The Causes of the Increase in Meat Consumption and its Impact on the Environment

by Abdosalam Azmi

Abstract

Meat consumption has dramatically increased over the past half century. This increase in consumption has caused a rise in meat production, raising environmental concerns. This paper aims to answer the questions: how has the increase in meat consumption impacted the environment, why is meat consumption increasing, and how the increase in meat consumption can be alleviated. First, this paper discusses how meat production contributes to deforestation, soil erosion, nutrient pollution, greenhouse gas emissions, and global warming. Moreover, this paper shows that growth in population, economy, and income have been the main drivers of the increase in meat consumption globally. It argues for government regulations regarding the consumption of meat, a shift to eating plant-based, as well as raising consumer awareness. This paper concludes that having full government support to alleviate the increase in meat consumption is essential to mitigate the environmental impact of the meat industry.

Keywords: deforestation, soil erosion, greenhouse gasses, population growth, cultured meat

---

Asrar: Dialogues from the Diaspora, Summer 2022

The Causes of the Increase in Meat Consumption and its Impact on the Environment

Meat consumption has significantly surged on a global scale. According to Sans and Combris (2015), "over the last 50 years, meat consumption rose worldwide from 23.10 kg per person per year in 1961 to 42.20 kg per person per year in 2011" (p. 106). In other words, it has almost doubled. In fact, Whitnall and Pitts (2019) show that meat consumption has increased by 58% in the world over the last 20 years (para. 1). With the increase in meat consumption, there has also been an increase in meat production (Zia et al., 2019). Petrovic et al. (2015) believe that "Meat production has tripled over the last four decades and increased 20 percent in just the last 10 years" (p. 1). This increase in the consumption of meat has raised environmental concerns (Tilman & Clark, 2014). This is because meat production puts pressure on the environment, and thus is becoming increasingly problematic. This raises the question of whether this increase in meat consumption is sustainable in the long run, especially as the data seems to demonstrate that this increase shows no signs of abating. Meat is undeniably a source of protein which, throughout history, has played a crucial role in the human diet (Herrero et al., 2016). Nevertheless, we need to analyze the drivers of meat consumption and explore whether meat consumption has a place in a sustainable future. As such, this paper aims to assess the possibility of sustainable meat production by exploring the effects of increase in meat consumption on the environment. It provides a comprehensive evaluation of consequences of the increase in meat consumption by studying deforestation, soil erosion, and greenhouse gasses. This paper further discusses growth in population and increase in income. Solutions such as government recommended diet plans and cultured meat will also be explored, aiming at reducing meat consumption and mitigating its environmental impact.

Meat Consumption and Its Impact on the Environment

Meat consumption is not sustainable because it affects the environment by causing deforestation. To produce meat and beef, a large area of land is needed. While fruits and vegetables can be produced and consumed directly, meat consumption happens in two stages. While the first stage of cattle ranching involves cattle feeding on plants, the second stage involves human consumption of the produced goods, such as milk and meat. The first stage, cattle ranching, requires a huge amount of space. According to Mekonnen and Hoekstra, 35% of the world's agricultural land is used for the livestock sector alone (as cited in Bonnet et al., 2020, p. 3). However, this large space is not used productively. Boucher (2011) stated that beef production is "inherently extensive" (p. 43). This means that, while it requires a large amount of space, meat production yields are not enough to justify the space used. Moreover, this space, which is required for cattle ranching, is often created by reducing trees and jungles, that is, deforestation. A study by Sy et al. (2015) showed that around 71% of the deforestation that took place across South African jungles was solely to provide land for cattle ranching. Meat production also leads to deforestation in the Amazon. According to Global Forest Atlas (2019), more than 80 percent of deforestation in the Amazon is happening to create space for beef production. This amount is equivalent to nearly 74,100 football fields being cleared for beef production every year (as cited in Phillips et al., 2019, p. 2). These studies therefore show that cattle ranching not only contributes to but causes deforestation. Ultimately, the increase in the demand for meat drives deforestation by taking up land.

Moreover, the increase in meat consumption affects the environment by altering soil function. This alteration of soil function is due to deforestation, which also leads to soil

erosion (The Food and Agriculture Organization, n.d., p. 2). Trees protect the soil from erosion by water. When the leaves and branches fall to the ground, they provide nutrients for the roots of trees. These roots prevent the soil from eroding. According to Brusseau et al. (2019), deforestation increases the vulnerability of soil to erosion by water (p.221). Because roots can no longer hold the soil together by absorbing water, soil erosion leads to diminishing natural nutrients and important minerals that exist in the top layer of the soil. This layer of soil is essential for agricultural practices, such as growing crops (as cited in Kalkhoff et al., 2016, p. 53). This reduction in soil nutrients has two major consequences: first, soil infertility occurs, leading to a reduction in plant agriculture (Mekonnen et al., 2015). As such, the second consequence emerges, which is the indirect result of the increase in meat consumption, that is, that fewer plant-based products can be produced.

Furthermore, soil erosion leads to water pollution, which threatens aquatic ecosystems. Soil erosion causes minerals and nutrients such as nitrogen and phosphorus to be dissolved in water. Known as nutrient pollution, this phenomenon contaminates surface water as minerals seep into the water cycle (as cited in Kalkhoff et al., 2016, p. 54). These contaminants reduce the quality of the water, disrupting the whole water cycle by entering groundwaters, rivers, and lakes (as cited in Hildebrandt et al., 2008, p. 1). This means that although soil erosion can happen in one region, its effect on water can spread elsewhere. High concentrations of phosphorus and nitrogen cause algae to bloom, decreasing the amount of oxygen in the water and thus threatening aquatic animals such as fish, crabs, and oysters (National Ocean Service, 2021, para. 2). According to Mason County Community Services (n.d.), in Hood Canal, a natural waterway in the United States' Washington state, "low-oxygen conditions killed thousands of juvenile perch and left numerous octopuses, sea cucumbers and other marine life suffocating and dying" (para. 2) in 2006. Hence, soil erosion indirectly contributes to the death of aquatic animals through polluted water as a result of the deforestation caused by increased livestock production. Therefore, meat production can be directly associated with the contamination and destruction of water bodies.

Indeed, the increase in meat consumption is also not sustainable because it contributes greatly to greenhouse gas emissions, in particular, carbon dioxide, or CO_2. According to the World Wildlife Fund for Nature (2008), "the deforestation caused by cattle ranching is responsible for the release of 340 million tons of CO_2 to the atmosphere every year, equivalent to 3.4% of current global emissions" (para. 2). When companies cut down trees for cattle ranching, fewer trees are available to absorb carbon dioxide. Hence, more of the CO_2 gas that is emitted due to anthropogenic activities will remain in the atmosphere. Not only does deforestation reduce the amount of CO_2 absorption from the atmosphere, but the actual process of deforestation also *releases* CO_2, further exacerbating greenhouse gas emissions in the atmosphere. To illustrate, according to Gerber et al. (2013), "Clearing and burning of forests releases billions of tons of carbon dioxide and other greenhouse gases into the atmosphere each year" (p. 16). This amount is approximately 25% of total human carbon emissions. Hence, the deforestation taking place directly as a result of cattle ranching causes the amount of CO_2 to increase in the atmosphere, which is the leading cause of climate change.

Not only does providing land for meat production diminish the opportunity for CO_2 absorption, but meat production itself produces CO_2. According to Petrovic et al. (2015), beef production's biggest contribution to greenhouse gasses comes from the loss of CO_2 absorbing trees, grasses, and other plants, which animals feed on (p. 236). When animals like cows feed on sources from plants such as grass and fresh roughage, these plants no longer absorb CO_2 from the atmosphere, increasing the amount of CO_2 in the atmosphere. In addition, according to a study conducted by Gerber et al., crops that are produced for animal feed account for around 7.7% of total emissions produced on a global scale (p. 17). This shows that meat

production contributes to CO_2 emissions also through crops used for animal feed. This contribution is also done through secondary agricultural activities associated with meat production. These processes include "the use of machinery for crop management, harvesting, processing and transportation" (Gerber et al., 2013, p. 20). However, the contribution of the secondary processes to the CO_2 emissions is negligible compared to other aforementioned activities (Gerber et al., 2013, p. 20). In summary, animal feed and activities related to feeding livestock impacts environmental sustainability negatively through increasing CO_2 gas.

Additionally, carbon dioxide is not the only emission from the meat industry that we need to worry about. Meat production damages the environment as it contributes to greenhouse gasses by releasing methane gas, or CH_4. Animal activities such as food digestion release methane (Petrovic et al., 2015, p. 236). According to Levitt (2019), "Agriculture is responsible for an estimated 10% of the UK's climate-heating emissions, of which 90% is methane from livestock" (para. 5). Similarly, Shindell et al. (2009) found that animal livestock production accounts for 18% of greenhouse gas emissions in the world with methane making up a large portion of the emissions. These studies show that meat production contributes largely to the release of CH_4 in the atmosphere. Methane gas is more harmful to the atmosphere than CO_2 gas. According to Christianson (1999), methane molecules are at least 10 times more effective than CO_2 molecules at trapping heat and reflecting energy. This property of methane impacts the atmosphere by preventing heat from escaping, which is the prime cause of global warming– trapped heat. In this way, livestock is a major contributor to the warming climate global leaders are pushing so hard to prevent precisely because of the methane gas released from their digestion process.

Finally, meat production contributes to global warming through the salient effects of large amounts of greenhouse gas emissions. According to Nunez (2019), global warming happens when certain gases, known as greenhouse gases, increase in the atmosphere. These gases, CO_2 and CH_4 in particular, allow light to come in through the atmosphere but prevent heat escaping from it. Hence, an increase in CO_2 and CH_4 released from meat production leads to, if not exacerbates, global warming. According to Tukker et al. (2006), of all food consumed by humans in the world, meat products contributed an average of 8% to global warming in 2006, and this was 16 years ago, before the 20% increase in the production of meat that took place in the last ten years. Tukker et al. believe that this contribution was mainly because of CO_2 and CH_4 emissions. As such, if the increase in meat production is to continue, it will continue to contribute to global warming, undermining our efforts at achieving environmental sustainability.

What Causes an Increase in Meat Consumption?

There are several reasons for why there has been an increase in meat consumption in the last few decades. The first is population growth consumption. According to The World Bank (2021), the world population has been increasing at around 1% every year over the last 20 years. While the growth rate at this percentage seems negligible, its compound effect reflects the overall exponential growth over time. To demonstrate, while the total population was around 3 billion people in 1960, today's population is more than 7.5 billion. Indeed, the world population is forecasted to reach about 9 billion by 2050 (Vranken et al., 2014, p. 1). More people require more food such as meat to be produced for consumption. Petrovic et al. noted that population growth has caused a worldwide increase in meat production over time (p. 236). Similarly, according to Whitnall and Pitts (2019), authors at the Department of Agriculture, Water, and the Environment of Australia, 54% of the increase in meat consumption over the recent 20 years has been the result of population growth (para. 1). This

means that an increase in the number of people raises the demand for meat, which in turn leads to an increase in the supply of meat. Whitnall and Pitts stated that the population growth in China has been the main driver of increase in meat consumption in the country (para. 2).

More than population growth, expansion in the economy in developing countries also contributes to an increase in meat consumption. According to Delgado (2003), meat consumption in countries where the economy is experiencing growth is rapidly increasing. This shows that economic growth in developing countries leads to higher meat consumption. Taking China as an example, a rapidly developing country, economic development has affected eating habits. According to Zhou, until the 1980s, Chinese people's diets predominantly consisted of plant-based products (as cited in Al-ali et al., 2018, p. 1). This diet included rice and wheat with minimum amounts of animal proteins and oil. However, this diet has gradually shifted to consist of more meat-based products. Zhang et al (2018) pointed out that "The per capita annual total meat consumption was 13.62 kg in 1980, which increased to 61.05 kg in 2013" (p. 24). On average, every person in China is currently consuming 63 kg of meat annually (Campbell, 2021, para. 3). Similarly, according to Yang, people in China are integrating more meat in their diet (as cited in Al-ali et al., 2018, p. 2). According to Whitnall and Pitts, "around 85% of the rise in global meat consumption" of the last 20 years has happened in the developing countries (para. 2). The authors continue by stating that meat consumption in China in this period increased by 72%, acquiring 34% of the global consumption increase. This is because of the economic growth, which has shifted people's diet.

Like China, Indonesia's economy has also experienced expansion. This expansion happened between 1998 and 2008 and resulted in the doubling of the amount of meat consumed (Whitnall & Pitts, 2019, para. 3). Over the last 20 years, Indonesia's meat consumption increased by 89%, accounting for 3% of the meat produced in the world (Whitnall & Pitts, 2019, para. 3-5). This shows that a growing economy contributes to the increase in meat consumption. According to the Food and Agriculture Organization of the United Nations (FAO), growth in the economy of developing countries has increased the global average annual per capita consumption of meat from 10 kg to 26kg between 1960 and 2000, respectively (as cited in Vranken et al., 2014, p. 96). This amount is expected to reach 37kg in 2030 as the global economy grows. These studies show that increase in meat consumption is not only related to the economy of China or Indonesia, but every other economy in developing countries can contribute to the increase in meat consumption worldwide.

On the other hand, economic expansion in developed countries does not necessarily lead to a significant increase in meat consumption. According to Bodirsky et al., different economies contribute to meat consumption differently (as cited in Milford et al., 2019, p. 2). Regmi and Meade's study found that growth in economies in Sub-Saharan Africa and South Asia, which are non-developed countries, leads to higher increase in meat consumption than wealthy countries such as the United States (as cited in Milford et al., 2019, p. 2). This is because most developed countries, such as the US and European countries, have already undergone a rapid economic transition period. This means that after a certain amount of economic growth, the increase in meat consumption hits an inflection point and decelerates (as cited in Milford et al., 2019, p. 2). Hence, increase in meat consumption is more common in developing countries, that is, countries that historically could not afford to eat animal products, than developed countries, those that historically always had access to them.

Income growth at the individual level leads to higher purchasing power, further accelerating the increase in meat consumption globally. Meat is known from an economic perspective to be a normal good, because the demand for meat increases as income increases

resulting in higher meat consumption. According to Park et al. (1996), income elasticity for meat is positive. Elasticity is the measure of responsiveness of a good, in this case meat, to an act, which is income. If elasticity is positive, it shows that there is a direct relationship between income and normal goods, which are represented by meat in this case. In other words, as income increases, meat consumption increases as well (Chen et al., 2014). Additionally, Whitnall and Pitts stated that rising incomes have contributed to an increase in meat consumption considerably (para. 7). Hence, increase in income affects the meat consumption by increasing it. According to Ren et al.'s (2011) study, which was conducted in China, as income increases, demand for food such as beef increases. Similarly, Zhang et al. conducted a study on 617 households in Guangdong province, China, and they discovered that growth in household income leads to higher meat consumption. These findings illustrate that increase in income contributes directly to an increase in meat consumption.

How Can the Increase in Meat Consumption be Mitigated to Reduce Its Environmental Impacts?

Aside from the causes of the increase in meat consumption, it is also important to discuss ways to stop the increase in meat consumption. As stated, the increase in meat consumption has damaged the environment on a global scale. Meat consumption is expected to increase nearly 76% worldwide by 2050 (Post et al., 2020). This increase further accelerates environmental impacts of meat consumption. Hence, solutions are needed to reduce these impacts.

Governments should recommend diet plans for their populations aiming at promoting consumption of meat alternatives to advance environmental sustainability. This recommendation is important because guiding people about what type of products to consume instead of meat will be more effective than telling them to not eat meat. Plant-based products would be a great substitution for their meat counterparts because their carbon footprint is significantly lower than animal-based products, while maintaining high amounts of proteins (as cited in Lynch & Pierrehumbert, 2019, p. 4). Some countries have already implemented these dietary recommendations. Sweden as an example has recommended its people to use more plant-based food rather than animal-based food in order to increase environmental sustainability (as cited in McCarthy et al., 2018, p. 3). Similarly, the Chinese government has issued a dietary plan recently to reduce greenhouse gas emissions (Al-ali et al., 2018, p. 9). This diet suggests a 50% reduction of meat-based products and substituting them by plant-based products. As a result of this implementation, it is hoped that the environmental impact of meat consumption decreases. Hence, introducing plant-based products as a suitable substitution for meat can help to improve environmental sustainability in the future.

To increase the effectiveness of such recommendations, governments should also advertise the environmental effects of meat consumption, raising awareness. Allais et al. (2010), conducted a study in France and found that the higher the educational level of families, the less meat is consumed. This means that if people were to be educated about the environmental impact of meat consumption, they might choose an alternative to this product. When the Swedish government implemented its dietary guidelines, it also mentioned that plant-based products have lower environmental impacts compared to a diet consisting of large amounts of meat (as cited in McCarthy et al., 2018, p. 3). Increasing consumer awareness on environmental consequences of meat production might be effective in reducing meat consumption. Additionally, the Chinese government recently launched a campaign with a slogan of “Less Meat, Less Heat, More Life” (Al-ali et al., 2018, p. 9). Such campaigns can raise awareness to help shift from an animal-based diet towards a more plant-based one in

order to reduce the environmental impact. Given these precedents, societal stakeholders, especially policymakers, have the responsibility to fill the knowledge gaps of meat consumers, with the aim of protecting the environment.

Beyond shifting to plant-based diets and governmental recommendations, in order to cope with increasing demand for meat due to the rising population, cultured meat, which has been produced in a lab, has emerged as a practice that seems, at this stage, to be more sustainable. Cultured meat is an evolving technology in which meat is produced in the laboratory through tissue engineering (as cited in Lynch & Pierrehumbert, 2019, p. 1). Cultured meat, which is known as synthetic meat or lab-grown meat, is produced using derived animal cells in a controlled environment. Advocates of cultured meat believe that producing meat in a lab can be more efficient since there is a lower energy consumption and fewer resources are used. This means that converting input, which includes roughage and grain, into output becomes more efficient using the cultured meat production system (Lynch & Pierrehumbert, 2019, p. 2). Additionally, cultured meat decreases the energy consumption since the meat is engineered and there is no animal involved (as cited in Lynch & Pierrehumbert, 2019, p. 2). This means that animal biological functions such as breathing and sleeping will not happen as there is no physical animal present. Therefore, this will reduce total energy consumed for meat production. According to Westhoek et al. (2014), cultured meat products consume significantly lower energy ranging between 7% to 45% depending on the meat product. Ultimately, cultured meat can be better than traditional meat because it uses less energy and resources, leading to greater efficiency. As a result, this meat, which is grown in a lab, provides an alternative to the traditional slaughtering of animals.

Cultured meat production can be superior to that of traditional meat because it can reduce the environmental issues such as greenhouse gas emissions (as cited in Lynch & Pierrehumbert, 2019, p. 1). Since there is no animal feeding, there will not be any digestion, and hence, methane gas will not be released as a result of cultured meat production. Moreover, Westhoek et al. (2014) point out that cultured meat is produced using 99% less land compared to the traditional livestock system. This significant reduction in land avoids deforestation, increasing environmental sustainability. Several studies discovered that greenhouse gas emissions released due to the cultured meat production method is significantly less than the livestock production mechanism (as cited in Lynch & Pierrehumbert, 2019, p. 2). Although the values fluctuated across studies as they were performed under different conditions, inputs, and methods, all cultured-meat studies concluded that its production produces less greenhouse gas. While still early in its stages and controversial in nature, cultured meat is emerging as an option to be a superior choice to traditional meat because it reduces the environmental footprint.

Conclusion

In conclusion, the increase in meat consumption is threatening environmental sustainability. Livestock production requires an excessive utilization of land, which destroys the environment as it contributes to deforestation, soil erosion, and nutrient pollution. Meat production also plays a notable role in increasing greenhouse gasses such as carbon dioxide and methane in the atmosphere, exacerbating global warming. It is becoming more problematic as demand for meat consumption is increasing due to growth in population, economy, and income. To curb meat consumption, government interference is required. Governments should provide dietary guidelines to shift people's diet plan towards more plant-based products, which can help to increase environmental sustainability. Policy makers have the responsibility of informing their inhabitants of the effects of meat consumption, which will accelerate the implementation of the dietary recommendation. With so much

global politics emphasizing environmental sustainability and “net zero”, governments should be leaders in promoting a shift away from animal-based diets to increase environmental sustainability.

References

Al-ali, E., Shingler, A., Huston, A., & Leung, E. (2018). *Meat: The past, present, and future of meat in China's diet.* University of Waterloo. https://uwaterloo.ca/chinas-changing-food-system/sites/ca.chinas-changing-food-system/files/uploads/files/geog_474_term_project_-_dec2018_-_meatification_of_china.pdf

Allais, O., Bertail, P., & Nichèle Véronique. (2010). The effects of a fat tax on french households' purchases: a nutritional approach. *American Journal of Agricultural Economics*, *92*(1), 228–245. https://www.jstor.org/stable/40647979

Bonnet, C., Bouamra-Mechemache, Z., Réquillart, V., & Treich, N. (2020). Regulating meat consumption to improve health, the environment and animal welfare. *Food Policy*, *97*, 101847. https://www.sciencedirect.com/science/article/pii/S0306919220300312

Boucher, D. (2011). Cattle and Pasture. In D. Boucher, P. Elias, K. Lininger, C. May-Tobin, S. Roquemore, & E. Saxon (Eds.), *The Root of the Problem: What's Driving Tropical Deforestation Today?* (p. 41-49). Cambridge, MA: Union of Concerned Scientists. Retrieved from https://www.jstor.org/stable/resrep00075

Brusseau, M.L., Pepper, I.L., & Gerba, C.P. (2019). *Environmental and Pollution Science* (3rd ed.). London, England: Academic Press. Retrieved from https://www.sciencedirect.com/science/article/pii/B9780128147191000148

Campbell, C. (2021, January 22). *How China could change the world by taking meat off the menu.* Time. https://time.com/5930095/china-plant-based-meat/

Chen, J., Lobo, A., & Rajendran, N. (2014). Drivers of organic food purchase intentions in mainland china - evaluating potential customers' attitudes, demographics and segmentation. *International Journal of Consumer Studies*. https://onlinelibrary.wiley.com/doi/abs/10.1111/ijcs.12095

Christianson, G. E. (1999). *Greenhouse: the 200-year story of global warming*. Walker.

Delgado, C., Rising Consumption of Meat and Milk in Developing Countries Has Created a New Food Revolution, *The Journal of Nutrition*, Volume 133, Issue 11, November 2003, Pages 3907S–3910S, https://doi.org/10.1093/jn/133.11.3907S

Gerber, P.J., Steinfeld, H., Henderson, B., Mottet, A., Opio, C., Dijkman, J., Falcucci, A. & Global Forest Atlas. (2019). *Cattle Ranching in the Amazon Region.* Retrieved from Yale School of Forestry and Environmental Studies website: https://globalforestatlas.yale.edu/amazon/land-use/cattle-ranching

Herrero, M., Henderson, B., Havlík, P., Thornton, P. K., Conant, R. T., Smith, P., Wirsenius, S., Hristov, A. N., Gerber, P. J., Gill, M., Butterbach-bahl, K., Valin, H., Garnett, T., & Stehfest, E. (2016). Greenhouse gas mitigation potentials in the livestock sector. *Nature Climate Change*, *6*(5), 452–461. https://www.nature.com/articles/nclimate2925

Hildebrandt, A., Guillamón M, Lacorte, S., Tauler, R., & Barceló D. (2008). Impact of pesticides used in agriculture and vineyards to surface and groundwater quality (north spain). *Water Research*, *42*(13), 3315–26. https://doi.org/10.1016/j.watres.2008.04.009

Kalkhoff, S. J., Hubbard, L. E., Tomer, M. D., & James, D. E. (2016). Effect of variable annual precipitation and nutrient input on nitrogen and phosphorus transport from two midwestern agricultural watersheds. *Science of the Total Environment*, *559*, 53–62. https://doi.org/10.1016/j.scitotenv.2016.03.127

Levitt, T. (2019, October 8). An*imals farmed: deforestation and meat, Dutch cattle wars and wildlife parks.* The Guardian.

https://www.theNguardian.com/environment/2019/oct/08/animals-farmed-deforestation-and-meat-dutch-cattle-wars-and-wildlife-parks

Lynch, J., & Pierrehumbert, R. (2019). Climate impacts of cultured meat and beef cattle. *Frontiers in Sustainable Food Systems*, *3*. https://doi.org/10.3389/fsufs.2019.00005

Mason County Community Services. (n.d.). *Nutrient Pollution, low dissolved oxygen and fish kills*.https://masoncountywa.gov/health/environmental/water-quality/hood-canal-nutrient-pollution.php

McCarthy, S. N., O'Rourke, D., Kearney, J., McCarthy, M., Henchion, M., & Hyland, J. J. (2018). *Excessive Food Consumption in Irish Adults: Implications for Climatic Sustainability and Public Health* (No. 2133-2018-5439). https://ideas.repec.org/p/ags/eaa166/276208.html

Mekonnen, M., Keesstra, S. D., Baartman, J. E., Ritsema, C. J., & Melesse, A. M. (2015). Evaluación de presas de retención de sedimento: medidas estructurales de control del transporte de sedimento en el noroeste de etiopía. *Cuadernos De Investigacion Geografica*, *41*(1), 7–22. https://doi.org/10.18172/cig.2643

Milford, A. B., Le Mouël, C., Bodirsky, B. L., & Rolinski, S. (2019). Drivers of meat consumption. *Appetite*, *141*. https://doi.org/10.1016/j.appet.2019.06.005

National Oceanic and Atmospheric Administration. (2021). *What is nutrient pollution?* https://oceanservice.noaa.gov/facts/nutpollution.html

Nunez, C. (2019, February 7). Climate 101: Deforestation. *National Geographic*. https://www.nationalgeographic.com/environment/article/deforestation

Park, J. L., Holcomb, R. B., Raper, K. C., & Capps, , O. (1996). A demand systems analysis of food commodities by U.S. households segmented by income. *American Journal of Agricultural Economics*, *78*(2), 290–300. https://www.jstor.org/stable/1243703

Petrovic, Z., Djordjevic, V., Milicevic, D., Nastasijevic, I., & Parunovic, N. (2015). Meat production and consumption: environmental consequences. *Procedia Food Science*, *5*, 235–238. https://doi.org/10.1016/j.profoo.2015.09.041

Phillips, D., Camargos, D., Campos, A., Wasley, andA., & Heal, A. (2019). Revealed: rampant deforestation of amazon driven by global greed for meat. *The Guardian (Online)*. https://www.theguardian.com/environment/2019/jul/02/revealed-amazon-deforestation-driven-global-greed-meat-brazil

Post, M. J., Levenberg, S., Kaplan, D. L., Genovese, N., Fu, J., Bryant, C. J., Negowetti, N., Verzijden, K., & Moutsatsou, P. (2020). Scientific, sustainability and regulatory challenges of cultured meat. *Nature Food*, *1*(7), 403–415. https://doi.org/10.1038/s43016-020-0112-z

Ren, J., Chung, J.-E., Stoel, L., & Xu, Y. (2011). Chinese dietary culture influences consumers' intention to use imported soy-based dietary supplements: an application of the theory of planned behaviour. *International Journal of Consumer Studies*, *35*(6), 661–669. https://doi.org/10.1111/j.1470-6431.2010.00959.

Sans, P., & Combris, P. (2015). World meat consumption patterns: An overview of the last fifty years (1961-2011). *Meat Science, 109*, 106-111. https://doi.org/10.1016/j.meatsci.2015.05.012

Shindell, D. T., Faluvegi, G., Koch, D. M., Schmidt, G. A., Unger, N., & Bauer, S. E. (2009). Improved attribution of climate forcing to emissions. *Science*, *326*(5953), 716–718. https://doi.org/10.1126/science.1174760

Sy, V. D., Herold, M., Achard, F., Beuchle, R., Clevers, J. G. P. W., Lindquist, E., & Verchot, L. (2015). Land use patterns and related carbon losses following deforestation in

South America. *Environmental Research Letters 10 (2015) 12*. Retrieved December 4, 2021, from https://edepot.wur.nl/372987.

Gerber, P.J., Steinfeld, H., Henderson, B., Mottet, A., Opio, C., Dijkman, J., Falcucci, A. & Tempio, G. 2013. *Tackling climate change through livestock – A global assessment of emissions and mitigation opportunities*. Food and Agriculture Organization of the United Nations (FAO), Rome. https://www.fao.org/3/i3437e/i3437e.pdf

The Food and Agriculture Organization. (n.d.). *Cattle ranching and deforestation.* https://www.fao.org/3/a0262e/a0262e.pdf

The World Bank. (2021). *GDP growth.* https://data.worldbank.org/indicator/NY.GDP.MKTP.KD.ZG

Tilman, D., & Clark, M. (2014). Global diets link environmental sustainability and human health. *Nature*, *515*(7528), 518–22. https://doi.org/10.1038/nature13959

Tukker, A., Huppes, G., Guinée, J., Heijungs, R., De Koning, A., Van Oers, L., ... & Nielsen, P. (2006). Environmental impact of products (EIPRO): Analysis of the life cycle environmental impacts related to the total final consumption of the EU25. *Institute for Prospective Science Technologies. European Commission Joint Research Centre: Brussels, Belgium*. https://ec.europa.eu/environment/ipp/pdf/eipro_report.pdf

Vranken, L., Avermaete, T., Petalios, D., & Mathijs, E. (2014). Curbing global meat consumption: emerging evidence of a second nutrition transition. *Environmental Science and Policy*, *39*, 95–106. https://doi.org/10.1016/j.envsci.2014.02.009

Westhoek, H., Rood, T., Wagner, S., van, G. H., Lesschen, J. P., Oenema, O., De, M. A., Murphy-Bokern, D., Leip, A., & Sutton, M. A. (2014). Food choices, health and environment: effects of cutting Europe's meat and dairy intake. *Global Environmental Change*, *26*(1), 196–205. https://doi.org/10.1016/j.gloenvcha.2014.02.004

Whitnall, T., & Pitts, N. (2019). *Meat consumption.* ABARES. https://www.awe.gov.au/abares/research-topics/agricultural-outlook/meat-consumption

Zia, M., Hansen, J., Hjort, K., & Valdes, C. (2019). Brazil once again becomes the world's largest beef exporter. *Amber Waves*, *1-3*, 1–3. https://www.ers.usda.gov/amber-waves/2019/july/brazil-once-again-becomes-the-world-s-largest-beef-exporter/#:~:text=In%202018%2C%20Brazil%20was%20the,carcass%20weight%20equivalent%20(CWE).

World Wildlife Fund for Nature. (2008). *Unsustainable cattle ranching.* https://wwf.panda.org/discover/knowledge_hub/where_we_work/amazon/amazon_threats/unsustainable_cattle_ranching/

Zhang, H., Wang, J., & Martin, W. (2018). Factors affecting households' meat purchase and future meat consumption changes in china: a demand system approach. *Journal of Ethnic Foods*, *5*(1), 24–32. https://doi.org/10.1016/j.jef.2017.12.004