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The Impact of the American Diet on the Environment

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ABSTRACT

Today, Americans consume an excess amount of meat, which is not only detrimental to their health but also incredibly harmful for the environment. The production of meat involves the emission of harmful greenhouse gasses such as methane. Moreover, it also leads to mass deforestation, usage of large amounts of water and the production of incredible amounts of organic waste. However, if Americans make a transition to a more sustainable and plant-based diet, deforestation, pollution and greenhouse gas emissions will all decrease tremendously.

Introduction

The Earth maintains a habitable surface temperature primarily due to the composition of the atmosphere. Earth's atmosphere is primarily composed of gasses such as nitrogen and oxygen, but it is because of greenhouse gasses like carbon dioxide that the surface temperature is maintained to a moderate degree. Greenhouse gasses are a classification of gasses which have the ability to absorb UV radiation from the sun to a much larger extent than other gasses, thereby trapping radiation in a phenomenon known as the Greenhouse Effect (1) . They play a vital role in moderating the climate of the Earth and preventing it from reaching extremes.

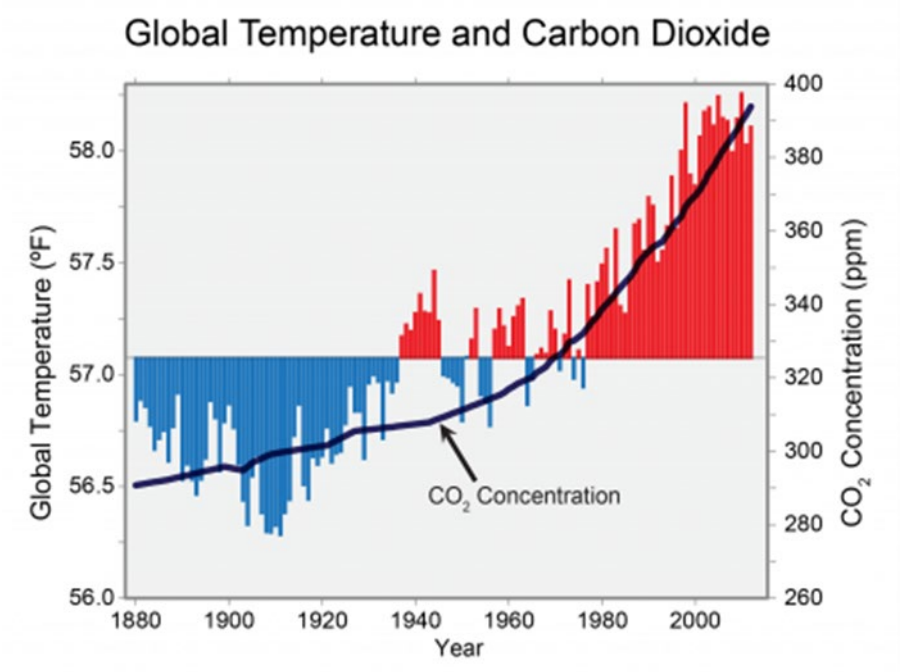


Figure 1. Source: National Climate Assessment

However, while the presence of greenhouse gasses in the atmosphere may be beneficial to our climate when in moderation, in excess it can be detrimental. Before the Industrial Revolution, atmospheric carbon dioxide was 280 ppm, whereas today it is 420 ppm (2). As can be seen from figure 1, global surface temperatures have been rising much greater than would be expected from cyclical changes. This rise in temperature is in direct correlation with the rise in atmospheric greenhouse gasses, like carbon dioxide (3).

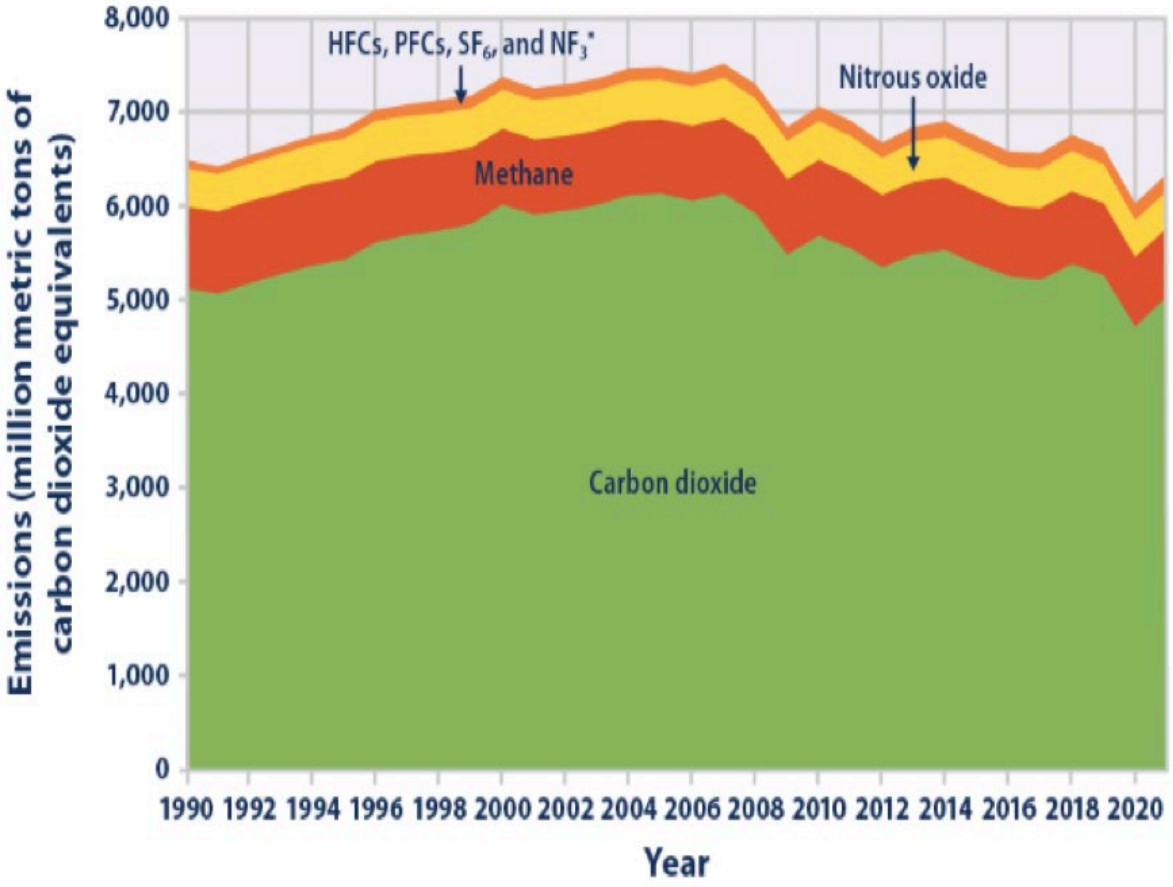


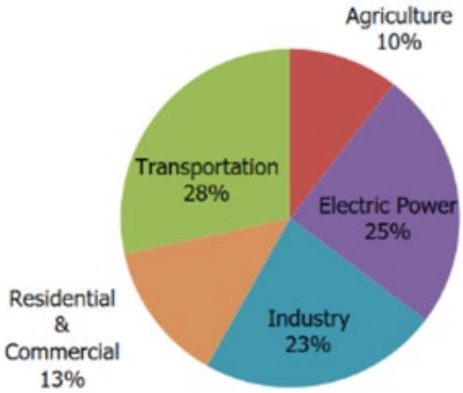
Figure 2.-Source: EPA

In 2015, 196 countries signed an international treaty known as the Paris Agreement (4) . The objective of this agreement is to set goals regarding greenhouse gas emissions in order to mitigate the impacts of Climate Change. One of the most important goals set was to limit the rise of global temperatures to no more than 1.5 C above pre-industrial levels, meaning that greenhouse gas emissions must peak before 2025 and decrease by 43%, by 2030. Despite annual greenhouse gas emissions beginning to decline in the past two decades within the US, we are still very far from meeting this goal (5) (Figure 2) . Moreover, even if we limit the increase in temperature to just 1.5 C, this would still result in various irreversible changes. One such change is the melting of the permafrost, which would release massive amounts of methane into the atmosphere and thereby accelerate the rise in temperature. The melting of glaciers (particularly from Greenland and the Arctic) also has the potential to disrupt weather patterns in the Atlantic, and overall a complete disruption of the Global ecosystem. Because of this, we risk facing an increase in natural disasters such as hurricanes, droughts, and wildfires which

have the potential to impact millions of people across the world (6) . Eventually, many parts of our world may cease to be habitable for humans. If we wish to prevent these disastrous outcomes, we urgently need to decrease our greenhouse gas emissions.

Greenhouse Gasses and Agriculture

Methane



Total U.S. Greenhouse Gas Emissions by Economic Sector

Figure 3.

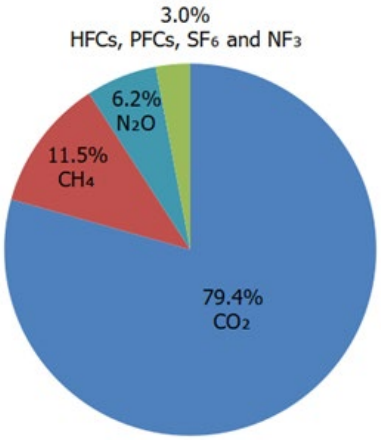


Figure 4.

Figure 3 shows the various factors that contribute to man-made greenhouse gas emissions. Burning fossil fuels for energy and transportation are both important factors, however, another source which is often overlooked is the agricultural industry (7). One area in which agriculture holds a major role is with methane emissions, as the industry is the largest contributor of man-made methane. Figure 4 shows the breakdown of total greenhouse

gasses in the atmosphere. Although methane only makes up 11.5% of the total greenhouse gasses in the atmosphere, it is 28 times more potent than carbon dioxide. This is often expressed in terms of Global Warming Potential (GWP), so if carbon dioxide has a GWP of 1, methane will have a GWP of 28 (8). Methane is shorter lived though, only having a half life of about a decade while carbon dioxide lasts for more than a century.

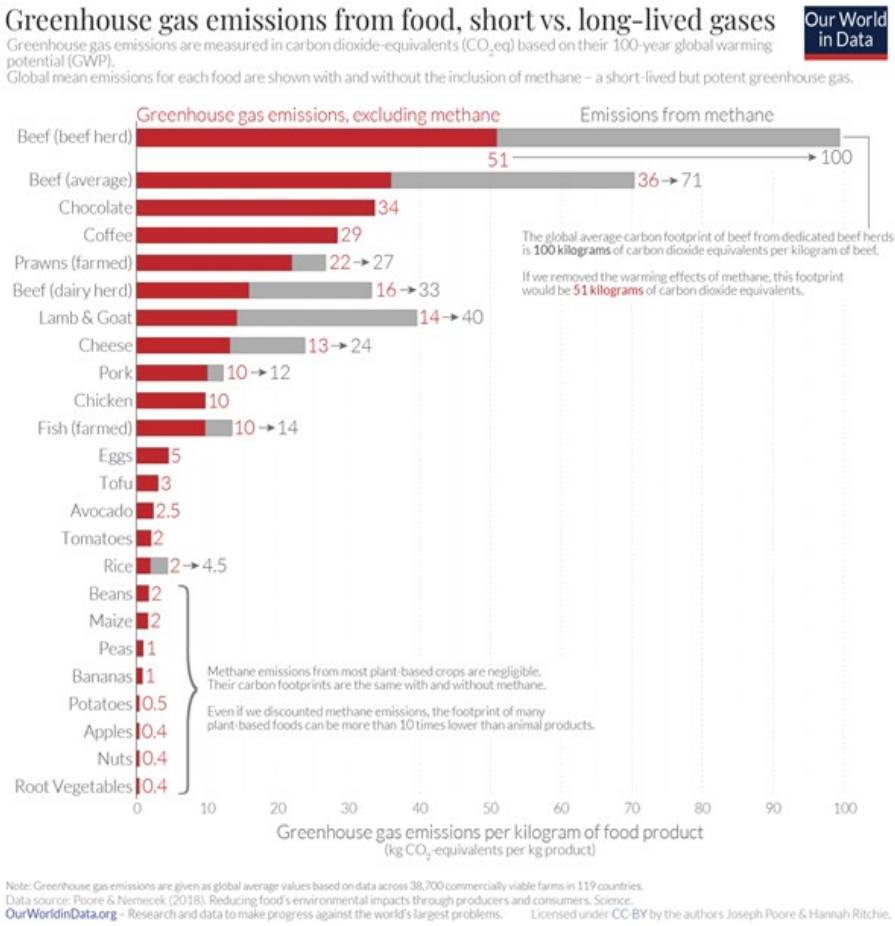


Figure 5.

Figure 5 shows the greenhouse gas emissions produced from the production of various foods from the agricultural industry. The clear outlier here is beef, which produces a large amount of carbon dioxide and methane due to the ruminant digestive systems of cattle. Ruminant animals have multi-chambered stomachs which allow cows and lambs to ferment food in their stomachs. When these ruminant animals are fed a diet of primarily corn (as is the case at most industrial farms), their digestive systems produce a large amount of methane. As shown above, beef has the highest emissions of greenhouse gasses, with methane accounting for almost half of this total. An argument is often made that although methane is a very potent greenhouse gas, it is very short lived as compared to carbon dioxide. Hence its impact may not be as harmful as that of carbon dioxide. However, the data also shows that the production of beef is also responsible for a very large amount of carbon emissions.

Other Environmental Impacts

In addition to greenhouse gasses, the production of beef also wastes resources such as land, food and water. Firstly, the massive scale of livestock production has resulted in the usage of 38% of the Earth's land surface (9). A single acre of prime land can produce 40,000 pounds of potatoes but only 250 pounds of beef (10). Similarly, where it takes 24 gallons of water to grow a pound of potatoes, a pound of beef requires 2500 gallons (11). Beef production also leads to an incredible amount of pollution and waste. An estimated 500 million tons of manure come from livestock on industrial farms annually, which is more than three times the estimated amount of waste produced by the human population annually. (12)

American Consumption of Beef

Pattern (Source)	Current U.S. Diet (NHANES, 2017-2018)	Healthy U.S. Diet (DGA, 2020-2025)	Mediterranean Diet (DGA, 2020-2025)	Vegetarian Diet (DGA, 2020-2025)	Vegan Diet (DGA, 2020-2025)
	Includes mean consumption for American adults >20 years old. Characterized by high meat and refined grains intake, and low in dairy, fruits, vegetables, whole grains, nuts, seeds and seafood	Omnivore diet that includes more fruits, vegetables, whole grains, dairy, nuts, and seafood and less refined grains and meat than the current U.S. diet pattern.	Omnivore diet that includes slightly more seafood and less dairy than the U.S. Healthy Diet pattern.	Vegetarian diet pattern that excludes meat, poultry, and seafood, and includes more eggs, legumes, nuts, seeds, and soy than the U.S. Healthy Diet Pattern.	Vegetarian diet pattern that excludes all animal protein and includes more legumes, nuts, seeds, and soy than the Vegetarian Pattern. Milk and milk products group includes non-dairy (soy milk).
Vegetables: total (c)	1.55	2.52	2.52	2.74*	4.40*
Dark green (c)	0.16	0.21	0.21	0.21	0.21
Beans and peas (c)	0.12	0.21	0.21	0.43	0.68
Red and Orange (c)	0.38	0.79	0.79	0.79	0.79
Other (c)	0.56	0.57	0.57	0.57	0.57
Starchy (c)	0.45	0.71	0.71	0.71	0.71
Fruits and juices	0.84	2.00	2.00	2.00	2.00

(c)					
Grains: total (oz)	6.64	6.00	6.50	6.00	6.00
Refined grains (oz)	5.76	3.00	3.00	3.00	3.00
Whole grains (oz)	0.84	3.00	3.50	3.00	3.00
Milk and milk products (dairy products): total (c)	1.44**	3.00	2.00	3.00	3.00**
Protein foods: total (oz)	6.33	5.61	6.55	3.43	5.43
Meat (oz)	2.60	1.80	1.80	0.00	0.00
Poultry (oz)	1.58	1.50	1.50	0.00	0.00
Eggs (oz)	0.62	0.40	0.40	0.43	0.00

Figure 6. MDPI

The USDA has collected data on how much food is produced and adjusts it for how much is lost (as waste). This loss-adjusted data can be averaged out over the entire population to determine the typical American diet. This data was analyzed by the CDC and presented through the National Health and Nutrition Examination Survey (NHANES) (13). Figure 6 shows the breakdown of this diet and contrasts it with other recommended diets from the Dietary Guidelines for Americans (DGA). As you can see, Americans typically consume 2.60 oz/day of meat, which is more than the total amount of vegetables and fruits. On the other hand, the Healthy U.S. diet only recommends 1.80 oz/day of meat, a significant decrease from the amount of meat consumed in the typical American diet. This is for the same amount of calories (2000 kcal) as the typical American diet. The Vegetarian and Vegan diets on the other hand contain no meat and can still meet dietary needs according to the USDA.

Transitioning to a Plant-Based Diet

Impact of Reducing Beef Consumption

Diet group	**GHG emissions**	**GHG emissions**	**GHG emissions**
	GWP100 CO2e (kg d^-1)	**GTP100 CO2e (kg d^-1)**	**GWP20 CO2e (kg d^-1)**
Vegans	2.47 (2.09, 3.36)	2.42 (2.05, 3.29)	2.73 (2.30, 3.64)

Vegetarians	4.16 (3.31, 5.82)	3.84 (3.04, 5.19)	5.35 (4.37, 7.95)
Fish-eaters	4.74 (3.85, 6.27)	4.39 (3.54, 5.72)	6.08 (5.00, 8.73)
Low meat-eaters	5.37 (4.26, 6.99)	4.92 (3.87, 6.31)	7.08 (5.78, 9.93)
Medium meat-eaters	7.04 (5.26, 9.39)	6.32 (4.71, 8.53)	9.55 (7.31, 13.04)
High meat-eaters	10.24 (7.04, 15.95)	8.97 (6.17, 14.15)	14.77 (10.23, 22.55)

Figure 7. Nature Food

Figure 7 analyzes different diet groups which have varying levels of meat consumption and the negative impact they have on the environment. This environmental impact is measured through the metric of GWP100 CO2e. This is a measure of the amount of energy the greenhouse gasses produced during the production of a 2000 kcal diet of each group will absorb over 100 years relative to the amount of energy 1 ton of carbon dioxide will absorb. The larger the GWP value is, the larger the impact on the environment is. A typical diet which contains a medium amount of meat would have a GWP100 CO2e of 7.04 (kg d^-1). On the other hand, a vegan diet which contains no meat would have a GWP100 CO2e of 2.47 (kg d^-1). In other words, a vegan diet has about a third the GWP as compared to a typical meat diet.

Conclusion

Global warming is manmade and unfettered will cause irreversible damage, making large parts of the Earth uninhabitable for humans. To curb this would require a substantial reduction in greenhouse gas emissions. A large contributor to greenhouse gasses is the food industry. Out of all the major contributors, modifying what we eat (particularly reducing meat consumption) may be the easiest way to reduce our greenhouse gas emissions. Furthermore, as compared to switching from fossil fuels to renewable sources for transport and energy, reducing the consumption of meat may be easier. It will also result in a healthier lifestyle. Therefore, if we wish to truly limit the impacts of Climate Change, reevaluating our own diets is a necessary and important part of the process.

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