

# THE GREENHOUSE HAMBURGER

Producing beef for the table has a surprising environmental cost: it releases prodigious amounts of heat-trapping greenhouse gases

By Nathan Fiala

## KEY CONCEPTS

- Pound for pound, beef production generates greenhouse gases that contribute more than 13 times as much to global warming as do the gases emitted from producing chicken. For potatoes, the multiplier is 57.
- Beef consumption is rising rapidly, both as population increases and as people eat more meat.
- Producing the annual beef diet of the average American emits as much greenhouse gas as a car driven more than 1,800 miles.

—The Editors

**M**ost of us are aware that our cars, our coal-generated electric power and even our cement factories adversely affect the environment. Until recently, however, the foods we eat had gotten a pass in the discussion. Yet according to a 2006 report by the United Nations Food and Agriculture Organization (FAO), our diets and, specifically, the meat in them cause more greenhouse gases—carbon dioxide (CO<sub>2</sub>), methane, nitrous oxide, and the like—to spew into the atmosphere than either transportation or industry. (Greenhouse gases trap solar energy, thereby warming the earth's surface. Because gases vary in greenhouse potency, every greenhouse gas is usually expressed as an amount of CO<sub>2</sub> with the same global-warming potential.)

The FAO report found that current production levels of meat contribute between 14 and 22 percent of the 36 billion tons of “CO<sub>2</sub>-equivalent” greenhouse gases the world produces every year. It turns out that producing half a pound of hamburger for someone's lunch—a patty of meat the size of two decks of cards—releases as much greenhouse gas into the atmosphere as driving a 3,000-pound car nearly 10 miles.

In truth, every food we consume, vegetables and fruits included, incurs hidden environmen-

tal costs: transportation, refrigeration and fuel for farming, as well as methane emissions from plants and animals, all lead to a buildup of atmospheric greenhouse gases. Take asparagus: in a report prepared for the city of Seattle, Daniel J. Morgan of the University of Washington and his co-workers found that growing just half a pound of the vegetable in Peru emits greenhouse gases equivalent to 1.2 ounces of CO<sub>2</sub>—as a result of applying insecticide and fertilizer, pumping water and running heavy, gas-guzzling farm equipment. To refrigerate and transport the vegetable to an American dinner table generates another two ounces of CO<sub>2</sub>-equivalent greenhouse gases, for a total CO<sub>2</sub> equivalent of 3.2 ounces.

But that is nothing compared to beef. In 1999 Susan Subak, an ecological economist then at the University of East Anglia in England, found that, depending on the production method, cows emit between 2.5 and 4.7 ounces of methane for each pound of beef they produce. Because methane has roughly 23 times the global-warming potential of CO<sub>2</sub>, those emissions are the equivalent of releasing between 3.6 and 6.8 pounds of CO<sub>2</sub> into the atmosphere for each pound of beef produced.

Raising animals also requires a large amount of feed per unit of body weight. In 2003 Lucas Reijnders of the University of Amsterdam and



Sam Soret of Loma Linda University estimated that producing a pound of beef protein for the table requires more than 10 pounds of plant protein—with all the emissions of greenhouse gases that grain farming entails. Finally, farms for raising animals produce numerous wastes that give rise to greenhouse gases.

Taking such factors into account, Subak calculated that producing a pound of beef in a feedlot, or concentrated animal feeding operation (CAFO) system, generates the equivalent of 14.8 pounds of CO<sub>2</sub>—pound for pound, more than 36 times the CO<sub>2</sub>-equivalent greenhouse gas emitted by producing asparagus. Even other common meats cannot match the impact of beef; I estimate that producing a pound of pork generates the equivalent of 3.8 pounds of CO<sub>2</sub>; a pound of chicken generates 1.1 pounds of CO<sub>2</sub>-equivalent greenhouse gases. And the economically efficient CAFO system, though certainly not the cleanest production method in terms of CO<sub>2</sub>-equivalent greenhouse emissions, is far better than most: the FAO data I noted earlier imply that the world average emissions from producing a pound of beef are several times the CAFO amount.

## Solutions?

What can be done? Improving waste management and farming practices would certainly reduce the “carbon footprint” of beef production. Methane-capturing systems, for instance, can put cows’ waste to use in generating electricity. But those systems remain too costly to be commercially viable.

Individuals, too, can reduce the effects of food production on planetary climate. To some degree, after all, our diets are a choice. By choosing more wisely, we can make a difference. Eating locally produced food, for instance, can reduce the need for transport—though food inefficiently shipped in small batches on trucks from nearby farms can turn out to save surprisingly little in greenhouse emissions. And in the U.S. and the rest of the developed world, people could eat less meat, particularly beef.

The graphics on the following pages quantify the links between beef production and greenhouse gases in sobering detail. The take-home lesson is clear: we ought to give careful thought to diet and its consequences for the planet if we are serious about limiting the emissions of greenhouse gases.

## [THE AUTHOR]



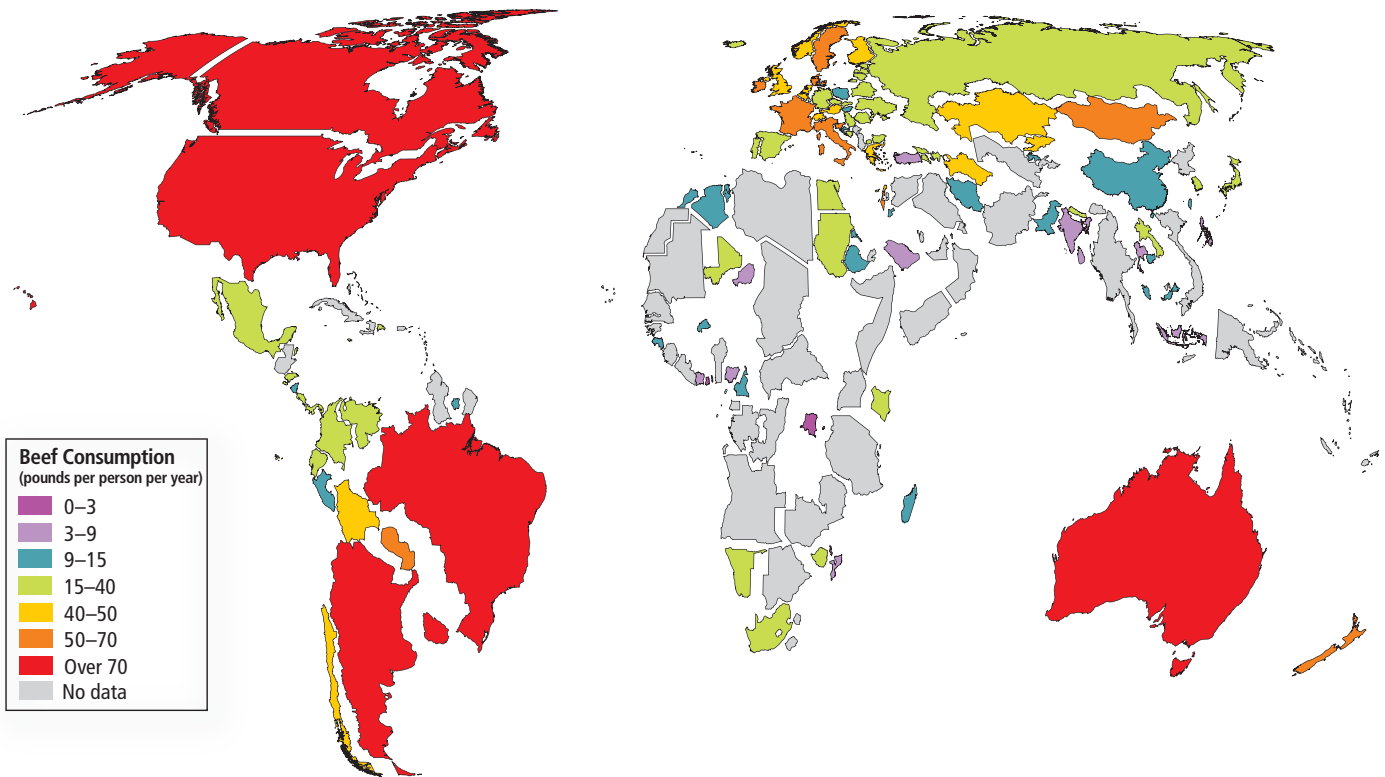
**Nathan Fiala** is a doctoral candidate in economics at the University of California, Irvine, focusing on the environmental impact of dietary habits. He also runs evaluations of development projects for the World Bank in Washington, D.C. In his spare time he enjoys independent movies and sailing. His study of the environmental impact of meat production on which this article is based was recently published in the journal *Ecological Economics*.

## Burgers or Tofu?

Annual beef consumption per capita varies from 120 pounds in Argentina and 92 pounds in the U.S. to only a pound in the small eastern European country of Moldova; the average is about 22 pounds per person per year. The colors of the countries and the distortions of their usual shapes reflect the amount by which beef con-

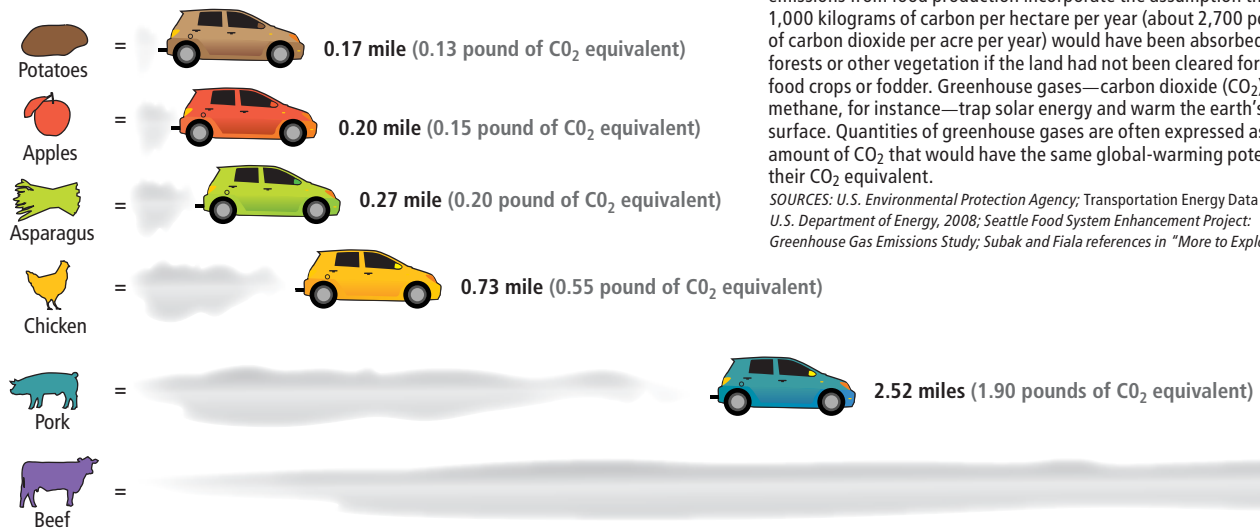
sumption per capita varies from the world average. World beef consumption per capita is growing, particularly in Asia, because of economic development: as people earn higher incomes, they purchase foods they find more desirable.

SOURCE: U.N. FAO, 2003



## Eating and Driving: An Atmospheric Comparison

CO<sub>2</sub>-equivalent emissions from producing half a pound of this food ... are the same as emissions from driving ...



The greenhouse gas emissions from producing various foods can be appreciated by comparing them with the emissions from a gasoline-powered passenger car that gets 27 miles per gallon. The estimated emissions from food production incorporate the assumption that 1,000 kilograms of carbon per hectare per year (about 2,700 pounds of carbon dioxide per acre per year) would have been absorbed by forests or other vegetation if the land had not been cleared for annual food crops or fodder. Greenhouse gases—carbon dioxide (CO<sub>2</sub>) and methane, for instance—trap solar energy and warm the earth's surface. Quantities of greenhouse gases are often expressed as the amount of CO<sub>2</sub> that would have the same global-warming potential: their CO<sub>2</sub> equivalent.

SOURCES: U.S. Environmental Protection Agency; Transportation Energy Data Book, U.S. Department of Energy, 2008; Seattle Food System Enhancement Project; Greenhouse Gas Emissions Study; Subak and Fiala references in "More to Explore"

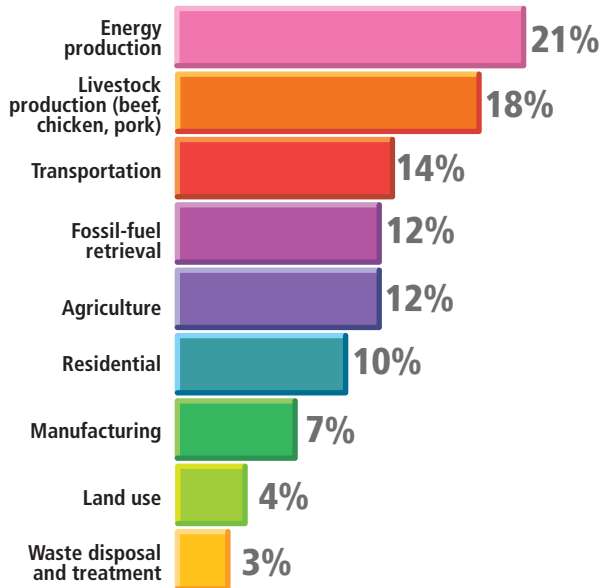
MAPPING SPECIALISTS (map); LUCY READING-IKKANDA (illustrations)



## The High (Greenhouse Gas) Cost of Meat

Worldwide meat production (beef, chicken and pork) emits more atmospheric greenhouse gases than do all forms of global transportation or industrial processes. On the basis of data from the United Nations Food and Agriculture Organization (FAO) and the Emission Database for Global Atmospheric Research, the author estimates that current levels of meat production add nearly 6.5 billion tons of CO<sub>2</sub>-equivalent greenhouse gases every year to the atmosphere: some 18 percent of the worldwide annual production of 36 billion tons. Only energy production generates more greenhouse gases than does raising livestock for food.

SOURCE: U.N. FAO, 2006



Total is greater than 100% because of rounding



## A Growing Appetite

	U.S. Beef Consumption (millions of tons)	CO <sub>2</sub> -Equivalent Greenhouse Gases from U.S. Beef Production (millions of tons)	World Beef Consumption (millions of tons)	CO <sub>2</sub> -Equivalent Greenhouse Gases from World Beef Production (millions of tons)
2009 (projected)	14	210	72	1,100
2020 (projected)	15	230	80	1,200
2030 (projected)	17	250	87	1,300
Cumulative (2009–2030)	340	5,000	1,800	26,000

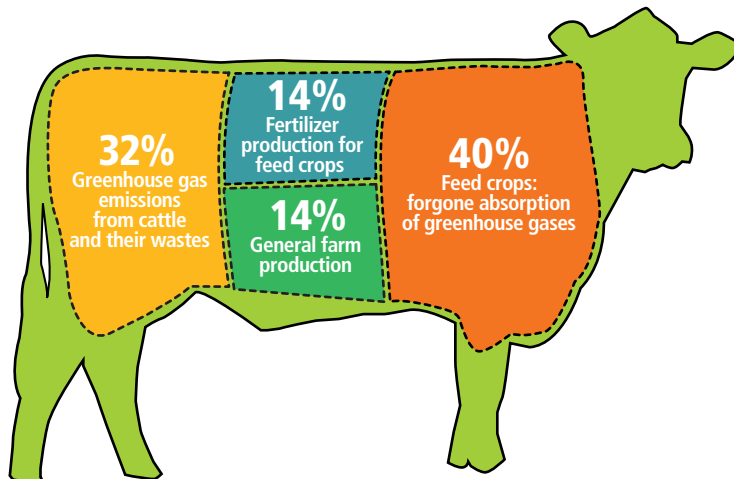
Quantities are rounded to two significant digits

World beef production is increasing at a rate of about 1 percent a year, in part because of population growth but also because of greater per capita demand in many countries. Economic analysis shows that if all beef were produced under the economically efficient feedlot, or CAFO (concentrated animal feeding operation), system—which generates fewer greenhouse emissions than many other common husbandry systems do—beef production by 2030 would still release 1.3 billion tons of CO<sub>2</sub>-equivalent greenhouse gases. If current projections of beef consumption are correct, even under the feedlot production system the buildup of CO<sub>2</sub>-equivalent greenhouse gases could amount to 26 billion tons in the next 21 years.

SOURCES: U.N. FAO; U.S. Census Bureau

## Prime Cuts: How Beef Production Leads to Greenhouse Gases

The largest fraction of the greenhouse effect from beef production comes from the loss of CO<sub>2</sub>-absorbing trees, grasses and other year-round plant cover on land where the feed crops are grown and harvested. Second most important is the methane given off by animal waste and by the animals themselves as they digest their food. This analysis of the U.S. feedlot beef production system was done by ecological economist Susan Subak, then at the University of East Anglia in England.



9.81 miles (7.40 pounds of CO<sub>2</sub> equivalent)



## MORE TO EXPLORE

**Global Environmental Costs of Beef Production.** Susan Subak in *Ecological Economics*, Vol. 30, No. 1, pages 79–91; 1999.

**Livestock's Long Shadow: Environmental Issues and Options.** H. Steinfeld, P. Gerber, T. Wassenaar, V. Castel, M. Rosales and C. de Haan. United Nations Food and Agriculture Organization, 2006. Available at [www.fao.org/docrep/010/a0701e/a0701e00.HTM](http://www.fao.org/docrep/010/a0701e/a0701e00.HTM)

**Meeting the Demand: An Estimation of Potential Future Greenhouse Gas Emissions from Meat Production.** Nathan Fiala in *Ecological Economics*, Vol. 67, No. 3, pages 412–419; 2008.