THE AMERICAN CARBON FOODPRINT




UNDERSTANDING AND REDUCING
YOUR FOOD'S IMPACT ON CLIMATE CHANGE

BRIGHTER PLANET

ABOUT BRIGHTER PLANET

Brighter Planet provides technology-driven climate change solutions that help people and businesses manage their environmental impacts. Its suite of innovative tools range from debit and credit cards that build renewable energy, to crowd-powered community climate projects, to a technology platform that integrates carbon emissions modeling with business operations. Brighter Planet has engaged over 150,000 customers to date. Learn more at brighterplanet.com.

ABOUT THIS PAPER

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Introduction

Greenhouse gases released by human activities (including feeding 6 billion people) are building up in the atmosphere, trapping heat that would otherwise escape into space and altering the fundamental climate processes that drive global weather patterns. Runaway climate change poses serious threats to humanity and the natural world, but with deliberate and concerted efforts to reduce our emissions, these consequences can be largely avoided.

Whether you live to eat or eat to live, one thing is sure: staying fed represents a substantial portion of your total impact on the climate. The greenhouse gas impacts of food are complex and far-reaching, as every bite of food you eat takes energy to grow, process, store, transport, sell, cook, and discard. But by understanding how your eating habits affect global warming, you gain the power to reduce those impacts through conscious daily living. (The social and environmental impacts of food extend far beyond climate change; our food system also affects biodiversity, water quality, ecosystem functions, human health, and human rights, to name a few, but these impacts are beyond the scope of this paper.)

Your "carbon foodprint" is the sum of all the greenhouse gases your meals produce as they wind their way through the food system. Three main gases comprise the vast majority of food-related emissions: carbon dioxide, methane, and nitrous oxide.

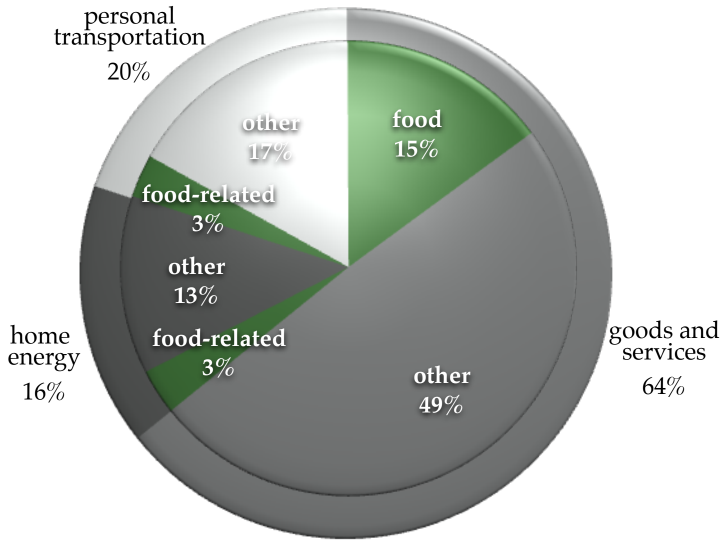
- Carbon dioxide (CO_2) is released whenever fossil fuels like coal, gasoline, or natural gas are burned to generate energy. CO_2 accounts for about 71%of your total food impact.
- Methane (CH_4) is released when food scraps and packaging decompose in landfills, and during livestock digestion and manure treatment. While methane is released in relatively low volumes, it is 25 times as potent as carbon dioxide. In all, it accounts for about 13% of your total food emissions.
- Nitrous oxide (N_2O) comes predominantly from chemical fertilizers used on crops. Although little nitrous oxide is released, each pound has a global warming impact equivalent to 300 pounds of carbon dioxide. N_2O makes up about 15% of the average American's foodprint.
- The remaining 1% of food's global warming impact comes from a number of gases that are released in very small quantities, primarily SF_6 from electricity production and HFCs from refrigeration systems.
- To simplify things, we combine all of these gases and their relative potencies into a single comprehensive measure of the climate impact of a given activity, called carbon dioxide equivalent (CO_2 e). When we talk about "CO_2 e," "carbon emissions," "climate impact," or "foodprints," we're referring to the combined impact of the various greenhouse gases.

So how big is your foodprint? Estimating the climate impact of food is a tricky process, and estimates of that total number vary. Many of the emissions are distantly removed in the supply chain – a fraction of the emissions for a hamburger bun might come from harvesting wheat in Washington, a fraction of those harvest emissions might come from manufacturing a combine at a factory in Louisiana, and a fraction of those combine production emissions might come from mining ore in Montana and smelting it into steel using coal shipped from Virginia. It's also tricky to decide which emissions sources should be included – is the electricity that lights your kitchen, allowing you to cook, part of your foodprint? (We think so, but we don't include the dining room lights.) But while it's important to understand that there is some inherent imprecision in carbon foodprint figures, that hasn't stopped us from pulling together the best data available and synthesizing it into a picture of the climate impact of eating in America.

The average American has a carbon foodprint of over 12,000 pounds CO_2e each year. That includes emissions from growing, processing, distributing, and selling food, emissions from getting it home and cooking it, and emissions from discarding or recycling the leftover waste products. In all, food represents 21% of the typical American's total annual carbon footprint of 28.6 tons CO_2e. Of course, that's just the average – your personal foodprint depends on how much and what kinds of food you eat, where and how that food is produced, how it's prepared, and what you do with the leftovers.

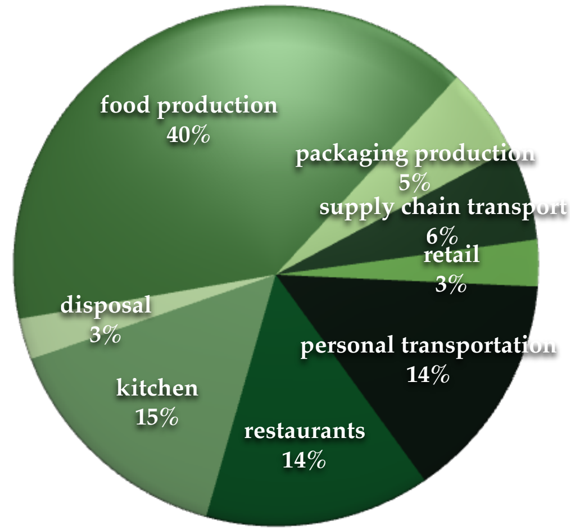
The good news is there's lots you can do to reduce your carbon foodprint, and many of the steps you take will have substantial non-climate benefits as well. Shrinking your foodprint will help improve environmental and social conditions in near and distant places touched by our food system. It can also increase your quality of life by saving you time and money, improving the healthiness and tastiness of your diet, and building community connections.

THE AMERICAN CARBON FOODPRINT AT A GLANCE



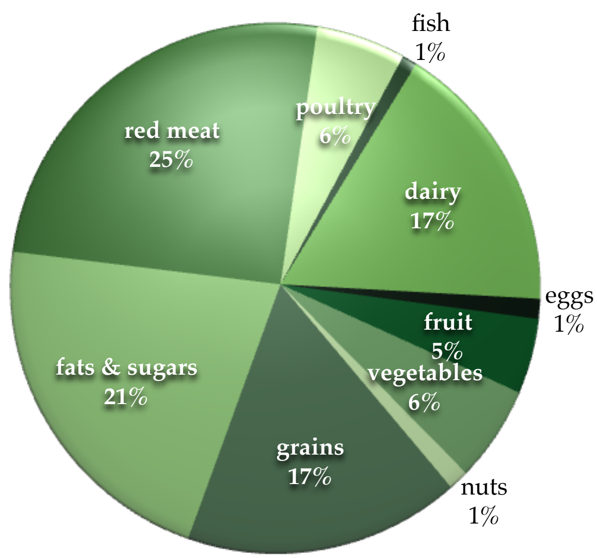
Foodprint as fraction of total footprint

Food-related emissions comprise 21% of total emissions, or 6.1 tons out of 28.6 tons per person per year. 15% of personal transportation relates to food, as does 20% of housing energy use, while 23% of the emissions from all other activity are food-related. The other charts on this page look at this pool of food-related emissions from three different angles.



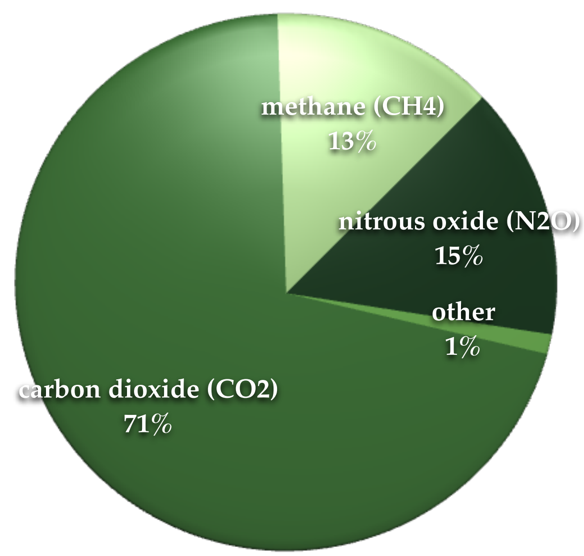
Breakdown by life cycle phase

54% of food-related emissions are released in the supply chain upstream of the consumption point. A further 14% come from personal transport to grocery stores and restaurants, while 29% are released during the cooking and serving process in restaurants and home kitchens. The final 3% released downstream via decomposition in the landfill.



Breakdown by food group

A quarter of the average American's foodprint derives from red meat, with another quarter coming from other animal products. Plant foods make up the remaining half, of which the majority result from grains, fats, and sugars. This emissions breakdown differs markedly from caloric breakdown, however – for example, red meat makes up only 11% of calories despite causing 25% of emissions.



Breakdown by greenhouse gas

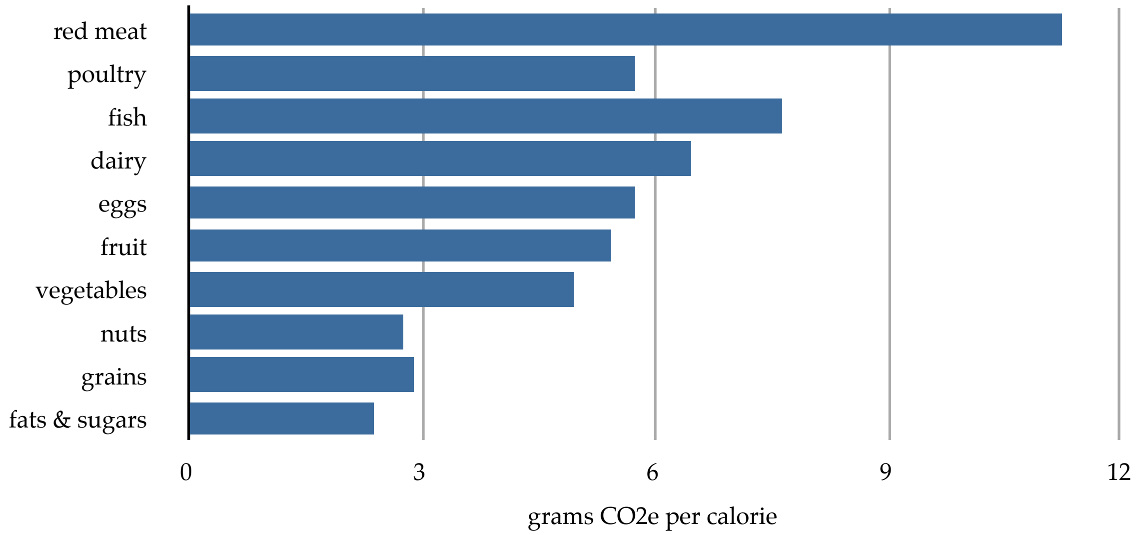
The majority of food's global warming impact comes from carbon dioxide, released during fossil fuel combustion. The remainder comes mostly in the form of methane and nitrous oxide, coming largely from livestock and chemical fertilizers, respectively. Other gases, including SF_6 from electricity production and HFCs from refrigeration systems, comprise the remaining 1%. All values are in CO_2e.

The ins and outs of food emissions

Not all foods are created equal

"Eat less meat" is one of the most common suggestions for reducing your diet's climate impact – and it's sage advice. Food groups vary widely in greenhouse gas emissions per calorie or serving, and red meat tops the chart. By understanding the relative carbon impacts of the various food groups, you can make informed decisions about which foods you choose to purchase.

Greenhouse gas emissions intensities by food group



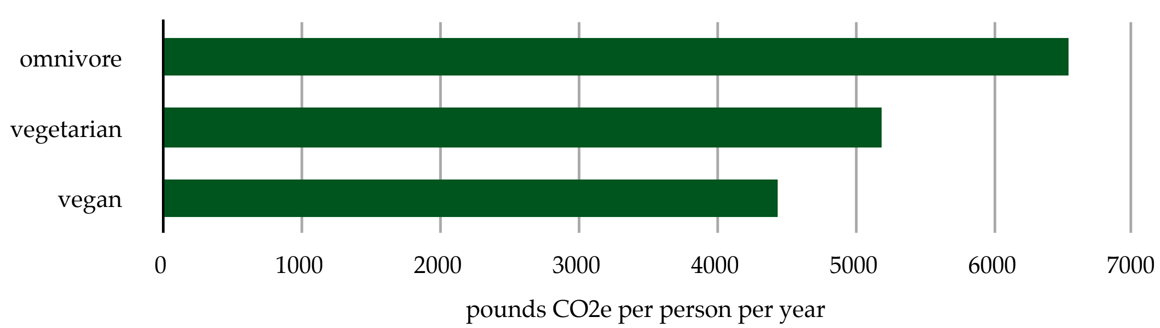
More than a third of the greenhouse gas emissions generated by the US agricultural system come from the livestock industry. And while red meat comprises just 11% of the typical American's caloric intake,[1] it accounts for a full 25% of their carbon foodprint. There are two main reasons that red meat is so much more carbon-intensive than other foods.

- Eating meat is less efficient than eating vegetables, because animals only convert a small portion of the energy in plants into meat. When we eat meat, we again only capture a small portion of the energy in the animal. And some animals (e.g. cows) are less efficient at converting plant energy into meat than others (e.g. chickens).
- Raising livestock creates emissions from "enteric fermentation" – essentially, burping and farting. Ruminants like cattle and sheep possess digestive systems that release large quantities of methane (a phenomenon that is exacerbated by feeding them corn, which is not their natural diet). Substantial quantities of methane are also released from the decomposition of livestock manure.

By comparison, every other food group averages substantially fewer greenhouse gases per calorie than red meat. Fish and dairy are the second most carbon-intensive food groups, producing 68% and 58%, respectively, the emissions per calorie of red meat. Poultry, eggs, and vegetables emit approximately half as much carbon per calorie as red meat, while cereals and grains, oils and sugars, and nuts produce roughly a quarter as much.

To illustrate the carbon effects of making choices among the various food categories, it's helpful to consider the emissions profiles of three common diet types, each with the same number of total calories: a standard omnivorous diet representing the average American; a vegetarian diet that excludes red meat, poultry, and fish; and a vegan diet that excludes all animal products including eggs and dairy. While the average diet results in 4.3 grams of embodied CO_2e emissions per calorie consumed, a vegetarian diet emits only 79% of that average, and a vegan diet releases just 68%. Effectively, the typical vegetarian would thus emit about 1,300 pounds less CO_2e per year than the average American – and that's assuming they eat the same number of calories, when many vegetarians in fact eat fewer.

Embodied food emissions for three diet classes



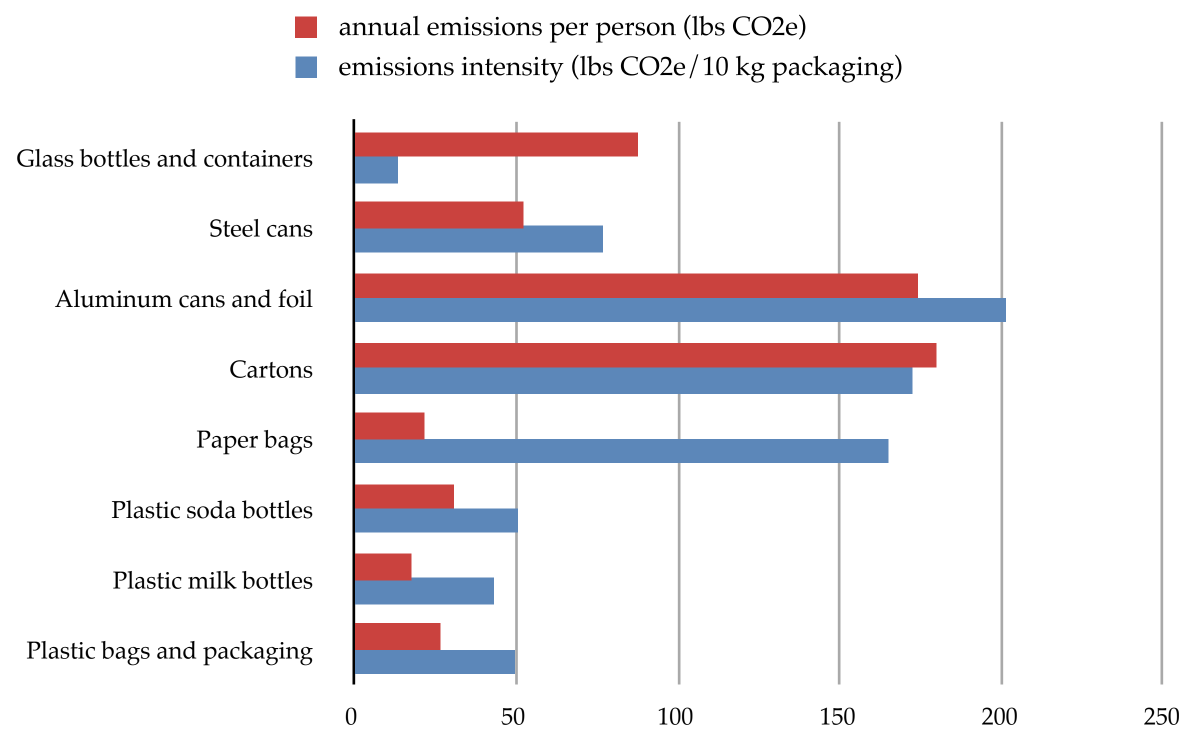
The simplest thing you can do to reduce your foodprint is to eat types of food that are less emissions-intensive. Yes, particular foods can be much better or worse than their food group average – grass-fed bison might be less carbon-intensive than a winter tomato grown in a Minnesota hothouse. But if you want a simple basic rule to follow, try to eat less like a carnivore and more like a vegan.

Getting back to the land

A huge portion of food's emissions come from the industrial supply chain – indeed, 54% of the average foodprint is comprised of "embodied" emissions from producing, distributing, and selling food, with the other 46% coming from cooking, household transport, and waste.

Just making the packaging that encases so many foods accounts for 10% of all food production emissions, or about 655 pounds of CO_2e annually per American. Cartons and aluminum packaging are the biggest contributors, primarily because they emit more per pound of packaging than other materials. While it's difficult to avoid packaging and processing entirely, you can decrease your carbon foodprint by shopping for fresh, whole, bulk foods with little or no packaging.

Life cycle packaging emissions



Taking it a step further and harvesting your own food directly from the land can completely eliminate the energy used to transport and sell food. Done properly, gardening, hunting, and gathering are as close as it comes to carbon neutral dining. Of course, these activities all take equipment, supplies, and some personal transportation, so the carbon benefits of gardening or hunting have to be weighed against the energy that goes into making them possible. But if you minimize new equipment, motorized travel associated with these activities, and the energy and supplies that go into preparing and storing these foods, living off the land is a major boon for the climate.

Organic chemistry

Organic chemists may have the mechanics of carbon compounds down to a science, but the question of how organic and conventional agriculture compare from a carbon emissions perspective is less clear-cut. Generally speaking, organic agriculture is significantly less carbon-intensive per acre,[2] but conventional agriculture can be significantly more productive per acre.[3]

From a global warming standpoint, the starkest differences between conventional and organic agriculture relate to fertilizers. Conventional farmers typically use substantial quantities of nitrogen-based chemical fertilizers, whereas organic farmers instead rely on manure and other natural supplements to increase soil fertility. Chemical fertilizer is produced in an energy-intensive process that converts inert nitrogen (N_2) from the air into ammonia (NH_3) by combining it with hydrogen extracted from water and methane. When this nitrogen fertilizer is applied to fields, much of the ammonia eventually degrades and is converted into nitrous oxide (N_2O), a greenhouse gas 300 times as potent as CO_2 that escapes into the atmosphere. Globally, N_2O from agriculture is responsible for approximately 6.3% of anthropogenic climate change.[4] There's also evidence that chemical fertilizers and other conventional farming practices can cause the release of soil carbon that has accumulated through centuries of plant growth.[5]

Still, from a greenhouse gas standpoint organic agriculture may or may not be preferable. Depending on the situation, nitrogen fertilization, chemical pesticides, and other methods employed in conventional farming can permit substantial increases in productivity, with conventionally-managed cropland sometimes yielding up to twice the harvest per acre of organically-managed land.[3] This means that producing a given quantity of food organically would require more acreage than producing it conventionally. But studies also indicate that organic farming uses less than half the energy per acre of conventional farming,[2] and that proper organic management can substantially increase the rate at which atmospheric carbon is removed from the atmosphere into the soil.[5]

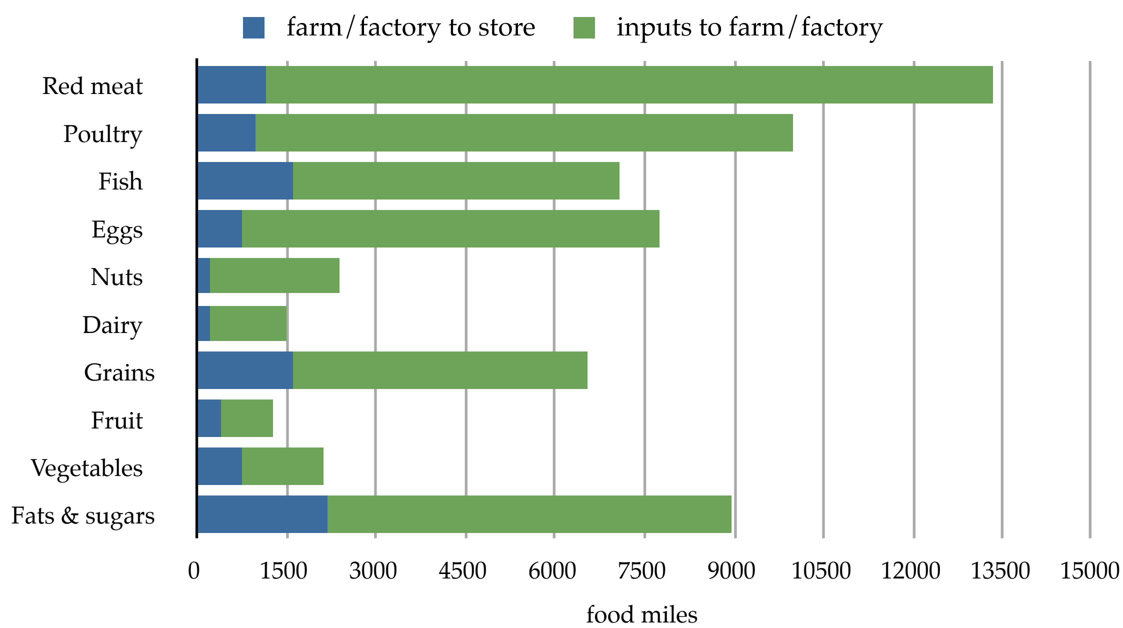
No overarching conclusion can yet be drawn as to which farming school is preferable from a carbon emissions standpoint, since their relative advantages depend on many variables including the crop, the local climate and soil, and the specific farming techniques employed. Still, while the climate benefits of organic agriculture may be open to debate, it bears remembering that carbon emissions are just one issue in the larger picture of organics, which also relates to human and environmental health beyond the issue of climate change.

The long and short of food miles

Recent decades have seen a flourishing of the local foods movement, and thankfully so – the environmental and social benefits of eating close to home are many. But as with organic food, when it comes to carbon emissions, the advantages of local food are more nuanced than they might first appear.

The average meal travels 4,200 miles en route to the store, and this journey is powered almost entirely by fossil fuels. But of those food miles, only a quarter are "final delivery" from farm or factory to retailer, while three quarters are delivery of inputs like fertilizer or raw ingredients.[6] Food groups vary in their average travel distances from a low of fruit (at 1,265 miles) to a high of red meat (at 13,273 miles).

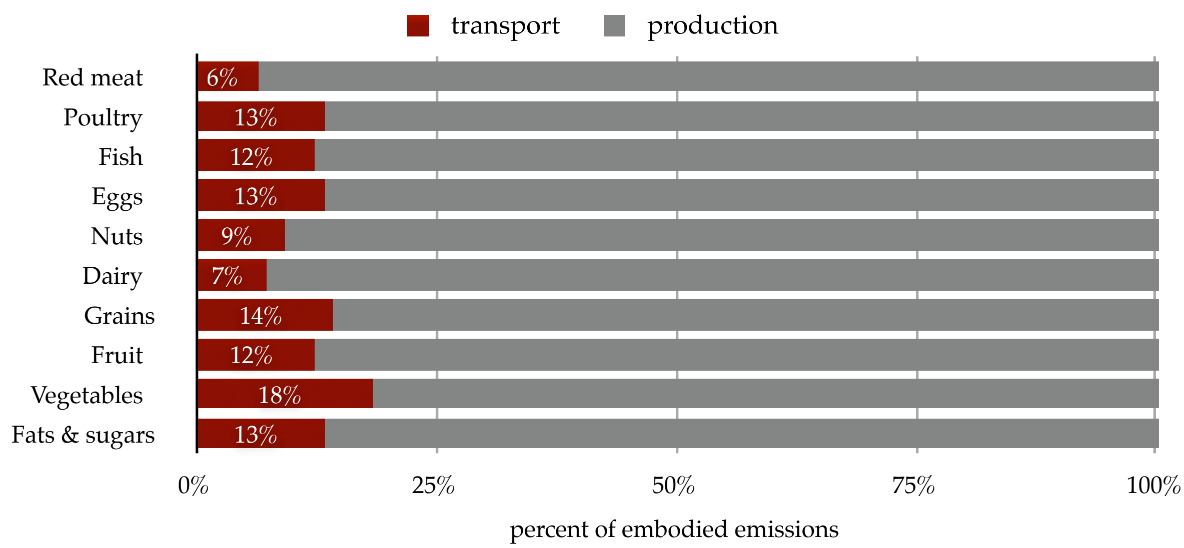
Supply chain food miles by food group



Working to reduce the distance your food travels before you purchase it can certainly have a positive climate impact. But you shouldn't assume that sourcing food closer to home necessarily emits less carbon. That's because of what economists call "comparative advantage," the idea that goods can be more efficient to produce in one location than another. Buying local foods that could have been more efficiently produced elsewhere can be counter-productive if producing them locally ends up emitting more carbon than transporting them from afar. Buying a local Vermont tomato might make sense in August, but in February that local tomato was either grown in a heated greenhouse under artificial light or stored for months in a refrigerator, making it more carbon-intensive than a sun-ripened tomato shipped from southern California. In short, in-season local specialties are perfect to source locally, and in general should be prioritized in your diet over imported foods and inefficiently produced local novelties.

Despite the impressive distance that most food travels, transportation accounts for a modest 11% of the “embodied” emissions of the typical cartload of groceries (that's all the emissions that went into producing, transporting, and retailing the food), or 700 pounds CO_2e per person annually.

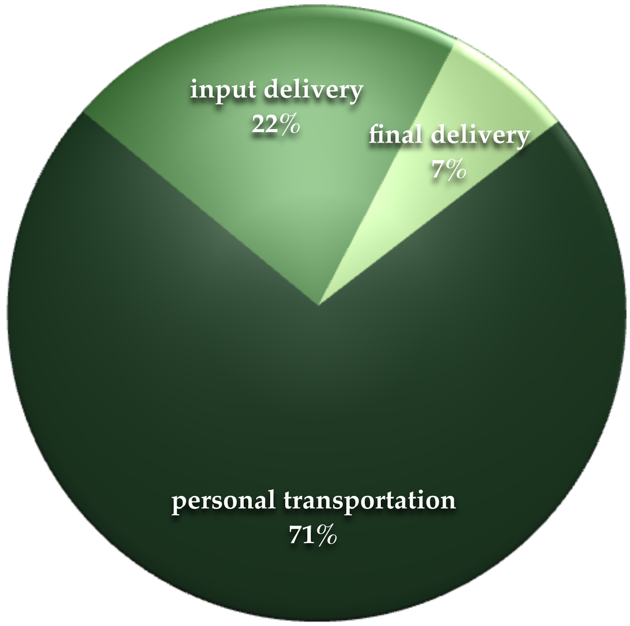
Supply chain emissions from transportation



The portion of a meal's footprint that comes from transportation also varies depending on the kind of food. For example, while transportation accounts for only 6% of the embodied emissions of red meat, it accounts for three times that amount in vegetables, or a full 18%. From a carbon standpoint, food groups in which a greater fraction of emissions come from transport should be a higher priority for local sourcing. But remember that final delivery only accounts for a fraction of the total transportation. Even for vegetables, the food group with the highest portion of miles from final delivery, two thirds of the total miles come from delivery of inputs. In other words, your steak’s carbon emissions may depend less on how locally you source your beef than on how locally your rancher sources his cattle feed.

But a singular focus on supply chain food miles belies the reality that all the miles a meal travels en route to your local vendor represent only 30% of total food transport emissions – the remaining 70% of that meal's transportation footprint comes from your own personal food-related transportation (travel to grocery stores and restaurants). While food travels much farther from farm to store than from store to pantry, traveling in a densely-packed container ship or tractor trailer is orders of magnitude more efficient than traveling in the back seat of a station wagon. Personal food-related errands comprise 14% of your total carbon foodprint, while supply chain transport accounts for just 6%. Indeed, going grocery shopping and going out to eat account for 15% of the typical American's total personal transportation, emitting 1,750 pounds of CO_2e every year.

Sources of food transportation emissions



The carbon benefits of eating local food are nuanced, and the emissions you reduce this way represent a minority of the total transportation emissions associated with your diet. Driving to grocery stores and restaurants produces a much larger quantity of greenhouse gas emissions, and the benefits of avoiding these errands are clear-cut. From a global warming perspective, you should focus at least as much on minimizing your own food-related travel as on pursuing a locavore diet.

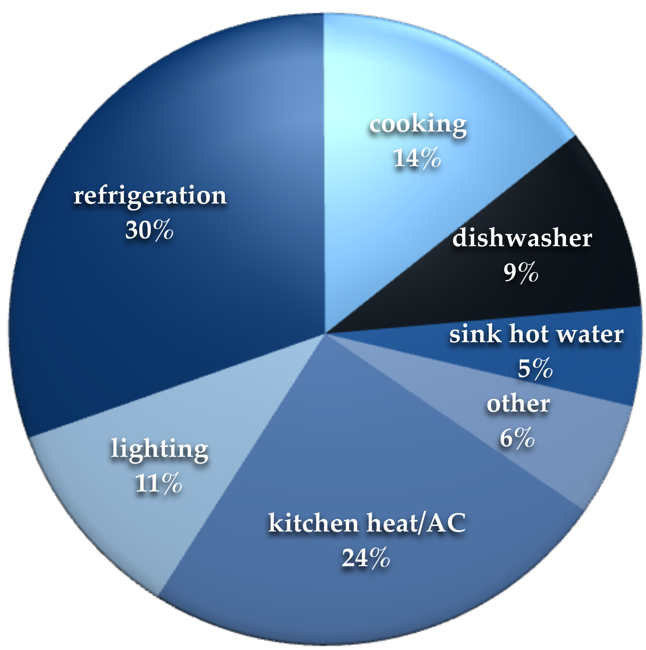
Dining in, eating out

Producing and transporting ingredients accounts for the majority of food-related emissions, but the energy to transform those ingredients into a steaming meal is an important contributor as well. Taking into account storage, cooking, and cleanup, kitchen energy use amounts to 15% of the average American's total food-related emissions. Home kitchens account for 1,850 pounds of CO_2e per person annually, or 15% of the average food footprint, while food service (including restaurants and cafeterias) accounts for another 14%, or 1,740 pounds. In all, the energy to cook and serve a meal accounts for nearly a third of its entire life cycle emissions.

The average American eats out at a fast food or full service restaurant about 4.5 times a week, or roughly one in five meals.[7] And yet food service operations consume roughly the same amount of energy as home kitchens – and that's before you consider the carbon impact of traveling to the restaurant. A simple way to reduce your carbon foodprint is to cook more and eat out less.

On the home front, kitchens consume 21% of total household energy while occupying just 13% of household area, making them one of the most energy-intensive rooms in the house. Of this kitchen energy, a third comes from heating, cooling, and lighting the kitchen itself, with the remainder more centrally related to the cooking process. Refrigeration is the biggest energy hog in the kitchen, consuming 30% of all kitchen energy, and emitting 1,440 pounds of CO_2e annually per household while adding $330 a year to the utility bill. If you have an old fridge or freezer running in your garage or basement, get rid of it – it

Home kitchen energy consumption by end use



probably uses at least twice as much energy as the one in your kitchen. And check the ENERGY STAR website to see how much you could save by replacing your current fridge.

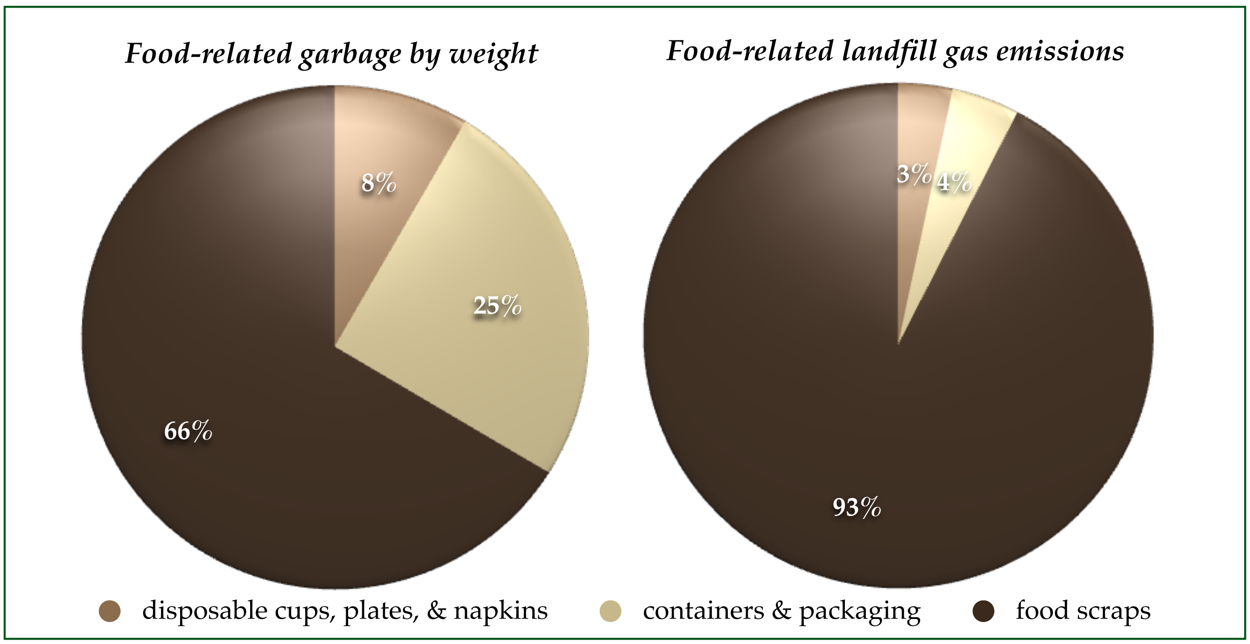
The actual act of cooking comes in second to refrigeration in terms of appliance energy use, with stoves, ovens, and microwaves consuming a combined 14% of kitchen energy, or 685 pounds of carbon emissions annually per household. But there are important differences between them. Microwaves are the most energy-efficient at cooking food, as they generate very little waste heat. Stoves come in second place, while ovens (which transfer a relatively small portion of the energy they consume into the food) are the least efficient cooking method.

The aftermath of the meal is also an important part of your foodprint, with hot water and dishwasher energy use consuming a combined 14% of kitchen energy. Of the 9% consumed by dishwashers, one quarter is hot water, meaning that a total of 7% of kitchen energy goes toward powering the dishwasher, while another 7% goes toward heating water for the sink and dishwasher. Whether it's more energy efficient to wash dishes in the sink or the dishwasher depends on your specific model of dishwasher and your hand washing techniques, but either method presents opportunities for energy savings. Unless you're a super-efficient handwasher, using a new, efficient dishwasher and only running it when fully loaded is your the best bet for minimizing dish washing energy.

A last gasp from the grave

Even once a meal has been grown, transported, cooked, and eaten, all is not quite said and done. Americans discard over 620 billion pounds of garbage (not including recycling and compost) every year, 29% of which is food-related. This waste doesn't just disappear – it's trucked to the landfill, where it decomposes underground, producing methane that seeps into the atmosphere. This final pulse of greenhouse gas from the grave accounts for the last 3% of the average meal's total carbon impact, or about 315 pounds CO_2e per person per year. Food-related waste is responsible for 28% of all US landfill gas emissions.

Food scraps themselves constitute 66% of food-related garbage by weight, while glass, metal, plastic, and paper packaging from food and drink products make up the rest. But food scraps contribute a much larger share of landfill gas emissions (93%), because inorganic food packaging doesn't decompose to release methane. Composting food scraps rather than landfilling them can drastically reduce their climate impact. That's because in the oxygenated environment of a compost pile decomposition occurs aerobically and produces carbon dioxide, whereas in the oxygen-poor depths of a landfill food decomposes anaerobically and generates methane, which is 25 times as potent in it's global warming potential. Unfortunately, just 3% of food scraps are composted. Better still than composting, get creative with leftovers before they head south; it will reduce both waste in the landfill and the amount of food you buy in the first place.



Recycling also plays an important role in reducing the carbon emissions from the food industry. About 35% of food-related waste that can be recycled actually is, while the rest is bound for the landfill. Recycling reduces the energy needed to mine and refine virgin materials to produce new food and drink packaging. Indeed, the average American saves 655 pounds of carbon emissions every year by recycling food and drink packages – although this number could be tripled if recycling occurred with higher frequency.

Conclusions

If you're like the average American, the greenhouse gas impact of your diet is greater than the combined impact of your driving and flying. This may come as a surprise because public discussions of carbon emissions focus heavily on transportation, while discussions about the impacts of food are typically centered around non-climate issues. But what it means is that individually and collectively, we have a huge opportunity to reduce our impact on the climate by changing how we feed ourselves.

Eating to fight climate change is within reach for all of us, but it requires a carefully revised approach, even for those already accustomed to thinking about the social and environmental impacts of their diets. Local and organic foods may or may not be good indicators of low climate impact, although they do support the health of our communities, our planet, and our bodies. When it comes to climate change, a stronger focus on your meal's life cycle energy use is the key to a smaller footprint.

Whatever your current carbon foodprint, following these seven basic rules will get you on the fast track to a climate-friendly diet.

- Eat fewer animals and more plants
- Buy unprocessed foods with less packaging
- Grow and harvest your own food
- Minimize car trips to restaurants and stores
- Cook at home more and eat out less
- Cook with efficient appliances and techniques
- Compost, recycle, and relish leftovers

Citations

1 USDA, Economic Research Service, Food Availability Data System.

2 LaSalle, T.J. and P. Hepperly (2008). "Regenerative Organic Farming: A Solution to Global Warming," Rodale Institute.

3 The Bichel Committee (1999). "Report from the main committee: Conclusions and recommendations of the Committee: 8.7.1," Danish Environmental Protection Agency.

4 World Resources Institute, Climate Analysis Indicators Tool.

5 Azeez, G. (2009). "Soil Carbon and Organic Farming: A review of the evidence of agriculture's potential to combat climate change," Soil Association. 212 pp.

6 Weber, C.L. and H.S. Matthews (2008). "Food-Miles and the Relative Climate Impacts of Food Choices in the United States," Environmental Science and Technology, 42 (10), pp 3508–3513.

7 Ebbin, Robert (2000). "Americans' Dining-out Habits," Restaurants USA online. National Restaurant Association.

Data sources

Statistics presented in this report without direct citation were derived from the Brighter Planet carbon emissions model, which draws raw data from a wide variety of sources. Data from all of the following sources were used in the preparation of this paper.

- Arsova, L., et al. (2008). "The State of Garbage in America," BioCycle, 49 (12), pp 22.
- CDC – National Center for Health Statistics – National Health and Nutrition Examination Survey
- Census Bureau – National Population Projections
- DOE – Energy Efficiency & Renewable Energy – Buildings Energy Data Book
- DOE – Energy Information Administration – Monthly Energy Review
- DOE – Energy Information Administration – Annual Energy Outlook
- DOE – Energy Information Administration – Commercial Buildings Energy Consumption Survey
- DOE – Energy Information Administration – Residential Energy Consumption Survey
- DOT – Federal Highway Administration – National Household Transportation Survey
- EPA – 2009 U.S. Greenhouse Gas Inventory Report
- EPA – Municipal Solid Waste in the U.S.
- EPA – Fuel Economy Guide
- EPA – WAste Reduction Model
- USDA – Economic Research Service – Food Availability Data System
- Weber, C.L. and H.S. Matthews (2008). "Food-Miles and the Relative Climate Impacts of Food Choices in the United States," Environmental Science and Technology, 42 (10), pp 3508–3513. And supplemental documents.

For more detailed information about the underlying calculation methodologies please contact Brighter Planet.