Understand the Carbon Footprint of Cheese

SPONSORS:
University of Wisconsin–Madison
College of Agricultural and Life Sciences
University of Wisconsin–Extension
Department of Food Science
Department of Biological Systems Engineering
Environmental Resources Center
Wisconsin Center for Dairy Research
USDA Rural Development
Innovation Center for U.S. Dairy
Many dairy processors, farmers, and consumers are concerned with energy use and global sustainability. Energy use is directly related to the cost of production and affects dairy product profitability. Buyers and consumers want to know the environmental impact of products. Lack of knowledge or transparency about a product’s environmental impact may make a business less appealing to a consumer. Since much of the energy we use is linked to production of greenhouse gases, using less energy saves money and reduces potential climate change.
How much impact do dairy plants have on climate change? Can you reduce greenhouse gas emissions effectively and still make a quality product with a competitive price? How do you calculate the carbon footprint of a dairy plant?

Recent research at the University of Wisconsin and other institutions gives us solid data to answer these questions. This publication will guide you through an understanding of the factors that influence the carbon footprint of cheese. It will help you look at your operation and identify ways you can lessen the amount of greenhouse gases produced during the manufacture and sale of your product. You’ll learn how to understand, calculate and discuss the carbon footprint of cheese.
What is meant by “carbon footprint”?  
Activities such as farming, manufacturing, packaging, and transportation cause carbon dioxide (CO₂) and other gases to be released into the atmosphere. Some of these gases cause warming of the earth’s climate since they re-emit solar radiation back to the earth. These gases are called “greenhouse gases” (GHG).¹

Carbon footprint is the overall amount of CO₂ and other greenhouse gas emissions associated with a product.² The carbon footprint is quantified using indicators such as the Global Warming Potential (GWP), which reflects the relative effect of a greenhouse gas in terms of climate change over time. This value expresses the overall contribution to climate change of these emissions.² Levels of CO₂ are increasing in the atmosphere.³
Greenhouse gases

Greenhouse gases are gases that trap heat in the atmosphere and create a warming layer like a blanket that warms the earth. They absorb heat reflected off the earth's surface. Some of this heat goes into space and some is emitted back to earth. Greenhouse gases occur naturally and as a result of human activities. Human activity has increased the amount of greenhouse gases, as evidenced by studies of the CO₂ level in air bubbles in cores of ice formed thousands of years ago in Greenland and Antarctica. Before human activity, the level of CO₂ in the atmosphere was never more than 300 ppm. Now it is 390 ppm, and rising by about 2 ppm every year. Earth is also warming at a rapid rate. Scientists believe a level of 350 ppm is the safe upper limit for CO₂ in the atmosphere. We need to curb CO₂ emission to prevent climate catastrophe such as the melting of the Greenland ice sheet and major flooding.

“Greenhouse gases can be thought of as pollutants that are invisible.”

Carbon dioxide is not the only greenhouse gas. Methane, nitrous oxide, ozone, and water vapor are also naturally occurring greenhouse gases. Other greenhouse gases are human-made, such chlorofluorocarbons commonly used as refrigerants and aerosol propellants. We are concerned not only with CO₂ but with methane and other greenhouse gases because they have a much higher potential to warm the earth than CO₂ does. Not only do greenhouse gases warm the earth, but some cause conditions which help increase the ozone hole in the upper atmosphere. Greenhouse gases can be thought of as pollutants that are invisible.
Global warming potential of greenhouse gases

When thinking about greenhouse gas emissions, it is useful to think in terms of CO₂ equivalents (CO₂-eq). Carbon dioxide equivalents are used to compare greenhouse gases based on their global warming potential, having CO₂ as the reference value (Table 1). Methane, for example, has a CO₂ equivalent of 25 in a 100 year period. If you can reduce methane emission by 100 lbs it is as if you have reduced your CO₂ emission by 2,500 lbs, because methane has a much higher global warming potential than CO₂.

### Table 1. Greenhouse gases and their potential for global warming over a 100-year period

<table>
<thead>
<tr>
<th>Gas</th>
<th>Formula or Designation</th>
<th>Global warming potential, or CO₂ equivalent</th>
<th>Causes ozone depletion?</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Common Greenhouse Gases</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carbon Dioxide</td>
<td>CO₂</td>
<td>1</td>
<td>No</td>
</tr>
<tr>
<td>Methane</td>
<td>CH₄</td>
<td>25</td>
<td>No</td>
</tr>
<tr>
<td>Nitrous Oxide</td>
<td>N₂O</td>
<td>298</td>
<td>No</td>
</tr>
<tr>
<td><strong>Refrigerants</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Freon</td>
<td>CFC-12 (R-12)</td>
<td>10,900</td>
<td>Yes</td>
</tr>
<tr>
<td>Arcton</td>
<td>HCFC (R-22)</td>
<td>1,810</td>
<td>Yes</td>
</tr>
<tr>
<td>Genetron</td>
<td>HFC-134a (R-134a)</td>
<td>1,430</td>
<td>No</td>
</tr>
<tr>
<td>Ammonia</td>
<td>NH₃</td>
<td>0</td>
<td>No</td>
</tr>
<tr>
<td><strong>Fire Extinguisher Gas</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Halon</td>
<td>Halon 1301</td>
<td>7,140</td>
<td>Yes</td>
</tr>
</tbody>
</table>
Are the refrigerants that leak from my cooling system greenhouse gases?

Some refrigerants are greenhouse gases and some are not. Freon (R-12) and some other ozone depleting compounds have been phased out since the late 1980s. Since that time we have seen the ozone hole in the Antarctic shrink, which is a good example of how human action can reverse environmental damage by making changes based on scientific evidence. Arcton (R-22) and genetron (R-134a) are greenhouse gases but ammonia is not.

Regulation of greenhouse gases

Greenhouse gases became a federal pollutant through an EPA and Department of Transportation rule as of January 1, 2011. Large emitters, over 25,000 metric tons of CO$_2$-eq per year, are required to report. However, there is no enforcement for reduction. Only the largest dairy plants would fall into that category. Further regulation limiting greenhouse gas emissions is politically contentious; so we expect lengthy delays in further actions.
How does this relate to cheese making?

During the processes to make cheese and deliver it to the consumer, there are several potential sources of greenhouse gas emissions. The largest percentage of cheese GHG emissions occurs during milk production at the dairy farm (greater than 90%).

Modern dairy practices produce about 1.2 kg CO₂-eq per kg milk, or 1.2 lbs CO₂-eq per lb of milk. Nearly 10 pounds of milk are needed to produce one pound of cheese. Farm greenhouse gas emissions come mostly from rumen methane, nitrous oxide from fertilizer, and methane from manure. When cows and other ruminants eat, microbes in their rumen break down the food and produce methane. This is called enteric methane, and most is expelled as burps. Enteric methane is the major single contributor to farm greenhouse gas emissions. When farmers apply fertilizer or manure to fields, nitrous oxide is emitted, another potent greenhouse gas. Nitrogen leaching and runoff into water also causes nitrous oxide to escape into the air.

Farmers can lower their GHG emissions in several ways. They can alter the feed composition to reduce methane, manage fertilizer to...
limit excess nitrogen and runoff, and continue to aim for more efficient milk production. Farmers can also capture manure methane and use it to make biogas in a digester. Any improvement at the dairy farm level will result in a substantive reduction in GHG emissions.

Dairy manufacturing, including packaging, contributes the second highest percentage of cheese GHG (the dairy farm is the first). A dairy plant that produces a hard cheese emits about 0.4 to 0.6 kg CO$_2$-eq/kg of cheese or 0.4 to 0.6 lbs CO$_2$-eq/lb. The emissions resulting from this stage can vary significantly and there are a lot of ways you can reduce GHG emissions. Some factors that influence emissions at this stage are:

- **Type of cheese.** For example, a higher moisture Monterey Jack needs less energy per pound than a drier Cheddar cheese for aging.

- **Length and type of aging.** Cheeses that require storage at low temperatures will use more energy for refrigeration than those that do not.

- **Production of co-products, such as whey cream or butter.** You might be able to lower the GHG of your primary product by making a second product, thus distributing the impact over more products.

- **Recovery of energy from permeate.** You can dramatically reduce your GHG emissions if you make heat or electricity by feeding your permeate into a digester to make biogas.
Another, smaller percentage of GHG emissions from cheese production are CO₂ emissions from the combustion of fossil fuel such as gasoline and diesel for transportation, and electricity and natural gas for retail, and final use stages.

The remaining GHG emissions in cheese production occur when the consumer eats the cheese and discards the packaging. If you landfill spoiled cheese or packaging, methane and CO₂ are emitted.

In 1995, 27% of food in the U.S. was wasted. The energy lost from producing, transporting, selling, and preparing this wasted food equals 2% of U.S. annual energy consumption. Mold is a large contributor to cheese waste at the consumer level. Besides producing a better quality product, manufacturers who control mold also contribute to a better environment.
What is a Life Cycle Assessment?

A Life Cycle Assessment (LCA) is a value given to a product that takes into consideration all the environmental and health impacts associated with producing and using that product over its entire life cycle. It's a way to evaluate the sustainability of a production process. The inputs and outputs of an LCA cover how the raw materials are acquired, the emissions given off, and what happens in production, use, recycling, and disposal of the product. Life Cycle Assessment is a structured, comprehensive, and internationally standardized method. A related “eco-indicator” method takes into consideration a product’s impact on the ecosystem, human health, and the scarcity of raw materials.

The life cycle GHG emissions of a kilogram of hard cheese is about 8.8 kg CO$_2$-eq, similar to driving a car 20 miles or leaving an incandescent 100 w light bulb on for one hour.
Carbon Footprint is part of a Life Cycle Assessment

The term “carbon footprint” is a value that only takes into consideration the product’s effect on greenhouse gas emissions, sometimes called “carbon emissions.” Greenhouse gas emissions are only one part of the Life Cycle Assessment in cheese production.

What is a Carbon Footprint Calculator?

If you know what steps go into making cheese you can calculate its carbon footprint. In the following section we illustrate a simplified calculation method. You can follow the calculations to see how we arrive at the carbon footprint of cheese or calculate the carbon footprint of your own cheese based on some of the parameters of your process. The parameters we use are based on research literature and on the cheese manufacturing process. The calculator includes choices that show what factors matter most.
Cheese Carbon Footprint Calculator

<table>
<thead>
<tr>
<th>Unit Process</th>
<th>Your custom calculation, running total</th>
<th>Average for U.S. Cheddar cheese, running total</th>
</tr>
</thead>
</table>
| **Milk Production Impact:** Average U.S. Dairy Farm (values are based on Fat and Protein Corrected Milk, FPCM, units are “kg CO₂ eq per kg FPCM” (Thoma et al.).
FPCM = \[
\frac{(0.0929)(\text{fat% tested})+(0.05882)(\text{protein% tested})+0.192}{(0.0929)(4%)\text{tested}+(0.05882)(3.3%)\text{tested}}+0.192
\]
GHG emissions calculated by the “Green Cheese” Project in Wisconsin were on average 0.75 kg CO₂-eq per kg ECM (Energy Corrected Milk). The major differences in emissions are because the Green Cheese study considered best management practices for manure handling (e.g. collection and application), crop production (e.g. minimization of chemical fertilizer through manure application) and feeding efficiency; while the Thoma et al. study used survey data to assess actual practices on farms.
When considering the existence of a digester that uses manure to produce biogas, GHG emissions were further reduced up to 25%. This reduction was due to the avoided natural gas production and combustion, and to avoided CH₄ emissions from manure storage. When maximizing DDGS (dried distillers grains with solubles) in the diets, the reductions in GHG emissions could reach up to another 25% due to the avoidance of gasoline production and combustion by ethanol use. | 1.2 |

| **Cream Removal Impact:** If you are removing (or adding) cream, we need to convert standard producer milk into kg CO₂ eq per kg milk solids (U.S. average producer milk is 3.66% fat and 12.31% solids):
kkg CO₂ eq per kg milk solids = 1.2/0.1231 = 9.75 kg CO₂ eq per kg milk solids. | 1.2+0= 1.2 |
### Cheese Carbon Footprint Calculator (continued)

<table>
<thead>
<tr>
<th>For each 1% cream (37% fat content) removed, this removes 0.432% solids from milk. Therefore:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Solids milk after cream removal = 12.31 – [(___% cream removed)X(0.432)]</td>
<td></td>
</tr>
<tr>
<td>Adjust kg CO₂ eq per kg milk solids after cream removal = (9.75 kg CO₂ eq per kg milk solids)X(Solids milk after cream removal)</td>
<td></td>
</tr>
<tr>
<td>Cheddar cheese will remain at 1.2 kg CO₂ eq per kg FPCM.</td>
<td></td>
</tr>
<tr>
<td>Typical mozzarella cheese milk will have 3.25% cream removal from the producer milk before, so mozzarella cheese milk contains 10.91 solids. 1.06 kg CO₂ eq per kg will be mozzarella cheese milk.</td>
<td></td>
</tr>
</tbody>
</table>

**Shipping Impact:** Shipping impact is based on miles milk traveled from farm to processing plant:

- U.S. average is 86.75 miles (Newton 2007).
- Tanker holds 40,000 pounds.
- Semi mileage rate average is 7.3 mpg.
- CO₂ eq per gallon diesel fuel= 22.38#. (EPA 2010)

Example: Farm to plant shipping CO₂ eq per kg FPCM = [(86.75/7.3)X(22.38)]/(40,000)

Then convert to kg (1 lb = 0.454 kg)

<table>
<thead>
<tr>
<th>Processing Plant Impact: There are a number of major factors with processing impacts. Main contributors are: Electric use, fuel use, caustic use, refrigerant loss, packaging use, and aging time. The majority of the emissions are related to energy use, which is mainly in the forms of electricity for cooling, refrigeration, lighting and mechanical applications; and natural gas for thermal applications. Generally, thermal</th>
<th>8.3</th>
</tr>
</thead>
</table>
energy use will result in less “net emissions” because the energy embedded in the production of natural gas is lower than electricity (producing electricity has lower efficiencies than generating heat, therefore more primary fuel is needed to produce the same amount of energy). Also, the emissions will be affected depending on the mix of fuels that is used to produce electricity. For example, in systems where coal is the main fuel to produce electricity the emissions will be higher than in systems that have a bigger inclusion of cleaner energies such as wind, solar, or hydro.

We do not have yet all the appropriate in-factory contributions for cheese manufacture. However, we do have total factory contributions, concentration factors for making cheese and whey from milk, and energy allocations from cheese and whey.

We are recommending that 0.086 kg CO₂ eq per kg FPCM (FAO 2010) as the amount contribution from dairy processing and the cheese and whey allocation percentage (Feitz et al.).

Cheddar manufacture kg CO₂ eq per kg FPCM = (0.086 kg CO₂ eq per kg FPCM) X (5.1 cheese energy factor) = 0.4386 kg CO₂ eq per kg FPCM

0.4386 kg CO₂ eq per kg FPCM + 1.203 kg CO₂ eq per kg FPCM = 1.64 kg CO₂ eq per kg FPCM.

(10 raw milk)/(1 finished cheese) X 1.64 X 50.4% solids used from milk for cheese = 8.3 kg CO₂ eq per kg cheddar

Whey manufacture kg CO₂ eq per kg FPCM = (0.086 kg CO₂ eq per kg FPCM) X (7.6 whey energy factor) = 0.6536 kg CO₂ eq per kg FPCM

0.6536 kg CO₂ eq per kg FPCM + 1.203 kg CO₂ eq per kg FPCM = 1.87 kg CO₂ eq per kg FPCM.

(17.76 raw milk)/(1 finished whey) X 1.87 X 43.2% solids used from milk for whey = 14.3 kg CO₂ eq per kg whey powder.
**Cheese Carbon Footprint Calculator (continued)**

<table>
<thead>
<tr>
<th><strong>Shipping Distance to Retail Impact:</strong> Shipping distance to average U.S. retail (consumer):</th>
<th>8.3+ 0.077 = 8.377</th>
</tr>
</thead>
<tbody>
<tr>
<td>Geographic center of Wisconsin is Pittsville.</td>
<td></td>
</tr>
<tr>
<td>Geographic population center of density for the U.S. is Edgar Springs, MO, which is 600 miles from Pittsville, WI.</td>
<td></td>
</tr>
<tr>
<td>Distance from Edgar Springs, MO to New York City is 1079 miles and to Los Angeles, CA is 1735 miles. We will credit shipping miles as not having to ship to Edgar Springs but rather as direct as ½ the distance of each leg:</td>
<td></td>
</tr>
<tr>
<td>Average distance to average U.S. customer = (600/2) + [(1079/2)+(1735/2) / 2] = 1003 miles.</td>
<td></td>
</tr>
<tr>
<td>Semi mileage rate average is 7.3 mpg.</td>
<td></td>
</tr>
<tr>
<td>CO₂ eq per gallon diesel fuel= 22.38#.</td>
<td></td>
</tr>
<tr>
<td>Cheddar shipping CO₂ eq per kg cheddar = [(1003/7.3) X(22.38)]/(40,000) = 0.077</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Total Carbon Footprint of Cheddar Cheese:</strong> Total CO₂ eq per kg cheddar delivered to retail sale.</th>
<th>8.377</th>
</tr>
</thead>
<tbody>
<tr>
<td>It is not given here, but refrigeration, consumer travel and storage, and the disposal of the package in the land-fill would also contribute to the CO₂ eq per kg cheddar impact with the completion of the cradle-to-grave analysis of cheddar cheese consumption. Estimates are up to another 0.05 CO₂ eq per kg cheddar cheese could be added (Berlin 2002).</td>
<td></td>
</tr>
</tbody>
</table>

Copyright: FX Milani, UW-Madison
What is meant by allocation?

We may soon be required to adhere to greenhouse gas emissions limits and need to be able to describe the emissions caused by making a product, such as cheese. The process of “allocation” is an important method to accurately describe the energy used and environmental impacts of producing a product. During allocation (or “partitioning”), you describe how the individual inputs and outputs of production are split up among the products and by-products. If possible, allocation should reflect the underlying physical, chemical and biological relationship between the different products. Allocation is a key part of a Life Cycle Assessment.

As an example of LCA allocation we can look at the greenhouse gas emissions allocation of a passenger on an airline. The input of fuel consumption needs to be partitioned into the fuel used to transport the passenger and the fuel used to transport mail and cargo on the same flight. Passengers who fly coach take up less space (and therefore use fewer resources) than those flying first class.
How does energy use affect your carbon footprint?

Energy used is the main driver of emissions at the processing and transportation stages. You can lower your emissions by increasing your energy efficiency or by using renewable energy with lower overall emissions. The best place to start is to improve your energy efficiency. If you reduce electricity consumption by 1 kilowatt hour you avoid the production of 3 kilowatt hours of primary energy, which come mainly from fossil fuels.

Typically, energy efficiency measures are the cheapest way to reduce energy costs. After improving energy efficiency, a conversion to renewable energy systems causes a dramatic reduction in greenhouse gas emissions. If you switch to renewable energy you will lower your greenhouse gas emissions at least 90% (Table 2).

<table>
<thead>
<tr>
<th>Energy Source</th>
<th>kg CO₂-eq/MWh</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coal or Oil</td>
<td>1,030</td>
</tr>
<tr>
<td>Natural Gas</td>
<td>622</td>
</tr>
<tr>
<td>Anaerobic Digester</td>
<td>46</td>
</tr>
<tr>
<td>Solar PV</td>
<td>39</td>
</tr>
<tr>
<td>Nuclear</td>
<td>17</td>
</tr>
<tr>
<td>Wind</td>
<td>14</td>
</tr>
</tbody>
</table>

Table 2. Approximate greenhouse gas emissions from different electricity generation systems¹⁵
**How does nutrient value affect carbon footprint?**

Typically, the carbon footprint of a food is expressed as pounds of CO₂ per pound of food produced. But if we ignore the nutrient content of food we may be missing some key comparisons. On a pound for pound basis, milk, cheese, and yoghurt are very nutritious. As an example, let’s look at cow milk compared to soy milk. Compared on the basis of weight, cow milk has 3 times the carbon footprint of soy milk, but when you compare them on the basis of nutrient density, cow milk has half the carbon footprint of soy milk.牛奶的碳足迹是豆浆的三倍，但是当比较它们的营养密度时，牛奶的碳足迹是豆浆的一半。Cow milk is more nutrient dense than soy milk. It makes a lot of sense to consider the functional unit when you talk about carbon footprint, especially the carbon footprint of food.

**What about recycling?**

Recycling can make a big impact on reducing the carbon footprint of a product. As an example, consider the blow-mold plastic used for milk gallons. If you recycle the plastic into another plastic product such as a doormat, you save the energy needed to refine that plastic from crude oil and you prevent the disposal of the plastic into a landfill. In the landfill, the plastic will produce methane as it decomposes. That methane in the atmosphere is 25 times more potent to global warming as compared to the CO₂ given off if the plastic had been incinerated.
Environmental impacts

The earth is a complex system consisting of many closely interconnected subsystems. If everything on our planet would function according to the simple principle of cause and effect, it would be possible to solve problems simply by intervening at one point. But the earth’s systems are more complex than that. As we try to solve the problem of reducing greenhouse gas emission, it is important to avoid creating

Is burning wood really “green”?

We think of wood as a renewable energy source because we can replenish it by growing more. While trees grow, they capture carbon from the atmosphere and energy from the sun during photosynthesis. Keep in mind that even though fossil fuels also captured carbon from photosynthesis, that occurred millions of years ago and doesn’t help us today. When biofuels are burned, they reduce the amount of carbon released to the atmosphere by greater than 80% because we give credit to account for the carbon captured from the atmosphere during growth of the tree. However, this amount is not 100% because burning biofuels also releases some pollutants.

There is a big difference between wood versus other biofuels such as corn ethanol because of the time it takes to grow a tree. Consider for example an old oak tree. It would take this tree many years to capture the carbon, but that
new problems. Cheese production has impacts on global warming, ozone depletion, acidification of lakes and streams, biodiversity, land use, and other environmental issues. The results of our management decisions often appear much later, are unpredictable, and can therefore not be entirely planned. We must understand cheese production as a whole to maintain environmental, social, and economic sustainability.

carbon is released instantaneously when you burn the wood in your fireplace. Since we live in an age where we are adding more carbon to the atmosphere than can be absorbed by the natural carbon cycle, the impact of that carbon release is greater now. It is as if years of carbon accumulation are released to the atmosphere in an instant.

The efficiency of the wood stove affects the fuel’s impact on greenhouse gases, and stoves vary greatly. Many wood heating systems may not be as efficient as fossil fuel systems. Generally, larger biofuel burning systems are more efficient than small. A fireplace wastes heat. Also, burning wood could release particulate air pollution if not combusted efficiently.

If you burn wood to heat your pasteurizer you can claim a reduction in CO₂ emissions if you have these factors: a high efficiency energy system, good energy conservation, optimal firebox design, and optimal flue design. You should have a regeneration configuration to recycle heat on your pasteurizer. If you know you have excellent process designs, you can support a statement that is an ethical declaration of your biofuel use and near zero carbon emission.
How does a digester make energy from waste?

Organic waste contains nutrients which, when fermented by certain types of bacteria in the absence of air (anaerobic conditions), release methane and carbon dioxide. The combination of these gases from this process is named biogas. Microorganisms break down the short chain hydrocarbons, cellulose and hemicelluloses and release biogas. Biogas is composed of 60-65% CH₄, 35%-40% CO₂, trace amounts of other compounds, and has an energy content of 20 to 25 MJ/m³. Biogas can be used to generate heat or electricity.

Anaerobic digestion is a valuable way to recover energy from organic waste with high water content, such as dairy manure. In confined herds where liquid manure is stored in lagoons, anaerobic digesters also improve nutrient and manure management, reduce odor, and decrease the population of weed seeds and pathogens in manure. The by-products of anaerobic digestion are liquids and solids, both of which can be used as fertilizers or for other purposes.

If you produce heat or electricity by burning methane that would otherwise have been given off from liquid manure stored in lagoons, you reduce GHG emissions in two ways. You replace a fossil fuel used to produce heat or electricity, and you convert methane into CO₂ which is a less potent greenhouse gas. A Midwest study of food and beverage companies that use anaerobic digesters to make energy from their waste has recently been published.

Illustration source: Wisconsin Focus on Energy
©2011 Wisconsin Milk Marketing Board, Inc.
You can make decisions today to reduce greenhouse gas emissions

Some of the greenhouse gas emissions occur during processes that are beyond our control. Other sources of greenhouse gas emissions are within our control. Along the way, you can make decisions that affect the amount of greenhouse gases given off. Here are some examples of areas where your choices can make a difference:

**Simple first steps to take to reduce your greenhouse gas emissions:**

1. Since most GHG emissions come from producing milk on the farm, keep your cheese yield as high as possible with moisture and vat optimization.

2. Conduct a cleaning and pasteurization energy use audit, as these areas typically use the most energy in your plant. Remember that for every kilowatt hour saved you reduce global energy use by 3 kilowatt hours in transmission losses.

3. At the retail store, are there ways to save energy? A full display case is more energy efficient than half empty, and is more appealing to customers. Keep your refrigerant systems well maintained to stop leaks and losses.
Next steps that can further reduce your greenhouse gas emissions:

1. Think about how many heat recovery projects are waiting to be done in your plant. If the air in your plant is greater than 50°F ambient, or the temperature of discharge flows greater than 30°F ambient to water, there should be payback for heat recovery projects.

2. Are there ways to age cheese using shorter time periods? Think of adjunct (aging) starter cultures. Or less energy? Consider in-ground aging caves.

3. Can you package your product with less waste?

4. Design your product for less waste at the consumer level: mold control, package size, and yummy rinds.

5. Try not to landfill any waste from your plant (“zero landfill”). This reduces the greenhouse gases given off at disposal.

6. Look at the energy you use to transport cheese to market. Can you increase fuel efficiency or replace fossil fuels with renewable fuels?

Going further to reduce greenhouse gas emissions:

1. What renewable sources of energy would fit for your situation? A windmill installation if you are in a remote location? Anaerobic digestion and production of biogas from your wastewater or unwanted permeate? Does it make sense to build a digester that other regional food processing plants or farms can share? Can you add solar power and make it pay back within a reasonable amount of time?
2. Are you aware of all the tax incentives, aid programs, manufacturers’ rebates, and government incentive programs for energy conservation and alternative energy systems? If not, please contact these agencies: Focus on Energy, EPA, Wisconsin State Energy Office, and Energy.gov. You may also contact the authors of this publication.

3. Source milk from farms that have a lower carbon footprint because they use manure instead of synthetic fertilizers that require high fossil fuel energy inputs, reduce manure storage time (from collection to application) in warm weather, minimize the surface area of manure lagoons, cover manure storage lagoons, flare methane emissions from manure storage facilities or digesters, inject manure into the soil to reduce volatilization of methane and nitrous oxide, and prevent runoff into lakes and streams.

University of Wisconsin research

Professor Doug Reinemann leads a “Green Cheese” research team that is creating a decision making tool for dairy farmers and dairy processors to help them calculate the energy impact of different practices they use to produce cheese.²⁰ For example, if a cheese plant adds an anaerobic digester, how much will that reduce the carbon footprint of the cheese? If a farmer grows and sells biofuels as part of their dairy business, how does that reduce the carbon footprint of cheese produced from the milk? Researchers from Bolivia, Brazil, and Germany are working together on the project.

The researchers are (from left): Doug Reinemann, Franco Milani, Horacio Aguirre-Villegas, Simone Kraatz, Thais Passos-Fonseca and Astrid Newenhouse.
What Can Consumers Do?

The biggest impact consumers can have on the carbon footprint of dairy products is not to waste food. So much energy goes into food production, packaging, transportation, and sale that with every ounce of cheese left uneaten, more than half a pound of CO₂ emissions are given off. It may not sound like a lot, but it adds up. A single slice of cheese is about ¾ of an ounce. Purchase only what you think you will use. Save leftovers and regularly check the fridge so you eat what’s available. Avoid buying a special ingredient for a recipe that you will only use once. Take leftovers home from the restaurant. Teach your kids not to throw away food.

Conclusion

There are many ways to think about the carbon footprint of cheese and the impact cheese production has on climate change. This publication will help you get started. Life cycle assessment demonstrates a useful tool for this analysis. A focus on sustainability will lead to other benefits such as energy savings, monetary savings, and a cleaner environment. Contact the authors for more information on how to calculate the carbon footprint of your cheese.
Citations


Understand the Carbon Footprint of Cheese

Authors: Horacio Aguirre-Villegas is a research assistant, Simone Kraatz is an associate research fellow, Franco Milani is an assistant professor, Astrid Newenhouse is an associate scientist, Thais Passos-Fonseca is a research assistant, and Doug Reinemann is a professor. Milani is in the Department of Food Science, College of Agricultural and Life Sciences, University of Wisconsin-Madison and University of Wisconsin-Extension, Cooperative Extension. All other authors are in the Department of Biological Systems Engineering, College of Agricultural and Life Sciences, University of Wisconsin-Madison. Reinemann is also in the University of Wisconsin-Extension, Cooperative Extension. Cooperative Extension publications are subject to peer review.

This publication is available from your county UW-Extension office (www.uwex.edu/ces/cty) or from Cooperative Extension Publishing. To order, call toll-free: 1-877-947-7827 (WIS-PUBS) or visit our website: learningstore.uwex.edu. You can also contact the authors for a copy.