall) would save as much CO_2 emissions as trading in a Camry for a Prius[9].

4. Less ... period

The US Department of Agriculture maintains detailed statistics on food production over time. That includes working out the available calories per capita, accounting for food wastage and spoilage[11]. The total calories available for 1970-1974 averaged 2,167 calories. In the last year for which data are provided, 2007, the calorie total was 2,775, a "whopping" 28% increase.

Those same data were analyzed, for 1970-2005, from a nutrition and health point of view[12]. The authors point out that "According to the National Center for Health Statistics, about two-thirds of U.S. adults in 2003-04 were either overweight or obese, compared with 47 percent in 1976-1980. The U.S. obesity rate among adults has more than doubled, from 15 percent in 1976-1980 to 32 percent in 2003-04."

In addition to the health costs of being overweight, that extra, un-needed food has a carbon cost, as well. If each person were to shave off those surplus 600 calories (and, eventually, the accumulated weight), in addition to improving individual health (and reducing societal health care costs!) it would also save each average 2.64-person household about 3,600 pounds of CO_2 equivalent emissions, and be as beneficial to the environment as driving 4,400 fewer miles per year (assuming 25 mpg). Nationwide, that would amount to over 200 million tons per year CO_2 equivalent reduction, roughly a quarter of the total US food production related greenhouse gas emissions, and equal to about 15% of annual US GHG emissions from personal transportation.

5. Other factors, and some background.

Another article worth reading on this topic, less technical than the formal papers, appeared in the ongoing Climate Change series in New Scientist magazine.[10] The article does a good job of clearly explaining where the different greenhouse gases are produced in the many steps along the way of getting food onto your plate.

The magazine provides a neat graphic based on (but not attributed to) the Weber and Matthews paper, illustrating that the actual CO_2 GHG component of food production is actually exceeded by emissions of methane and nitrous oxide (in terms of their global warming CO_2 equivalence). Both methane (mostly produced by livestock, or their manure) and nitrous oxide (largely from application of nitrogen-based fertilizers) are extremely potent greenhouse gases.

The same graphic shows that transportation, overall, contributes only 11% of the GHG emissions from the full food production process (although their graphic incorrectly attributes that 11% to getting the finished food products to the market - the actual percentage for "food miles" is only around 4%). So, you can reduce your food-based carbon footprint by about 4% by "buying local", and you can get up to another 4% by cutting out red meat for one day a week.

6. A useful table

Here is how the different food groups stack up, in terms of how much of each make up our diet (as percentage of total calories), what their GHG intensities are (pounds of CO_2 equivalent per pound), how much total GHG is produced for each (in pounds per year per 2.64-person household), and the equivalent car driving miles per household for each (for 25 mpg, and 20.4 lb CO_2 eq per gallon, see Note 4). The CO_2 information in the following table comes from the figures in Weber and Matthews, while calorie percentages are from USDA data for 1997[11], and the mileage equivalents are calculated values. Red meat, while comprising only 10% of the calories in the average US diet, due to the extremely high GHG intensity for livestock (largely from methane and nitrous oxide emissions), is responsible for about 36% of our food-related GHG emissions.

Food group	% of calories	CO2 eq lbs/lb	CO2 lbs/yr per hh	Car miles (@ 25 mpg)
Cereals/Carbs	24	3.0	1,980	2,430
Poultry/Fish/Eggs	6	6.0	1,700	2,080
Dairy Products	11	4.2	3,180	3,900
Fruits/Vegetables	9	1.7	1,880	2,300
Oils/Sweets/Nuts	40	1.7	995	1,220
Red meat	10	22.1	5,360	6,570
Total	100	-	15,095	18,500

References

[1] 21 July 2007 issue, New Scientist, http://environment.newscientist.com/article.ns?id=mg19526134.500
[2] Ogino A, Orito H, Shimada K, and Hirooka H. 2007. Evaluating environmental impacts of the Japanese beef cow-calf system by the life cycle assessment method. Animal Science Journal 78:424-32. (Animal Science Journal, DOI: 10.1111/j.1740-0929.2007.00457.x). http://dx.doi.org/10.1111/j.1740-0929.2007.00457.x
[3] http://www.bts.gov/publications/national_transportation_statistics/html/table_04_11.html
[4] Per the EPA: 2,421 g X 44/12 X 0.99 X 100/95 / 453.6 = 20.4 lb/gal including non-CO_2 GHG components (http://www.epa.gov/OMS/climate/420f05004.htm)
[5] Christopher L. Weber and H. Scott Matthews, Food-Miles and the Relative Climate Impacts of Food Choices in the United States, Environ. Sci. Technol., 2008, 42 (10), pp 3508–3513, DOI: 10.1021/es702969f http://pubs.acs.org/doi/full/10.1021/es702969f
[6] See http://en.wikipedia.org/wiki/Life_cycle_assessment and http://www.epa.gov/nrmrl/lcaccess/.
[7] http://rmi.org/images/PDFs/Climate/C02-12b_GHGPerCapita.pdf
[8] http://geosci.uchicago.edu/~gidon/papers/nutri/nutri.html
[9] From Eshel and Martin, Table 1: Energy consumption for personal travel (per capita, 8,332 mi/yr).

model	miles per gallon city	miles per gallon highway	miles per gallon weighted average	annual consumption gallons	annual consumption 10^7 BTU	annual consumption ton CO_2
Prius	51	60	57	146	1.7	1.19
Camry	24	33	30	278	3.2	2.24
Suburban	11	15	14	595	6.8	4.76

[10] Bijal Trivedi, What is your dinner doing to the climate?, New Scientist magazine, issue 2673, http://www.newscientist.com/article/mg19926731.700-what-is-your-dinner-doing-to-the-climate.html
[11] http://www.ers.usda.gov/Data/FoodConsumption/spreadsheets/foodloss/Calories.xls
[12] http://www.ers.usda.gov/Publications/eib33/