



## What's For Lunch? An Introduction to Food Production Impacts on Greenhouse Gas Emissions



**Developed by the New Mexico Museum of Natural History & Science**

**Grades:** 7, 8, 9, 10, 11, and 12

**Goal:** To introduce students to how our food choices impact the environment.

**Objective:** Students will learn:

- How greenhouse gases contribute to climate change.
- Discover how food production produces greenhouse gas emissions.
- Compare the varying amount of greenhouse gases emitted by the production of common food items.

**Materials:** Attached article and food item cards (see attached file [whatsforlunchfooditemcards.pdf](#), printed out double-sided “booklet” format)

**Background Information:** Review the basics of greenhouse gas emissions and how the amount of greenhouse gases impact local weather patterns and ultimately influence climate change. In other words, the more greenhouse gases that exist in our atmosphere means less heat can escape from our atmosphere. This type of heat capture can lead to changes in the climate worldwide including higher temperatures, more arid areas, and larger weather events such as more powerful hurricanes. Climate change in the past one hundred years has occurred more rapidly than at any other point in geologic history. This time period coincides with human population growth and the Industrial Revolution. One hundred years ago, the worldwide human population was under two billion and today is now over six billion people. The daily choices we make as individuals can affect the amount of greenhouse gases trapped within the atmosphere.

**Instructions for Classroom Use:**

1. Review background information and have students read the attached article from the February 2009 *Scientific American*, “How Meat Contributes to Global Warming: Producing beef for the table has a surprising environmental cost: it releases prodigious amounts of heat-trapping greenhouse gases” by Nathan Fiala. This article can also be found online at <http://www.scientificamerican.com/article.cfm?id=the-greenhouse-hamburger>  
Look at this website for useful graphics as well.
2. Students will brainstorm what parts of the food production process contribute to greenhouse gas emissions. These can include
  - a. Fuel for farming
  - b. Transportation of food from farm to table
  - c. Refrigeration of food

- d. The production and application of pesticides and fertilizers
  - e. Water pumping for irrigation
  - f. Methane produced by animals and plants
3. Spread the food item cards in front of the students, picture side up. Have each student start planning out their menu for the day.
  4. Once students have chosen their food items, they can flip over the food item cards and begin adding up the total of the greenhouse gas emissions produced for each of their planned menus. Describe that *CO<sub>2</sub>E is a measurement of greenhouse gases. The more greenhouse gases produced means the more heat trapped in our atmosphere which will affect weather, impact agriculture, and change ecosystems.*
  5. Have students compare their menus and total greenhouse gas emissions produced for their food items. Was anyone surprised by their choices?
  6. Students can compare similar food items such as a bean burrito and a beef burrito, and a slice of cheese pizza versus pepperoni pizza. What accounts for the differences in the amount of greenhouse gas emissions produced?

**Instructions for Use by Informal Educators as a Walk-by Activity:**

1. Place food item cards on a table, face down.
2. Ask visitors to pick out foods they like to eat--then turn them over and compare the CO<sub>2</sub>E amounts of each.
3. Encourage them to compare food choices:
  - Pepperoni pizza to cheese pizza
  - Bean, cheese and rice burrito to beef and cheese burrito
  - Chicken sandwich to hamburger/cheeseburger to grilled cheese
4. Have copies of the February 2009 Scientific American article and associated graphics from the slideshow available to hand out. This article can be found at <http://www.scientificamerican.com/article.cfm?id=the-greenhouse-hamburger>.
5. Reinforce that our food choices can affect our carbon footprint and the greenhouse gases that are produced.
6. Scientists say that if we reduce the amount of meat, and especially the amount of beef we eat, even by a couple of meals a week there would be a huge difference in greenhouse gases released. For example, according to Dr. Christopher Weber, a researcher at Carnegie Mellon, if we did not eat red meat or dairy products for one day per week, it would have the same impact greenhouse gas emission reduction as driving 1,500 less miles per year. For the interview containing this information, please visit

<http://www.earthsky.org/radioshows/52539/beef-production-has-high-cost-to-earths-climate>.

Food Item Card information obtained from [www.eatlowcarbon.org](http://www.eatlowcarbon.org)

**Table of Food Items Ranked in Terms of Grams of Greenhouse Gases  
Emitted During Production**

<b>Food Item</b>	<b>Comida</b>	<b>Grams of CO2E</b>
Bar of Milk Chocolate	Barra de chocolate de leche	277
Toast w/ Jam	Pan tostado con jamon	103
Toast w/ Butter	Pan tostado con mantequilla	106
French Fries		122
Bottle of Water	Agua	125
Rice and Beans	Arroz y frijoles	129
Steel Cut Oats	Aven cortada	144
Chocolate Cookies	Galletas de chocolate	153
Soda	Gaseosa	168
Minestone Soup	Sopa minestrone	189
Chicken Noodle Soup	Sopa de pollo y tallarines	253
Black Coffee	Café negro	284
Yogurt w/ Fruit	Yogurt con fruta	306
Hard Boiled Egg	Huevo hervido duro	333
Fried Egg	Huevo frito	336
Latte	Café con leche	380
Pasta Primavera		392
Garden Salad	Ensalada	401
Bean, Cheese, and Rice Burrito	Burrito de frijoles, queso, y arroz	448
Chicken Sandwich	Sandwich de pollo	520
Smoothie	Licuada	540
Fish and Chips	Pescado con papas	541
Slice of Cheese Pizza	Pizza de queso	556
Caesar Salad	Ensalada cesar	558
Slice of Pepperoni Pizza	Pizza de pepperoni	644
Chicken Chow Mein	Pollo chow main	646
Macaroni and Cheese	Macaroni con queso	906
Grilled Cheese Sandwich	Sandwich de queso a la parrilla	929
Cereal and Milk	Cereal y leche	1224
Pancakes w/ Syrup and Butter	Panqueques con jarabe y mantequilla	1277
Chile w/ Beef	Chile con carne	1281
Spinach and Tofu Salad	Ensalada de espinaca y tofu	1296
Spaghetti and Meatballs	Spaghetti con albondigas de carne	1659
Beef and Cheese Burrito	Burrito de carne y queso	2257
Hamburger	Hamburguesa	2541
Cheeseburger	Hamburguesa con queso	2826

**Extensions:**

1. Compare and contrast the amount of greenhouse gas emissions produced for food items and their nutritional values. Does more nutritious food mean a smaller amount of greenhouse gas emissions produced? Hint: Look at the french fry compared to the tofu and spinach salad cards.
2. How can our daily choices such as what we choose to eat for lunch affect climate change and the environment?
3. Split students into groups and have them design meals with the lowest impact on the environment possible. This activity could include a field trip to local farms, ranches, and farmers markets and/or preparation of these food items for a school event.
4. What are the differences in the amount of greenhouse gases emitted through the production of factory-farmed beef versus grass-fed range beef?
5. What are ways we can reduce greenhouse gas emissions in food production?
6. How do other daily choices in our lives affect climate change?
7. How does food production contribute to overall greenhouse gas emissions worldwide?

<http://www.scientificamerican.com/article.cfm?id=the-greenhouse-hamburger>  
From the 2009 February Scientific American

**“How Meat Contributes to Global Warming: 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.**

Most 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 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 environmental 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.

*Note: This article was originally printed with the title, "The Greenhouse Hamburger".*