

Meili Gault  
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## The Life Cycle of a Hamburger and its Environmental Implications

The hamburger is one of the most common items of the American lifestyle: three-quarters (82%) of Americans eat hamburgers one to two times a week<sup>1</sup>. It is cheap, convenient, readily accessible through the many fast-food restaurants across the United-States, and unavoidable in a barbecue. It is ideal for our short lunch breaks because it takes just a few minutes to purchase and eat a hamburger. In appearance, it is a basic, simple item, and yet, a closer look reveals that it takes a lot to make a hamburger. The paper will talk about the lifecycle of a hamburger sold in a fast-food restaurant, from production to disposal, as well the environmental impacts associated with the lifecycle, and will conclude with examples and suggestions on how to reduce the impact.

### *Ingredients of a hamburger*

According to McDonald's official website, here is what is put in a hamburger, which the fast-food chain sold billions of since its creation<sup>2</sup>:

100% Beef Patty, Regular Bun, Ketchup, Mustard, Pickle Slices, Onions<sup>3</sup>

These ingredients have to be produced then processed then made into a hamburger, which will be sold to the customer. Therefore, the lifecycle of a hamburger comprises an agricultural phase, a processing phase and a consumption phase. *See Appendix 1 for lifecycle chart.*

### The lifecycle of the hamburger

#### *The agricultural phase*

The agricultural phase involves raising cattle, growing forage, cereals and other seed crops, as well as vegetables and fruits. Land is needed for each of these activities, and farmers sometimes have to convert forests into pasture and cropland in order to grow the quantities necessary to supply the demand for hamburgers. The ensuing intensive agriculture uses fertilizers, insecticides, herbicides

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<sup>1</sup> Impulse Research Corporation survey (2004)

<sup>2</sup> PubMed, U.S. National Library of Medicine, National Institutes of Health,  
<http://www.ncbi.nlm.nih.gov/pubmed/15831345>

<sup>3</sup> McDonald's USA Ingredients Listing for Popular Menu Items,  
[http://nutrition.mcdonalds.com/nutritionexchange/nutrition\\_ingredients.html?DCSext.destination=http://nutrition.mcdonalds.com/nutritionexchange/nutrition\\_ingredients.html](http://nutrition.mcdonalds.com/nutritionexchange/nutrition_ingredients.html?DCSext.destination=http://nutrition.mcdonalds.com/nutritionexchange/nutrition_ingredients.html)

and other chemicals which contribute to soil and water degradation. Indeed, US cattle feedlots are responsible for the erosion and loss of about 9 pounds of topsoil for every hamburger produced<sup>4</sup>. The US also imports beef from Central and South America, with the same consequence for the local land: according to People of the Tropical Rainforest, for each quarter-pound of hamburger made from Central American beef, 55 square feet of tropical forest containing 165 pounds of living plants and animals, is destroyed.<sup>5</sup> Further deforestation takes place in order to manufacture the paper wraps of the hamburger.

*The processing phase*

The next phase involves transforming the cattle into ground beef; the wheat into buns; the mustard seeds into prepared mustard; the vegetables and fruits into ketchup, pickles and onions. Wood is also processed into paper for the packaging.

The ground beef and the bread require several steps in their processing. The wheat is harvested, dried, milled into flour and baked into buns. The cattle is slaughtered then transformed into meat cuts. Every ingredient is stored and transported at some point. Food losses occur at every step (harvesting, freezing, storage, transportation), because of quality deterioration during storage or food clinging to equipment during processing<sup>6</sup>. As a result, more food is used to produce a hamburger than is actually consumed. In fact, because of the losses occurring during processing, the quantity of grain needed for four hamburgers could feed someone in a developing country for more than a week<sup>7</sup>. The details of mass flows for the hamburger ingredients are shown in the table below:

Mass flows for hamburger ingredients

Ingredient (before/after processing)	Wheat/ bread	Cattle/ burger	Lettuce (harvested /served)	Onion (harvested /served)	Cucumber (harvested /served)	Total mass
Original mass (kg)	0.083	0.238	0.039	0.021	0.019	0,20
Actual mass put into hamburger (kg)	0.074	0.090	0.028	0.0017	0.0074	2,53
% mass loss	10.84	60.87	28.21	91.90	61.05	272,99

Source: Energy Use in the Food Sector: A data survey, by Carlsson-Kanyama and Faist, 2000

The high loss percentage observed for onions and cucumber is due to the respective facts that the former is freeze-dried and the latter is pickled during processing.

<sup>4</sup> The Humble Hamburger, Brian Halweil, Senior Researcher, World Watch; Jul/Aug2004, Vol. 17 Issue 4  
<sup>5</sup> People of the Tropical Rainforest, Julie Denslow and Christine Padoch, University of California Press, 1988  
<sup>6</sup> Energy Use in the Food Sector: A data survey, by Carlsson-Kanyama and Faist, 2000  
<sup>7</sup> Canadian Green Consumer Guide, Pollution Probe, McClelland & Stewart Ltd, 1991  
<sup>8</sup> Mass of the part that will be turned into ground beef when animal enters slaughterhouse

The food loss is one of the hamburger's lifecycle main inefficiencies: for one pound of final product, about 12.5 pounds of ingredients must be produced.

#### *The consumption phase*

The final phase involves making the hamburger and selling it to the customer who will eat it and then dispose of the packaging as waste.

#### *An energy intensive lifecycle*

The hamburger requires important amounts of energy (fossil fuel consumption) during its lifecycle: fossil fuel is used for farm equipment (tractors, threshers) and grain transportation to mills and feedlots. Electric power (from coal) is needed to process cattle into beef, refrigerate it, and then cook it. And fossil fuel again needed for transportation of products, between each phase of the lifecycle, to processing plants, warehouses, and restaurants. It is estimated that, during the agricultural phase only, the meat production of one quarter-pound hamburger requires about one quart of gasoline<sup>9</sup>, or 10-20 times as much energy (per edible ton) as does grain production<sup>10</sup>. Therefore, more energy goes into the production of the hamburger (8,000 calories) than is gained by the person who consumes it (400-calorie gain).

#### Environmental implications

##### *Hamburger's carbon footprint*

The important energy requirements of the hamburger's lifecycle as well as the many processing and refinements steps have great environmental impacts, some of which can be measured in carbon footprint. The main greenhouse gas emitter in the lifecycle is meat production, as it requires the biggest share of fossil fuels – which results in carbon dioxide emissions –, and cattle itself releases methane (from manure and digestive process), which is 35 times a more harmful greenhouse gas than CO<sub>2</sub><sup>11</sup>. As a result, the production and processing of meat (and other ingredients) to supply the US demand for hamburgers releases about as much greenhouse gas as do 6.5 million SUVs

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<sup>9</sup> The Humble Hamburger, Brian Halweil, Senior Researcher, World Watch; Jul/Aug2004, Vol. 17 Issue 4

<sup>10</sup> Environment Canada, Connections: Canadian lifestyle choices and the environment, <http://www.ec.gc.ca/soer-ree/English/products/factsheets/95-1.cfm>

<sup>11</sup> Numerical estimates of Global Warming Potential. IPCC, 1992

annually<sup>12</sup>. On top of that, deforestation resulting from land conversion to agriculture, have released additional carbon dioxide into the atmosphere<sup>13</sup>.

Other environmental impacts (as mentioned earlier) results from intensive agriculture, which causes soil degradation and water pollution, as well conversion of land and deforestation.

Public health issues are also associated with hamburger consumption: obesity, heart disease (from overconsumption)<sup>14</sup> and food poisoning (E. coli bacteria found in undercooked hamburgers)<sup>15</sup>, among others.

Making a hamburger generates many inefficiencies: food loss, intensive energy use and negative environmental and public health impacts. Nonetheless, hamburgers are relatively low-priced and readily available to consumers. Indeed, the high costs resulting from those inefficiencies are not passed along to the consumers: they remain externalities, in part due to government agricultural subsidies<sup>16</sup>. As such, the market price of the hamburger does not reflect the true costs of producing it, thus sustaining a higher demand than should be, and beyond what is sustainable. Not accounting for the true costs also maintains the lifecycle inefficiencies.

### The economics of the hamburger

Despite the substantial issues generated by producing and consuming hamburgers, both on human beings and the environment, hamburgers are a cornerstone of the economics of the fast-food industry, which plays an important role of in the national economy. Americans eat about 13 billion hamburgers a year, and they spend about \$134 billion on fast-food<sup>17</sup>. And many industries are involved in the hamburger's lifecycle: agriculture, transportation, packaging and even advertising. In fact, the fast-food industry provides about 90 percent of new jobs in the US<sup>18</sup>. Therefore, it is not currently possible to get rid of the hamburger. However, it is possible to improve its lifecycle and reduce its inefficiencies.

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<sup>12</sup> The Cheeseburger Footprint, Jamais Cascio, Open the Future, [http://openthefuture.com/cheeseburger\\_CF.html](http://openthefuture.com/cheeseburger_CF.html). See Appendix 2 for calculation details.

<sup>13</sup> Environmental Law and Policy, James Salzman and al, 2d ed., Foundation Press, 2007

<sup>14</sup> Fast food franchises in hospitals, P. Cram and al, The Journal of American Medical Association, No. 22, June 12, 2002

<sup>15</sup> Raw ground beef often tainted with E. coli, Julie Vorman, Yahoo Daily News, March 1, 2000 [http://dailynews.yahoo.com/h/nm/20000301/hl/psb\\_43.html](http://dailynews.yahoo.com/h/nm/20000301/hl/psb_43.html)

<sup>16</sup> Farmers of Central Valley, CA, receive up to \$416 million per year in water subsidies. Part of the subsidies is used to raise cattle.

Source: Natural Resources: Water Subsidies, Environmental Working Group, <http://www.ewg.org/featured/10>

<sup>17</sup> Fast Food Nation, Eric Schlosser, Houghton Mifflin, 2001

<sup>18</sup> Ibid.

### Improving the hamburger's lifecycle

Below are some examples and suggestions of how to mitigate the negative effects of the hamburger's lifecycle.

#### *Recycling manure*

Manure is a significant by-product of beef production. About 200kg of manure are produced during a cow's lifetime<sup>19</sup>, releasing a substantial quantity of methane in the atmosphere. However, manure can be recycled as a crop nutrient by spreading it on farmland, thus reducing the dependency on artificial agricultural inputs, and saving farmers money<sup>20</sup>.

#### *Reducing waste: McDonald's McGreening*

In 1991, McDonald's implemented McGreening, a program aimed at reducing waste in their operations. They found out that more than 80 percent of a restaurant's solid waste was produced in the kitchen from materials that can be recycled or reused. So the restaurant adopted 42 measures, including replacing white bleached takeout bags with brown recyclable ones, and hamburger plastic wraps with recycled paper ones, as well using smaller paper napkins, and composting<sup>21</sup>. The program was efficient, since, among other things, switching to paper wrap resulted in cutting down on materials needed to make wrappers by 80 percent.

#### *CO<sub>2</sub>-emission labeling of food in Sweden*

According to Eric Schlosser, author of *Fast Food Nation*, the best way to change industry practices comes from the consumers of hamburgers themselves. Consumer demand can influence the supply chain all the way to its source. However, most people are unaware of the inefficiencies and negative byproducts of producing a hamburger, so educating them first is necessary. Sweden aimed at doing just that with its new regulation on CO<sub>2</sub>-emission labeling of certain food products and restaurants menus. Max, the largest Swedish fast-food chain has started putting emissions calculations next to each item on its menu boards, so customers can see that a Max hamburger produced 1.7 kilograms of carbon dioxide emissions while a chicken sandwich produced "only" 0.4 kilograms. So far, the results have been mixed, but since the emissions counts started appearing on Max's menu, sales of

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<sup>19</sup> Carbon Neutral Beef, <http://www.carbonneutralbeef.com/>

<sup>20</sup> Environment Canada, Connections: Canadian lifestyle choices and the environment, <http://www.ec.gc.ca/soer-ree/English/products/factsheets/95-1.cfm>

<sup>21</sup> McDonald's launches McGreening drive; with environmentalists' help, McD's plans to reduce its trash by 80%, Nation's Restaurant News, April 29, 1991 by Milford Prewitt

climate-friendly items have risen 20 percent<sup>22</sup>, and people are more aware about the CO<sub>2</sub> impacts of different types of meats. The labeling program is only one part of the education, though, and more efforts need to be done, from public and private sector, to really impact the lifecycle.

#### *An alternative to the hamburger: McDonald's McVeggie*

In an attempt to widen its customer base, McDonald's introduced the McVeggie, a hamburger with a soy-based patty, at the end of the 1990s. The McVeggie was sold at limited locations (in New York City and Southern California). However, it was a marketing failure, because it was not a vegetarian sandwich, and to people, hamburgers were associated with meat. Instead, the fast-food chain focused more on its salad offerings for healthier alternatives to hamburgers<sup>23</sup>.

However, given the appeal for healthy foods today (as well as the awareness created by books such as *Fast Food Nation*), there might be a potential market for the McVeggie. Therefore, McDonald's should try to reintroduce a version of it, as an alternative to the meat-based hamburger.

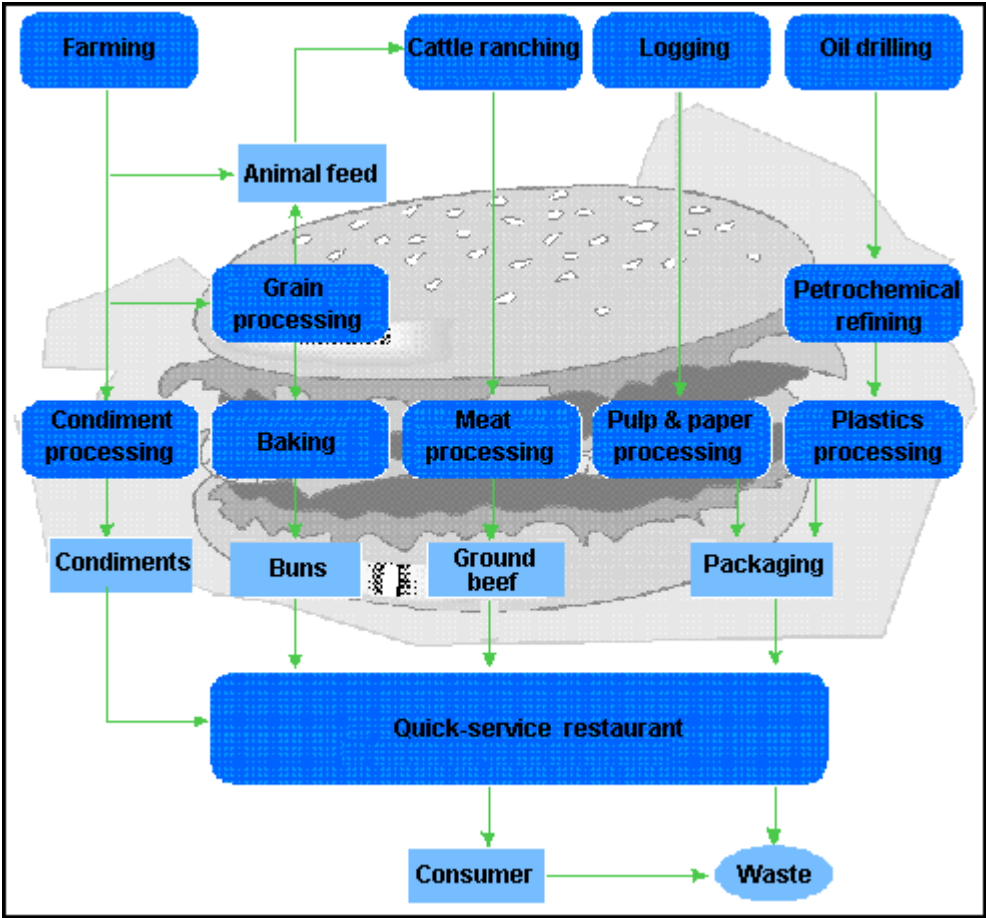
The lifecycle of a hamburger reveals just how extensive and far-reaching the environmental implications of this basic (yet very refined) product can be. Despite the substantial inefficiencies and negative byproducts, the hamburger remains extremely affordable and accessible, a common component of the American lifestyle, and a symbol of it overseas. However, like the American lifestyle, the hamburger is currently not a sustainable product, since it puts a great straining on natural resources and generates a lot of pollution. There have been some improvements of practices in the fast-food industry, and a beginning of public education. However, this is not enough to fundamentally change the lifecycle. Ideally, the true costs of producing a hamburger should be included in its market price, thus shifting demand to environmentally-friendlier products. Since it cannot be currently done, one of the possible avenues for change is through the consumers themselves: the public needs to be further educated in the environmental impacts of their food consumption to make more informed choices and reduce their demand for hamburgers.

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<sup>22</sup> To Cut Global Warming, Swedes Study Their Plates, Elisabeth Rosenthal, The New York Times, Oct 23, 2009

<sup>23</sup> McVeggie comes with disclaimer, Carly Roden, Spartan Daily, Mar 4, 2004

Appendix 1: The lifecycle of a hamburger



(source: Environment Canada, Connections: Canadian Lifestyle Choices and the Environment)

## Appendix 2: Excerpt of The Cheeseburger footprint<sup>24</sup>

By regulation, a beef cow must be at least 21 months old before going to the slaughterhouse; let's call it two years. A single cow produces about 110 kilos of methane per year in manure [...], so over its likely lifetime, a beef cow produces 220 kilos of methane. Since a single kilo of methane is the equivalent of 23 kilos of carbon dioxide, a single beef cow produces a bit more than 5,000 CO<sub>2</sub>-equivalent kilograms of methane over its life.

A typical beef cow produces approximately 500 lbs of meat for boneless steaks and ground beef. If we assume that the typical burger is a quarter-pound of pre-cooked meat, that's 2,000 burgers per cow. Dividing the methane total by the number of burgers, then, we get about 2.6 CO<sub>2</sub>-equivalent kilograms of additional greenhouse gas emissions from methane, per burger, or roughly as much greenhouse gas produced from cow burps (etc.) as from all of the energy used to raise, feed or produce all of the components of a completed cheeseburger!

That's a total of 3.6-6.1 kg of CO<sub>2</sub>-equivalent per burger. If we accept the [~1]/week number, that's [180-305kg] of greenhouse gas per year for an average American's burger consumption. And for the nation as a whole?

[...]

300,000,000	citizens
* 50	burgers/year (~Fast Food Nation)
* 4.35	kilograms of CO <sub>2</sub> -equivalent per burger
/ 1000	kilograms per metric ton
= 65,250,000	annual metric tons of CO <sub>2</sub> -equivalent for all US burgers

Those numbers are big, impressive, and probably meaningless.

So let's convert that to something more visceral. Let's compare to the output from a more familiar item: an SUV.

A Hummer H3 SUV emits 11.1 tons (imp.) of CO<sub>2</sub> over a year; this converts to about 10.1 metric tons, so we'll call it 10 to make the math easy.

[...]

65,250,000 annual metric tons of CO<sub>2</sub>-equivalent for all US burgers  
/10 metric tons of CO<sub>2</sub>-equivalent per SUV

=6.5 million SUVs

To make it clear, then: **the greenhouse gas emissions arising every year from the production and consumption of cheeseburgers is roughly the amount emitted by 6.5 million [...] SUVs.** There are now approximately 16 million SUVs currently on the road in the US.

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<sup>24</sup> The Cheeseburger Footprint, Jamais Cascio, Open the Future,  
[http://openthefuture.com/cheeseburger\\_CF.html](http://openthefuture.com/cheeseburger_CF.html)

Note: The author draws his data from the websites [www.carbonneutralbeef.com](http://www.carbonneutralbeef.com) and [www.fueleconomy.gov](http://www.fueleconomy.gov)