

Greenhouse gas emissions arising every year from the production and consumption of a **CHEESEBURGER** roughly equals the amount emitted by **6.5 to 19.6 million SUVs**.



Transport

The average distance raw milk travels from a farm to a cheese processing plant can be vast. Distances can range from **65 km to 425 km**.



Water consumption

Water consumption ranges from **13 to 77 liter** per kg of cheese. More than **50%** is devoted to **pasteurization** and **cleaning** (Washing, Disinfection, Cooling)

Wastewater production

This industry generates **0,7 to 60 liter** per kg of cheese wastewater: Mostly composed of washing water and cheese whey which has high nutritional and chemical contents.



Exportation

In 2019, **2,6 million tonnes** of cheese were exported all around the world, with air freighted emissions being much higher than other forms of transport.



Environmental Impact of Cheese

Atmospheric emissions (GHG)

The emissions from thermal energy production when making cheese consist of carbon monoxide (CO), nitrogen oxides (NOx) and sulfur oxides (SOx), and certain chemical materials.

Atmospheric **CO2** emissions during cheese production range from **8 to 13 kg** of CO2 per kg of cheese.

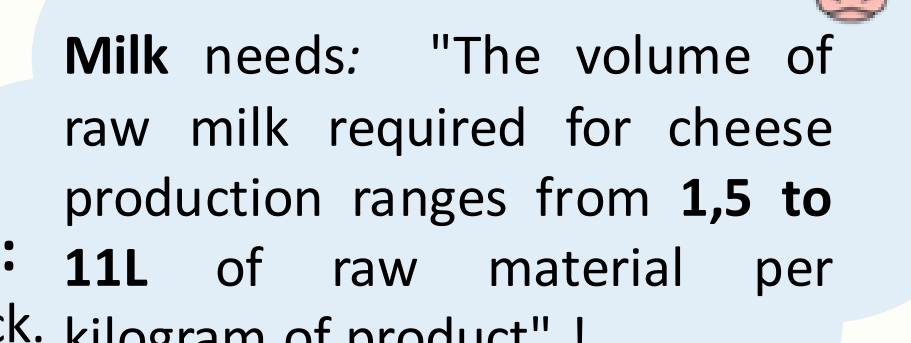


Life Cycle Assessment of Cheese (LCA):

1. **Milk production;** Raw milk from livestock.

2. **Cheese production:** making cheese takes many steps such as pasteurization and coagulation and requires many ingredients like: sodium chloride, calcium chloride, rennet, and dairy or bacterial culture.

3. **Cheese ripening:** Most cheeses are kept in storage where they need time to ripen. The energy consumed in this process range from 12% to 32% of the total energy consumption.



Milk needs: "The volume of raw milk required for cheese production ranges from **1,5 to 11L** of raw material per kilogram of product" !

Animal cruelty

Cows have a natural life expectancy of 20 years, but **live only between 4.5 to 6 years** when used as livestock. They are eventually slaughtered, as milk production drops as they age. Female calves are brought up to produce milk. **Males** are always **slaughtered young**.



Land-Use Change (LUC)

Land degradation like **deforestation** or **desertification** is caused by the expansion of croplands and unsustainable land management practices to enable the making of cheese products.



Environmental Impact of Cheese

Introduction

Cheese is an ancient food consumed all around the world in many forms. According to the FAO, in 2019, more than 2.6 million tonnes of cheese were exported all around the globe. This significant data raises questions: what are the impacts of the production of these cheeses that we love so much? Although production processes may vary according to the type of cheese or different companies, the main production chain is relatively constant and so are the impacts as well. These impacts are much more numerous and varied than we could examine completely and are linked to several of the United Nations sustainable development goals.

Cheese processing (Soares, 2021)

The main cheese production chain is relatively constant. (Figure 1) First, the milk is collected and stored. Cows (or other animals) are drawn with the help of breast pumps in chemically sterilized structures. The milk is then stored in refrigerated tanks which consume a lot of energy. Quality tests are carried out on this milk to ensure that it is not contaminated, these tests are also carried out on the cheeses produced. For this, chemical, biological agents, ... are used. Standardization consists of changing the fat content. Pasteurization uses a machine that cools, heats, and regenerates the milk in order to eliminate all pathogens, bacteria, ... still present in the milk. The machine is heated with steam and is cleaned after each use with water, disinfecting agents, ... During coagulation various ingredients are added (Sodium / Calcium chloride, bacteria,...) as well as a coagulant in order to precipitate the casein. During the cutting of curd, we divide the curd into small pieces that we separate from the whey. During the molding, the curd is baked in machines that require a lot of energy and water to heat. The pressing aims to extract the remaining liquid. Depending on the cheese we can have a shaping or a ripening. Finally, we salt, dry, package, store, and transport the cheese to the markets. These final stages require a lot of energy and emit a lot of greenhouse gases.

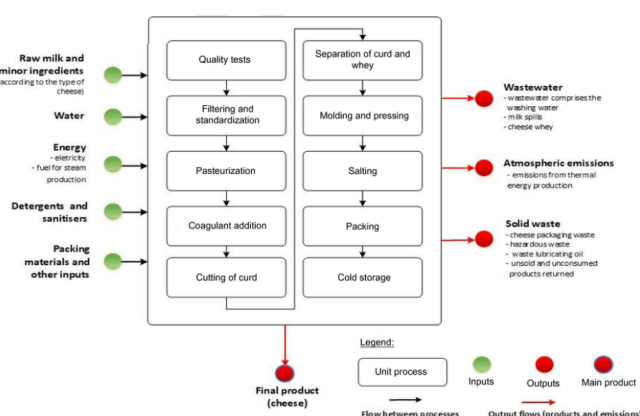


FIGURE 8.1 Common cheese production process.

Life Cycle Assessment (LCA) on cheese:

LCA, or life cycle assessment, is a method of evaluating how big the environmental impact of a product, process, or activity is during its life cycle. Requirements for energy and material, as well as the emissions and waste released to the environment have to be identified and described (Berlin, 2002). LCA also identifies which of the activities in the life cycle of a product contribute the most to this impact (Berlin, 2002). Some examples of impact categories are acidification, eutrophication, and global warming (Berlin, 2002). According to Canellada et al. in a study on the environmental impact of cheese production in

Southern Europe, cheese has been reported as one of the dairy products with a higher environmental impact. It is also clear in a different study that the production of milk at the farm is the biggest contributor of the environmental impact, and that the cheesemaking dairy was the second largest contributor (Berlin, 2002). In terms of milk, the volume of raw milk required for cheese production ranges from 1,5 to 11L of raw material per kg of product (Finnegan et al., 2018).

There is no exact answer for how much of an environmental impact cheese production has on the planet, mostly due to the big variations within the industry. For instance, there could be great variations between small- and large-scale cheese production. Small-scale cheese production might require less energy than large-scale ones, whereas large-scale might save resources because it produces cheese in large quantities (Canellada, 2018). According to the study from Canellada in 2018, the dry extract of the cheese, along with how much fat it is in the cheese, contributes to the big variations in the carbon footprint. How long a cheese is going to ripen can also contribute to changes in the environmental footprints. Some cheeses only need to ripen a few hours, whereas others need months to be completely ripened. When they ripen, they are kept in storages, and the energy consumed ranges from 12% to 32% of the total energy consumption (Finnegan et al., 2018).

Land-Use Change (LUC)

Land-use change includes the direct local impact on terrestrial species, soil erosion, and more degradation due to the change of land cover. This means that the food system, or in general agriculture affects the habitat of many species and their primary composition. In data, the food system is responsible for about 21-37% of total greenhouse gas (GHG) emissions (IPCC, 2019). Composed of many different influences as land use and agriculture, transport, processing, consumption, and more. The dairy sector is recognized as one of the most impacting agricultural activities. Different forms of land-use change concerning our valuable surface: deforestation, desertification, land degradation. Desertification is one of the major threats to food security and at the same time, we cause it through agriculture. Land degradation occurs over a quarter of the Earth's ice-free land area and adversely affects people's livelihoods (IPCC, 2019). There is a big issue within the farm gate causing land-use change, including deforestation and peatland degradation as well. To produce cheese are many different intensive steps of farming necessary. The production of 1 kg cheese requires 6.8m² of land and 47.2 MJ of energy. Milk production is the most influencing part of GWP (global warming potential) and land use (58%), followed by cultivation (Middelaar et al., 2011). Feed production, mainly the use of soy as an ingredient, is likely to have the greatest impact on natural land transformation. Soybean cultivation is related to serious environmental problems. The bean is one of the main drivers for rainforest depletion, especially in South America (Leguizamón, 2014). It's necessary to think about climate change and land-use change, for example, the Amazon rainforest has an impact on the entire global climate and not just on Brazil. The cultivation of the soybean on fire-clear new fields reinforces exactly that.

Water consumption

Cheese has the highest demand for water, materials, and energy of any dairy product (Soares, 2021), and adding in its large volume and economic value, the cheese becomes a

dominant dairy product. Freshwater is used in large quantities in the cheese industry, naturally in the cheese-making itself, but water is also used in cleaning, disinfecting, and cooling (Soares, 2021). The amount of water consumed can vary from 13 liters of water to up to 77 liters of water per kilogram of cheese (Soares, 2021). Groundwater, rivers, lakes and recycled wastewater acts as sources for the freshwater used (Soares, 2021).

Given the industry's large water consumption, it generates large amounts of wastewater as well. The volume and composition of wastewater changes depending on the type of cheese, with the volume ranging from 0.7 liters per kilogram of cheese to as much as 60 liters of wastewater per kilogram of cheese (Soares, 2021). Mozzarella, for example, requires a lot of water and thus produces more effluents (Soares, 2021). Losing raw milk and whey in the wastewater affects the productivity of a cheese factory and contributes to pollution of local bodies of water (Soares 2021). In addition, this is also a source of economic loss for the cheese industry by losing materials such as raw milk and whey which is a byproduct of cheese and has several uses in food (Soares, 2021).

Welfare of dairy cows

Cheese is usually made from milk taken from dairy cows, and most people may not be aware of how most dairy cows live and may give little thought to their welfare during everyday life. However, when asked many would want good conditions for all animals used as livestock. Unfortunately, the majority of dairy cows are prevented from living their full natural lifespan of 20 years and live only between 4.5 to 6 years (Vries & Marcadones, 2020). Cows are inseminated sperm to give birth which causes the production of milk in cows and this process is repeated until the cow's milk production goes down as a consequence, at which point they are slaughtered (Vries & Marcadones 2020). While female calves are brought up to replace their mothers as dairy cows, the male calves are culled at a young age where their meat is called veal (Weary, 2017).

Dairy cows may also have worse living conditions than people would expect them to have. For instance, less than 5% of cows in the US have access to pastures regularly and are instead kept in tight pens (Weary, 2017). Cows are sentient animals and have emotional needs that deserve to be met. Aside from basic emotions, such as hunger, pain etc, there is convincing evidence to suggest that cows experience many complex emotions such as grief, joy, hope, confidence, and suffering (Webster, 1987). As such, in imagining a more sustainable cheese industry in the future, it is vital to improving the livelihood of dairy cows that are responsible for making the raw material for most of the cheese we use today.

Conclusion

The first LCA studies focused on cheese production appeared in 2000 and, from then to now, the number of them has been increasing. However, several authors claim that there is still a lack of information regarding different aspects of the environmental performance of cheese factories (Finnegan et al., 2018). The impacts that we have mentioned in this paper are obvious but ultimately little known to cheese consumers around the world and it is not the producers who are bragging about it. It is therefore for us to be aware in the future that such consumption is not without heavy consequences, that it is not sustainable, and thus try to force industries to rethink their production chain to better.

References

Berlin, Johanna (2002). Environmental life cycle assessment (LCA) of Swedish semi-hard cheese. *International Dairy Journal* 12 (11), 939–953. [https://doi.org/10.1016/S0958-6946\(02\)00112-7](https://doi.org/10.1016/S0958-6946(02)00112-7).

Canellada, Fernando/Laca, Amanda/Laca, Adriana/Díaz, Mario (2018). Environmental impact of cheese production: A case study of a small-scale factory in southern Europe and global overview of carbon footprint. *The Science of the total environment* 635, 167–177. <https://doi.org/10.1016/j.scitotenv.2018.04.045>.

Finnegan, William/Yan, Mingjia/Holden, Nicholas M./Goggins, Jamie (2018). A review of environmental life cycle assessment studies examining cheese production. *The International Journal of Life Cycle Assessment* 23 (9), 1773–1787. <https://doi.org/10.1007/s11367-017-1407-7>.

IPCC (2019). Special Report on Climate Change, Desertification, Land Degradation, Sustainable Land Management, Food Security, and Greenhouse gas fluxes in Terrestrial Ecosystems. Summary for Policemakers.

Leguizamón, Amalia (2014). Modifying Argentina: GM soy and socio-environmental change. *Geoforum* 53 (1), 149–160. <https://doi.org/10.1016/j.geoforum.2013.04.001>.

Soares, B.B., Alvarez C.E., Neto, J.A.A., Rodrigues, L.B. (2021). Environmental impact of agro-food industry and food consumption (Chapter 8: Environmental impact of cheese production)

van Middelaar, C. E./Berentsen, P.B.M./Dolman, M. A./Boer, I.J.M. de (2011). Eco-efficiency in the production chain of Dutch semi-hard cheese. *Livestock Science* 139 (1-2), 91–99. <https://doi.org/10.1016/j.livsci.2011.03.013>.

Vries, A. de/Marcondes, M. I. (2020). Review: Overview of factors affecting productive lifespan of dairy cows. *Animal: an international journal of animal bioscience* 14 (S1), s155-s164. <https://doi.org/10.1017/S1751731119003264>.

Weary D. M., von Keyserlingk M. A. G. (2017). Public concerns about dairy-cow welfare: how should the industry respond?. *Animal Production Science* 57, 1201-1209.

Webster, J., (1987). *Understanding the Dairy Cow*. John Wiley & Sons.