CAPSTONE
THE MOO-VEMENT

GROUP 4

By: Kaela Gobencion, Samuel Ducharme, Yasmine Sabri, Meghan Cronin, Alexis Navarro, Matthew Dalton, and Julie Hon

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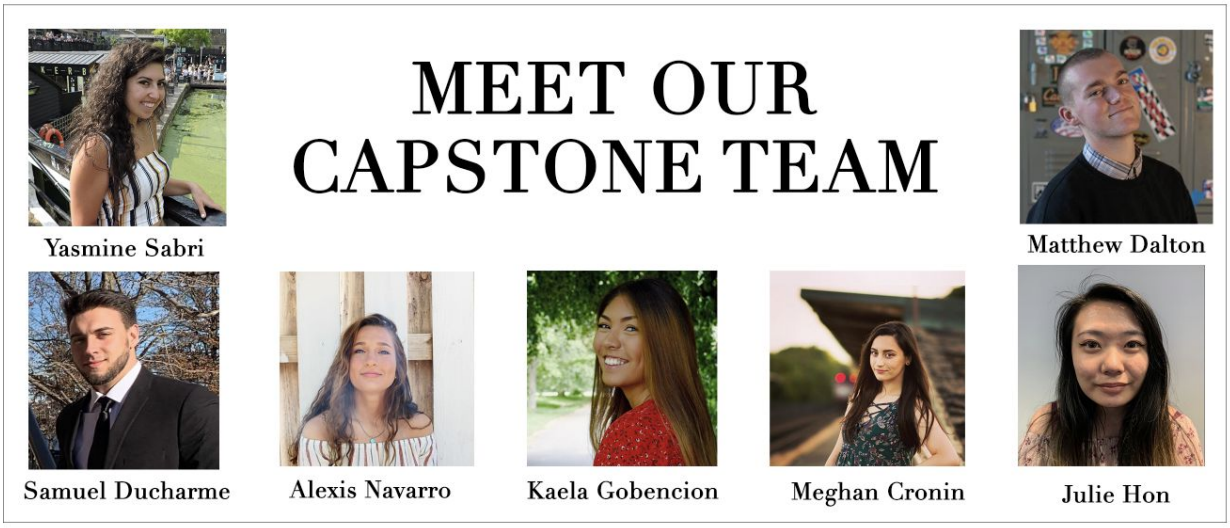
MEET THE TEAM



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MISSION STATEMENT

Our mission is to review the current practices of animal agriculture in the United States of America and how it affects the environment, human health, economy and overall animal welfare.

We want to inform consumers across America the risk factors of eating red, processed meats such as beef and dairy products. Furthermore, we aim to inform consumers that a well-balanced meal relies on lowering meat and dairy intake.

The Moo-vemnt seeks to not only reduce society's current dependence on the cattle industry, but also to improve the conditions on existing cattle farms, as it would protect the profitability for farmers and give cows a better quality of life. We will do this by analyzing the current practices on livestock farms and propose new methods that would be beneficial for farmers, cow welfare, and the economy.

We aim to raise awareness of the environmental consequences surrounding a high demand for dairy and beef. Our goal is for people to understand that a high demand for these products are unsustainable for our exponentially growing population.

We will look at the current environmental demands of the cattle industry, specifically the demands on water and land usage. Additionally, we will explore the effects of cow agriculture on climate change as a result of cow emissions.

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April 26, 2019

Consumers
The United States of America

Dear Consumers,

As a longtime activist organization, we, The Moo-vement, are writing to you to express the neglected issues within animal agriculture, human health, and the environment in the United States of America and how we can improve them. Unfortunately, the animal agriculture industry in America does not uphold appropriate standards, and we believe that as a first world country we have the luxury of treating animals humanely. With our proposals and with the help of your influence and choices, the US will still be able to profit off of the food industry and treat animals correctly. We, as a superpower nation, should be a prime example and set the standard for others globally and thus carry out such acts. Our proposals are: switching to plant-based farming would aid in the crisis of world hunger and human health, as well as strive to eliminate animal abuse and reduce negative environmental effects. Growing meat in a lab would aid the issue of overgrazing and the destruction of our environment. Adding more regulatory laws to protect water from being contaminated by CAFO's, and creating clear labels on meat packages so that consumers are not misled.

We realize that this is no small task, however, in order for these proposals to occur, a lot of work must be done. We must treat animals properly, help our environment and the health of our people. We must lead as a role model for other countries. We have faith in you, as the consumers of America. We appreciate your time in reading our cover letter and look forward to working with you. For more information visit our website; kaelaag.github.io.

Best Regards,
Kaela Gobencion, Yasmine Sabri, Julie Hon, Alexis Navarro, Meghan Cronin, Samuel Ducharme, and Matthew Dalton of The Moo-vement

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INTRODUCTION

Society has consistently relied upon the meat industry as a primary source for our caloric intake. As a result, we are now faced with many pressing issues involving our environment, health, and the welfare of animals. The economy additionally has cost benefits and downfalls due to our dietary habits. Many factors can be blamed for these progressing issues; however a major contributor to these problems is cattle farming. As society advances and world population increases, cow agriculture is becoming a less sustainable practice. Historically, beef and dairy were thought to be items necessary for daily nutritional intake. More recently, scientists have discovered the adverse effects outweigh the benefits, and instead human diets can be replaced with plant-based alternatives. The federal government is responsible for the general welfare of the American people and this includes the regulation of cow agriculture that has been scientifically proven to negatively affect consumers' health and the environment we live in.

The demand for beef has steadily grown over the past few decades. This is especially true in the United States as it is the country with one of the highest consumption of beef in the world. Steak is often deemed as luxurious, making it appropriate for celebrations, and additionally beef being the main breadwinner of the fast food industry. Not to mention, the fast food industry's success in the United States is tremendous. According to the CDC, 36.6% of American adults ate fast food daily from 2013-2016.[1] With more than a third of Americans consuming fast food daily, industrialized farms can become desperate to produce as much beef as possible in a shorter amount of time. This

[1] "Fast Food Consumption Among Adults in the United States, 2013-2016," Centers for Disease Control and Prevention, October 2018, https://www.cdc.gov/nchs/products/databriefs/db322.htm.

can lead to mistreatment of protocol in the industry, producing results that would leave both the public and environment at risk of reduced health.

A continuously changing world calls for change in industries. With our current agricultural practices, it is not possible to resolve issues like world hunger, the environment and increasing health problems. However, with an adjustment to the way we produce foods and with which foods we prioritize, positive results will be seen. If the United States begin taking steps towards forging more efficient and sustainable industrialized farming, the public's health would be greatly improved, resources would be used sustainably, and the environment can continue to thrive so that society can flourish. Safety, health, efficiency, and sustainability should be the main highlights of cow agriculture.

CHAPTER ONE: ENVIRONMENT

Environmentalists around the nation have been known for the measures they take to preserve the wellbeing of Earth's natural habitats and diverse species. This is done by protests, marches, petitions, boycotting, and other movements towards change. They have demanded the attention of the public with powerful demonstrations to raise awareness of the ways in which our Earth is deteriorating. Ocean acidification, deforestation, animal extinction, global warming, water pollution and air pollution are all tragic events taking place due to the immense amount of people that inhabit our dying planet. The thought of all of the immense destruction happening daily can only be described as daunting. The statistics of the amount of forests being mowed over in the amazon, the projected temperature spikes, and the growth of the great pacific garbage patch harming marine life all sound too troublesome to know what to do. The tidal wave of bad news is crippling for many people, leaving them without hope of recovery of the damage done.

What many people aren't aware of is the fact that small steps lead to big changes. The idea that a change in habits can lead to an impactful movement helped motivate The Moo-vement. The change that this movement focuses on is the shift away from consumption of bovine meats and dairy. Animal agriculture has been problematic for the Earth in many aspects such as water quality, air quality, and deforestation. While all animal products can be seen as problematic to the well being of nature, it is important to address the biggest culprit of all animal products: the cattle industry. Beef and dairy are the least sustainable food items, which is why above all other products their production should be reduced.

Land Usage

The Tragedy of the Commons demonstrates a progress trap to which society has fallen victim. It advises society of the dangers that may arise as a result of self-interest with the most prominent example being a group of people sharing a limited resource in the form of grazing land. In this scenario, the group allows their cattle to graze the land, but the only limitation is that the land has a carrying capacity. Although the users may allow as many cows to graze, the more that inhabit it, the more the land degrades and becomes unusable. Regardless, each individual was motivated to keep increasing their number of cows on the grazing land - why? This is because each individual is trying reap the greatest benefit from the given resource in order to maximize their profit which in turn hurts others including themselves.

This dilemma can be seen in the cattle industry where large corporations often take many shortcuts with the goal of maximizing profit and the overarching theme of self-interest in mind. The issues surrounding land usage within the livestock industry, especially the cattle industry, encompasses exactly what the Tragedy of the Commons warns us against. As a result of these actions, their destructive effects can be seen on regional water supply, soil fertility, biodiversity, and climate change.[2]

When we take a closer look at land usage, each year 13 billion hectares of forest area is converted into land used for the agriculture industry as pastures or cropland. The area with the most notable offenses is in the Amazon Rainforest. The Amazon is home to 10% of the world's plant and animal species, making it one of the most biodiverse areas in the world.[3] For this reason, the deforestation that occurs is an increasingly worrying issue. According to World Wildlife Fund,

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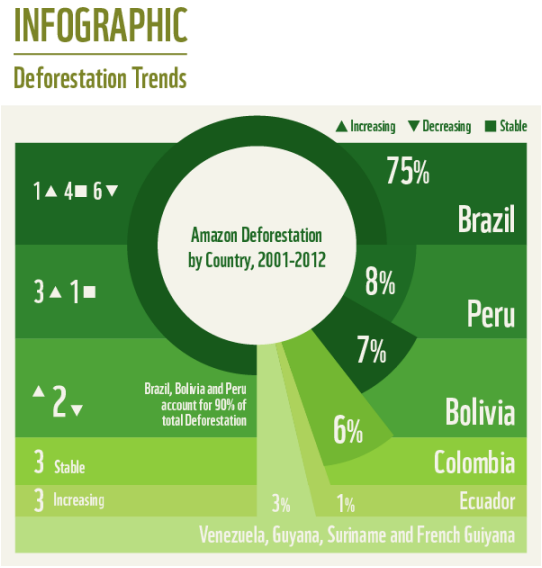
[2] "Livestock and Landscapes," Food and Agriculture Organization of the United Nations, n.d., http://www.fao.org/3/ar591e/ar591e.pdf.
[3] "Deforestation in the Amazon," WWF, https://wwf.panda.org/our_work/forests/deforestation_fronts/deforestation_in_the_amazon/.

"Today, the Amazon is facing a multitude of threats as a result of unsustainable economic development; 20% of the Amazon biome has already been lost and the trend will worsen if gone unchecked."[4] In Figure 1 (to the right), Brazil is the biggest offender of the losses reported in the Amazon, accounting for 75% of the deforestation from 2001-2012 followed by Peru, Bolivia, and Colombia.[5] Of the area lost, most of its use is directed towards the cattle industry for cattle ranching. Currently, the overall amount of grazing land used for animal agriculture accounts for 26% of the earth's usable land with 33% of all crop land being used to produce feed for livestock.[6]

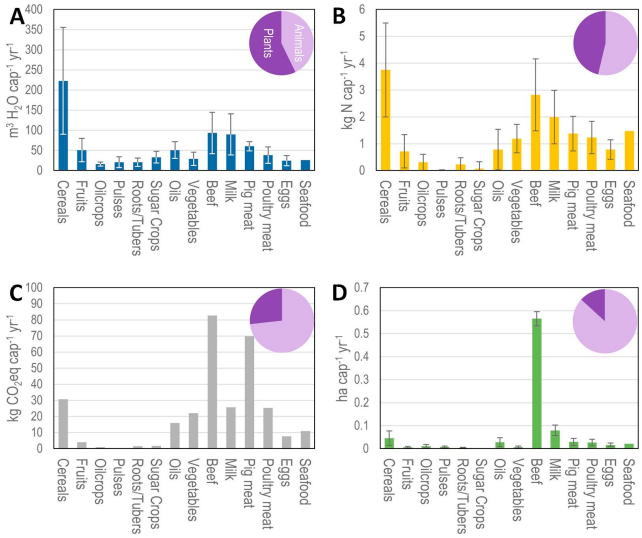


The alarming rate of deforestation is linked to our increasing demand within the food industry. Meeting the current consumption needs of the continuously increasing human population while keeping in mind the planet's biocapacity has been a constant challenge for the human race. Rather than trying to create a sustainable solution, corporations continue to deplete the earth's resources for a temporary fix while keeping the true actions of the industry hidden. As a result of the deforestation necessary for the animal agriculture industry, 2.4 billion metric tons of CO_2 is released annually.[7]

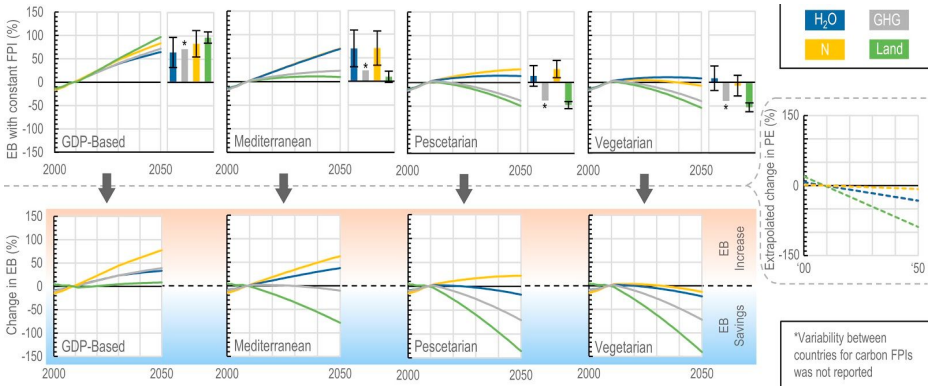
According to a study documenting global environmental change with respect to meeting the current demands in the food industry and considering our current agricultural resources, changes in

[4] WWF, *Deforestation in the Amazon*
[5] Ibid.
[6] The United Nations, *Livestock and Landscapes*
[7] Chesney Richter, Ann Skulas-Ray, and Penny Kris-Etherton, "The Role of Diet in the Prevention and Treatment of Cardiovascular Disease," Science Direct, May 5, 2017, https://www-sciencedirect-com.ezproxy.bu.edu/science/article/pii/B9780128029282000278.

beef consumption had the most important influence on land usage.[8] The cattle industry is a large driving factor for deforestation; moreover, as can be seen in Figure 2 (to the left) animal products account for much of the required land at 87%.[9] This usage by comparison only amounts to 18% of a person's daily caloric intake and 39% of protein intake.[10]



In order to improve these conditions and reduce the likelihood of projected outcomes for future generations, a change in diet needs to be made. In today's society, affluence continues to dictate diet. Therefore, simply improving the efficiency of current production standards is not sufficient to minimize the environmental burden of population growth and dietary change when existing technology and production systems are taken into consideration.[11] In Figure 3 below, it can be seen that transitioning to an alternative diet nationally would be less impactful on the environment and generally allow enhancements of footprint intensities to keep the pace with food demands and prevent growth



[8] Kyle F. Davis et al., "Meeting Future Food Demand with Current Agricultural Resources," *Global Environmental Change* 39, no. C (2016): pp. 125-132, https://doi.org/10.1016/j.gloenvcha.2016.05.004.
[9] Ibid.
[10] Ibid.
[11] Ibid.

in overall resource demand. By altering consumption patterns, it is possible to yield improvements in resource use. It can be seen already that by transitioning away from cattle and moving towards a plant-based diet that a reduction in land use is possible.

Emissions

As media has started to recognize that cattle farming may in fact have an impact on the emissions that are partly responsible for global warming, the extent of its impact seems to be ambiguous to the public since many differing statistics are being claimed. *Cowspiracy*, a documentary on Netflix that strongly advocates against all animal agriculture, claimed that animal agriculture produced 51% of the greenhouse emissions.[12] After scholars and researchers fact-checked the maker of the documentary, Kip Anderson, the Cowspiracy Twitter account came out and claimed that rather than 51%, it was in fact 18% of GHG (greenhouse gas emissions) were due to animal agriculture.[13] The study that the documentary based most of their information off of was not peer reviewed and had flaws in statistical calculations. So what is the truth, and what does that mean in terms of the impact that cattle agriculture has on the environment?

There is no doubt that animal agriculture has a large and important impact on the emissions of greenhouse gases. However, it is important to clarify that the high GHG levels are not due to the mere existence of cattle, but the high presence of cattle in America and food products that are derived from them. Part of the problem is the fact that there is such an abundance of cows and the rate at which they are bred and slaughtered is extremely high since America's average consumption of beef is 4 times the world average.[14] The main producers of the emissions are from the production of food,

[12] Danny Chivers,"Cowspiracy: Stampeding in the Wrong Direction?," New Internationalist, July 05, 2017, https://newint.org/blog/2016/02/10/cowspiracy-stampeding-in-the-wrong-direction.
[13] Ibid.
[14] Richard Waite, "2018 Will See High Meat Consumption in the U.S., but the American Diet Is Shifting," 2018 Will See High Meat Consumption in the U.S., but the American Diet Is Shifting | World Resources Institute, https://www.wri.org/blog/2018/01/2018-will-see-high-meat-consumption-us-american-diet-shifting.

enteric fermentation from ruminants, and manure decomposition. Part of the reason there is a focus on cattle when examining emissions is due to the fact that they are ruminants, or animals with stomachs that ferment their food with microbes before it is entirely digested, which results in methane metabolic byproducts. This affects global warming because methane is 83 times more potent than carbon dioxide and speeds up the GHG effect.[15] Cows also produce nitrous oxide and carbon dioxide which contribute to global warming. The burden of global warming is seen globally, ice caps are melting causing water levels to rise and destroy cities located near oceans, fires are becoming increasingly frequent, and we are nearing the maximum temperature earth can handle before complete destruction. Disaster is imminent if we continue to have such high rates of emissions, and reducing emissions from cow agriculture will alleviate this. We can start by feeding the cows diets that limit their methane and carbon emissions, while also limiting our intake of beef and dairy. If less cows were necessary to satisfy American demand, overall methane, carbon dioxide and nitrous oxide emissions would decrease significantly.[16]

Water Usage

People's diets affect the environment in more ways than just land usage and air quality. One thing that should be taken into consideration is the amount of water it takes to produce the food we consume. If the entire population has a diet that consists of foods that require a large amount of water to produce and process, the water supply will be significantly more limited. Our clean and potable water supply is a concern with a population that is growing exponentially. As T. Boone Pickens said,

[15] Phillip Ross, "Cow Farts Have 'Larger Greenhouse Gas Impact' Than Previously Thought; Methane Pushes Climate Change," International Business Times. November 26, 2013, https://www.ibtimes.com/cow-farts-have-larger-greenhouse-gas-impact-previously-thought-methane-pushes-climate-change-1487502.
[16] Ross, *Cow Farts have Large GHG impacts*.

"water is the new oil."[17] By 2025, it is projected that 1.8 billion people will experience absolute water scarcity and two thirds of the world's population will be under water-stressed conditions.[18]

When it comes to saving water, common methods are to reduce shower time and turn off the sprinklers on a rainy day. However, making slight changes to one's diet can also reduce water usage. Not all foods take the same amount of water and other resources to produce. Plant-based foods and animal based foods differ greatly in terms of the amount of water required for it to grow and for it to be processed. Plant-based foods would consist of all fruits and vegetables, grains, plant-based milk, and anything not derived from animal products. Animal based foods, more specifically cow products, like beef and dairy, tend to be the highest consumer of water. Before explaining the measures of water consumption and usage of meat and dairy products, it is important to understand how water footprints are measured. There are three types of water that are used: green, blue, and grey. Green water is the volume of rainwater that is evaporated from the soil or other natural water sources. Blue water is the volume of fresh water that is evaporated from wells, springs, groundwater, or surface water. Grey water is the amount of water that is used in order to dilute the pollutants so that the water is still above standard quality. Green water is the most common type of water to be used among plants and animals because the plants both we and the cows consume rely on water from the soil to grow.[19]

This means that the green water that is being used at such high levels is green water from the feed that cows eat. A study investigated just how much water (all types) is used to produce beef and found that "one pound of beef consumes over 2700 gallons of water, whereas one pound of grain

[17] Ross, *Cow Farts have Large GHG impacts*.
[18] Ibid.
[19] Ibid.

production consumes less than 200 gallons, and vegetables about half that".[20] This is logical because cows are animals with a large water and feed intake - which also needs water to be produce. The cattle consume large amounts of feed/grass and water over the span of 3 years before they are slaughtered for a yield of only about 440 pounds of that meat per cow. Plants and grains take much less time to grow with a much higher yield. They typically grow within the span of one year. In a recent study that compared the water footprint of different foods, the beef footprint per calorie was about 20 times larger than the footprint of cereals and starchy roots.[21]

Currently, there are a plethora of meat substitutes in the grocery aisles and on restaurant menus. Burgers made from nutrient rich vegetables and starches are quite common and are produced responsibly with a small water footprint. A study found that the "water footprint of a 150-g soy burger appears to be about 160 L, whereas the water footprint of an average 150-g beef burger is nearly 15 times larger".[22] It is quite clear that plant-based foods are much more sustainable, but even so, the footprint of poultry and pork is less taxing than the production of beef. Pork uses about one third of the amount of water as beef per pound, and poultry uses slightly less.[23]

One less obvious way to decrease ones water footprint is adjusting one's milk intake. The large water footprint from beef is accompanied by the large amount of water used to produce cows milk. According to Mekonnen, 98% of the water usage in producing beef is from feeding the cattle, dairy cows will also be using large proportions of water. In fact, according to the website, Water Footprint, the average water footprint of each dairy cow is about 2,000 square meters of water each

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[20] Robert Goodland, "Environmental sustainability in agriculture: diet matters," *Ecological Economics* 23 (1997) 189–200, Web, https://www.sciencedirect.com/science/article/pii/S092180099700579X.
[21] Mesfin M. Mekonnen, "A Global Assessment of the Water Footprint of Farm Animal Products," *Ecosystems (2012) 15: 401, https://doi.org/10.1007/s10021-011-9517-8/*.
[22] Arjen Y. Hoekstra, "The hidden water resource use behind meat and dairy," *Animal Frontiers* 2, no. 2 (2012): 3-8, https://waterfootprint.org/media/downloads/Hoekstra-2012-Water-Meat-Dairy_2.pdf.
[23] Ibid.

year, when the water footprint for beef cattle is 860 square meters annually.[24] Clearly, both figures are staggering statistics and extremely unsustainable levels of water to be consumed at such a high rate of demand, but it is a surprise to most people that even the dairy industry is consuming water at alarming rates. Alternative milks have become much more popular such as almond, soy, oat, and cashew milk. Soy and oat milk are the two most sustainable milk alternatives in terms of water usage. The soy milk has a water footprint of 297 liters per liter produced while milk derived from a cow uses a whopping 1,020 liters per kg of milk .[25]

Since clean water is a limited resource, water pollution caused by livestock such as cattle is a major concern. Raising cattle is destructive in depleting ground water and causes runoff and erosion, leading to pollution of rivers and lakes due to the deforestation caused by the construction of cow pastures. Main concerns of water contamination due to bovine agriculture include mismanagement of manure, manure lagoon spills, and agricultural runoff. Each of these concerns are quite relevant given the amount of manure that cows produce. Each Holstein, which is a breed of dairy cow, produces approximately 115 pounds each day and approximately 21 tons of manure each year.[26] These statistics mean there is an overwhelming amount of manure that is being produced given the high demand for meat and food products derived from cows. The concentrated animal feeding operations, also known as CAFO's are the large farms that raise meat and dairy cows. These crowded feeding operations are areas of very concentrated fecal matter, which may contain harmful pathogens such as E coli, Listeria, and Cryptosporidium.[27] Manure runoff from the operations is unfortunately

[24] Hoekstra, *The hidden water resource use behind meat and dairy.*
[25] A. Ertug Ercina, Maite M. Aldaya, Arjen Y. Hoekstra, "The water footprint of soy milk and soy burger and equivalent animal products,"*Ecological Indicators* 18 (2012) 392–402, Web, https://www.sciencedirect.com/science/article/pii/S1470160X11004110.
[26] Emily A Kolbe, "Won't You Be My Neighbor?" 99 Iowa L, Rev, 415 (2013), Web, https://ilr.law.uiowa.edu/print/volume-99-issue/wont-you-be-my-neighbor-living-with-concentrated-animal-feeding-operations/.
[27] Ibid.

very difficult to avoid since there is such an abundance of manure which makes it difficult to maintain. Runoff occurs when the soil is very saturated with water and the excess water on the surface level flows into ditches, rivers, creeks, and lakes bringing a layer of topsoil with it. It is common for the waste to reach surface and groundwater systems through runoff. The CAFO waste can cause runoff when it is overapplied to fields. Travel irrigators are trucks or tractors that spray the manure across fields, making it easy for waste to cause pollution by being swept into surface waters from wind or rain. [28]

Manure can be good for soil, however, penetration of manure through soil and into the field drainage tiles lead to its disposal in country drains and streams. Tests have shown that it only takes approximately 45 minutes for waste to sink 3 to 4 feet below the surface level, reaching the drainage tiles.[29] Although the waste is applied to the surface levels of the field, it has a much deeper effect. There is also an injecting system that shoots the manure into pockets of soil fields in attempt to mask the odor of the manure. This method is a concern since the manure may have a shorter travel time to steep through the soil, through the drainage tiles, and into drains and streams. Farmers have attempted to solve the issue by plugging the drains with gate valves, however it seems to be only a temporary fix. It is not an ideal situation because the gate valves only delay the pollution; they do not keep the manure from sinking into the groundwater and they do not remove the pathogens still present in the waste.

CAFO's also use manure lagoons to store the endlessly growing amounts of fecal matter, urine, and other waste produced by cattle. The lagoons are filled of all of the waste that had been washed from the floors of the CAFO daily and remain in storage untreated until it is needed for land application. There are laws in place that make sure the CAFO's treat their sewage, but that does not

[28] Kolbe, *Won't You Be My Neighbor*.
[29] Ibid.

entirely prevent water contamination. Overflows of these lagoons are a pressing environmental concern because the floods, lagoon spills, and lagoon collapse are all common sources of pollution in groundwaters. The reason this remains a problem is because only the large CAFOs are considered point sources for pollution, meaning that they are legally obligated to obtain a National Pollutant Discharge Elimination System (NPDES), but the medium and small sized CAFOs are not. Additionally, for the law to apply to a CAFO, "there must be an actual discharge into navigable waters to trigger the Clean Water Act's requirements and the EPA's authority. Accordingly, the EPA's authority is limited to the regulation of CAFOs that discharge".[30] The law only starts to apply to each CAFO after the damage has already been done. Each state has different regulatory laws for the CAFO in addition to the federal laws enforced by the Environmental Protection Agency (EPA). Iowa, which is the 7th state with the most cattle as of 2018, leaves CAFOs virtually unregulated with only the federal laws to govern them.[31] In a 2012 report by the EPA, the state failed to adequately follow the basic federal CAFO regulations.

The federal laws that are currently in place are better than no regulation at all, but they are not enough to sustain clean water for the nation. The US's poor animal agricultural practices are resulting in negative impacts on our environment. The gulf of Mexico is becoming an oxygen-starved "dead zone" due to the excess amount of nitrogen and phosphorus in the waters, which are the two most prevalent pollutants in manure.[32] This inhibits marine life from existing in that area. Unfortunately, this means that this "damage directly affects the industries that rely on the ecosystems

[30] Kolbe, *Won't You Be My Neighbor*.
[31] Rob Cook, "Top 10 States With The Most Cattle," *Beef 2 Life,* 2019, https://www.beef2live.com/story-top-10-states-cattle-0-110713.
[32] Ibid.

in the Gulf—industries that have been severely harmed by the lack of environmental regulations hundreds of miles up the Mississippi River" .[33]

Supporting a clean water system can be as easy as cutting out or even reducing beef and dairy intake. If the population can greatly reduce the amount of cattle farms, the amount of waste it produces would reduce as well. Since the high amounts of manure produced by cows cannot be avoided and instead must be managed, the best way to reduce the amount of manure contaminating the water is to lower the demand for beef and dairy products. Adjusting laws so manure management is more regulated may help keep waters clean, but only if the amount of manure is greatly reduced. Ultimately, if 335 million tons of manure continue being produced annually, managing it will continue to be a challenge and the waters will continue to suffer. Limiting beef and dairy consumption and replacing them with milk alternatives and plant-based sources of protein will also be beneficial for our environment since it takes much less water to produce. By being mindful of the consequences of the production of one's diet, water can be saved and potable so it does become a major scarcity.

[33] Cook, *Top 10 States With The Most Cattle.*

CHAPTER TWO: HEALTH

A nutrient-rich diet is one of the most important factors in maintaining a healthy lifestyle; however, red meat and dairy are two of the most unhealthy foods on the market yet they are still being consumed in excess across the nation. On an individual scale, this poses a threat to human health. High red meat intake is linked with high mortality rates via heart disease, cancer, or gastrointestinal complications to name a few and dairy is associated with its own threats to human health.[34] It is important for consumers to understand there are sufficient alternatives for a meat-based diet that are overall superior for individuals health.

Impacts of Beef on Human Health

Beef can play an important role in human diet as it contains various minerals that are necessary for human health, such as iron and zinc. Zinc is necessary for the immune system to function properly.[35] Iron plays an essential role in proper functioning of hemoglobin, "a protein that aids in the transportation of oxygen in red blood cells."[36] Beef can serve as a great source for meeting requirements when consuming these vital minerals. However, an excess amount of beef consumption can lead to severe health problems. According to the National Institutes of Health, consumption of red meat leads to higher overall caloric and saturated fat intake, playing a role in obesity, which will then lead to an increase in risk of cardiovascular diseases.[37] This problem of excessive beef

[34] John D Potter, "Red and Processed Meat, and Human and Planetary Health," May 09, 2017, doi:https://doi-org.ezproxy.bu.edu/10.1136/bmj.j2190.
[35] Atli Arnarson, "Beef 101: Nutrition Facts and Health Effects," Healthline, April 4, 2019, https://www.healthline.com/nutrition/foods/beef.
[36] Megan Ware, "Everything You Need To Know About Iron," MedicalNewsToday, February 23, 2018, https://www.medicalnewstoday.com/articles/287228.php.
[37] NIH, "Meat Consumption is Associated With Obesity and Central Obesity Among US Adults," National Institutes of Health, June 1, 2010. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2697260/.

consumption is especially prevalent in United States, as according to John Hopkins University, Americans eat beef about 3 times more than the global average.[38] The United States has one of the highest adult and child obesity rates in the world, standing at 39.8% of the United States' adult population and 18.5% of children and adolescents ages 2-19 as of 2014.[39]

Public Health

Excess consumption of beef not only affects people individually, but also as a whole. Cows in farms are often subjected to long-term overcrowding in small spaces that will lead to pain and discomfort in addition to being deprived of food. In response to these conditions, along with several others, they will undergo extreme physical and emotional stress leading to the deterioration of their overall health as a result of a weakened immune system. A decrease in the functionality of their immune system will lead to increased susceptibility of easily spreading diseases along with a decrease in appetite among cows. As a result, their poor health will lead to poor quality of meat.[40]

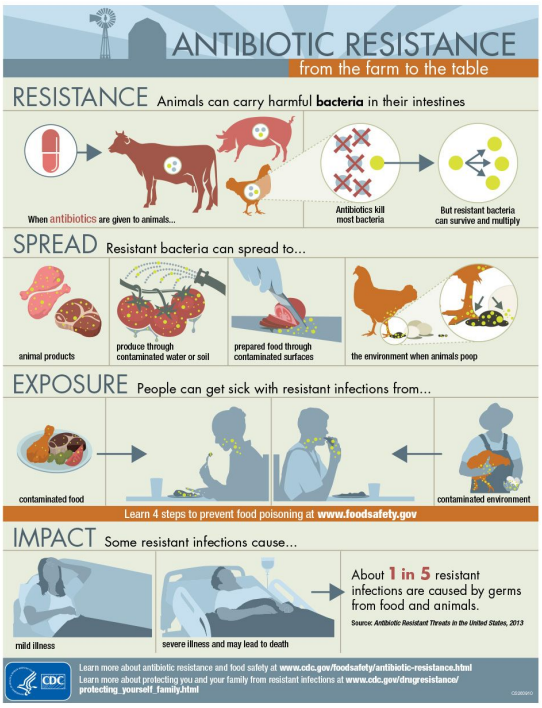
Another risk factor of cow farming on public health is the insurmountable amount of cow manure. As of 2015, the U.S. Department of Agriculture states that farm animals in the United States produces 335 million tons of manure per year.[41] While manure serves a positive role in the environment in terms of soil fertility, there can be an excess amount of manure to the point where the soil can not absorb it fast enough to prevent a negative impact on the overall environment and public health. As a result, the toxins from the manure will seep into the runoff in downstream communities

[38] JHSPH, "Health and Environmental Implications of U.S. Meat Consumption & Production," John Hopkins Bloomberg School of Public Health, https://www.jhsph.edu/research/centers-and-institutes/johns-hopkins-center-for-a-livable-future/projects/meatless_monday/resources/meat_consumption.html.
[39] "Adult Obesity Facts," Centers for Disease Control and Prevention, August 13, 2018, https://www.cdc.gov/obesity/data/adult.html. American obesity rates
[40] "Can Stress in Farm Animals Increase Food Safety Risk?" US National Library of Medicine and National Institutes of Health, September 6, 2019, https://www.ncbi.nlm.nih.gov/pubmed/19737056.
[41] "Two Numbers: Animal Manure a Growing Headache in America," Newsweek, December 18, 2015, https://www.newsweek.com/2015/12/18/two-numbers-animal-manure-growing-headache-america-402205.html

that will contaminate nearby water sources, further potentially contaminating anyone that consumes this water.

Another source of spreading diseases is the interaction between cows and workers on the farm.. Zoonotic diseases, diseases that are spread from interaction between cows and humans, are common in the farm industry because of the frequent contact between cows and workers. The common pathogens involved in zoonotic diseases consists of "*E. coli, Salmonella,* and *Cryptosporidium parvum* and can cause symptoms such as serious fevers, diarrhea, pregnancy difficulty or defects, respiratory problems, brain damage, bacterial infections, and even death."[42] Exposure to these pathogens is especially prevalent when there is frequent interaction between humans and calves. Because the calves are still in the growing stage, a significant stage in order to produce high-quality meat, they require more care and supervision. According to a study by the Western Center for Agricultural Health and Safety, calves are 3.6 times more likely to have multiple zoonotic diseases compared to older cows.[43] This makes sense because since calves are not fully developed, their immune systems are still in the process of developing, leaving them more vulnerable to contracting diseases. With thousands of workers frequently in contact with cattle infected by zoonotic diseases, the communities around the farms are at high risk for zoonotic diseases through the spread of toxins and contact with workers. This situation of fast-spreading zoonotic diseases poses as a greater danger in large industrial farms where overcrowding and malnourishment is common in their farming practices, further advancing the deterioration of the cows' health and exposure to zoonotic diseases.

[42] "Other Health Risks of the Meat Industry," PETA, https://www.peta.org/issues/animals-used-for-food/health-risks-meat-industry/.
[43] "Protecting Dairy Workers from Infectious Disease," Western Center for Agricultural Health and Safety, April 17, 2019, https://aghealth.ucdavis.edu/news/protecting-dairy-workers-infectious-disease.



Due to the conditions and practices of farms, cows are often in poor health. Therefore, antibiotics are necessary when caring for cattle. However, a combination of the frequent use of antibiotics, poor living conditions for cows resulting in poor health, and the mere abundance of cows can allow public health's biggest problem to persist which is antibiotic resistance. Antibiotic resistance occurs when a human or animal takes antibiotics to kill bacteria. Drug-resistant bacteria are not affected and reproduce more bacteria with the same resistance, making antibiotics less effective. With frequent use of antibiotics on cattle, the rate at which drug-resistant bacteria reproduce increases significantly. This makes the issue of antibiotic resistance increasingly alarming as cow farming becomes industrialized and remains in its poor conditions. In addition to antibiotic resistance, resistant bacteria can remain on meat that is being distributed and sold. If the meat is not cooked properly and is consumed by humans, it can lead to severe bacterial infections.

What farm industries inject into their cows can also lead to public health danger. Injections such as Recombinant Bovine Growth Hormone (rBGH), which is a synthetic version of Bovine Growth Hormone (BGH), can regulate cows milk production. When scientists figured out that making and injecting rBGH into cows could increase milk production therefore increasing profits, rBGH became quickly approved by the Food and Drug Administration (FDA) and countries all over the world. However, rBGH was banned in 2000 by countries around the world except the United States. While rBGH is not directly harmful to humans in ingestion, the American Cancer Society

states that there have been multiple studies linking the use of rBGH in cows to higher levels of the hormone Insulin-like Growth Factor (IGF-1) in humans. Since IGF-1 plays a role in the growth of cells, scientists suspect that increased levels of IGF-1, prompts the overgrowth of cells, which is called a tumor. While studies have consistently shown that the use of rBGH in cows is linked to higher levels of IGF-1 in humans, it is still unsure whether the tumors are necessarily linked to higher rates of cancer or not. In addition to rBGH linking to higher levels of IGF-1, cows with rBGH tend to develop udder infections called mastitis. To treat mastitis, antibiotics are given to cows, leading back to the previously discussed issue of increased antibiotic use leading to increased antibiotic resistance.[44]

Changes and regulations in how cows are raised and treated can produce significant benefits for public health. A large reason why cows fail to become high-quality and healthy meat is because of their living conditions. If the government sets regulations within the cattle industry such as, standardizing the spacing of cows, or enforcing a maximum number of cows to be held in a given area, the public health would be less at risk of being infected by any infection from cow farming. Outcomes include decreased contraction and spread of zoonotic diseases, healthier cows which will in turn lead to healthier and higher-quality meat, and better immune systems as a result of less stress from better living conditions.

It is also well-known that family farms are significantly more beneficial towards animals, workers, the environment, and public health overall. Family farms tend to have better living conditions for cows, allowing them to engage in their natural behavior that would otherwise be inhibited in overcrowded areas in industrialized farms. Industrialized farms are more focused on profits instead of general welfare. They contribute negative impacts to all kinds of aspects, including

[44] "Recombinant Bovine Growth Hormone," American Cancer Society, https://www.cdc.gov/foodsafety/challenges/antibiotic-resistance.html.

their livestock production contributing 18% to greenhouse gas emissions.[45] With regulations and less corporate farms, the public health would be significantly improved through prevention and supervision of how bacteria can leak out of farms to the public.

How cows are raised today may not seem threatening to the public since production happens inside buildings that give the illusion of being locked away from the outside world. This is blatantly wrong as the spread of bacterial infections on meat, through soil, and through water sources are the main reasons why public health remains in danger from cow farming. If more precautions are taken in the industry, many illnesses can be prevented and general welfare among working conditions for workers, living conditions for cows, and improved health for surrounding communities can be achieved.

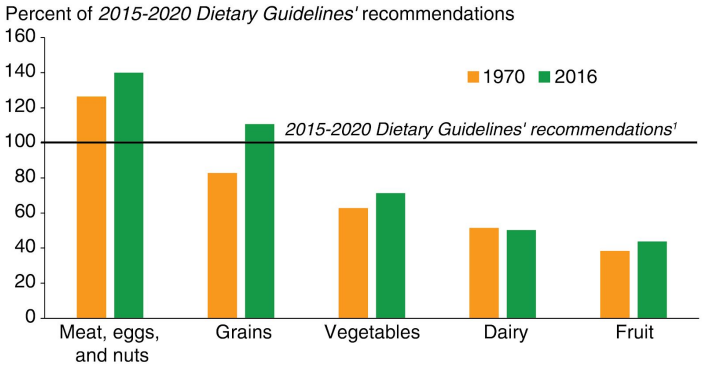
Daily Nutrition

We can see a highly disproportionate amount of food intake in America today. The United States Department of Agriculture (USDA), is responsible for a multitude of food-related duties like farming, pricing, safety, and regulates daily caloric eating reports to promote good balanced meals. Based on a daily 2,000 caloric intake, the recommendations are as follows;[46] 2 ½ cups of vegetables, 2 cups of fruits, 6 ounces of grain, 3 cups of dairy, 5 ½ ounces of protein foods and 27 grams of oils. With this in mind, a breakdown of the protein foods category delineates that meat products should make up 3 ⅓ of the 5 ½ ounces.[47] According to *Forbes,* in 2018, the average American consumed a record breaking 222.2 pounds of meat per person.[48] That would be 9 ⅔ ounces per day creating a

[45] "Industrial vs. Family Farms Comparison," Beyond Factory Farming, http://www.beyondfactoryfarming.org/get-informed/industrial-vs-family-farms-comparison
[46] "Appendix 3. USDA Food Patterns: Healthy U.S.-Style Eating Pattern," Appendix 3, USDA Food Patterns: Healthy U.S.-Style Eating Pattern - 2015-2020 Dietary Guidelines, 2015, https://health.gov/dietaryguidelines/2015/guidelines/appendix-3/.
[47] Ibid.
[48] Micheline Maynard, "Veggies May Be Healthier, But In 2018, Americans Will Eat A Record Amount Of Meat," Forbes, January 02, 2018,

ratio of recommended consumption that is absurdly unbalanced. The way Americans eat leaves no nutritional room for other sources of protein such as nuts, eggs, soy products, or legumes. As depicted by Figure 5 to the right, many people are under-consuming these daily recommendations, aside from grain, which is a trend seen for the past 50 years correlating with a huge increase of contracted health diseases such as diagnosed diabetes.[49] Another trend we can see is a decreased amount of dairy intake, which is good news to hear as discussed in the next section. However, dairy is factored in for calcium intake which is known for supporting bone growth and strength. Under-consuming calcium is problematic and could potentially lead to health problems such as osteoporosis.

Estimated average U.S. consumption compared to recommendations, 1970 and 2016



[1]Based on a 2,000-calorie-per-day diet.
Loss-adjusted food availability data are proxies for consumption. Rice availability data were discontinued and thus are not included in the grains group.
Source: USDA, Economic Research Service, Loss-Adjusted Food Availability Data and *2015-2020 Dietary Guidelines*.

On top of the fact that only 60% of daily protein should be meat, the USDA recommends the majority of meat eaten is lean meat. Meat is lean when it contains a low to no amount of fat and is much healthier than red meat like chicken, turkey and lamb with the fat cut out of it. Lean meat has a lower calorie count, and poultry in particular is a good source of protein, selenium, choline, and vitamins B3 and B6.[50] Selenium has antioxidants which promote thyroid health and protect against

https://www.forbes.com/sites/michelinemaynard/2018/01/02/veggies-may-be-healthier-but-in-2018-americans-will-eat-a-record-amount-of-meat/.

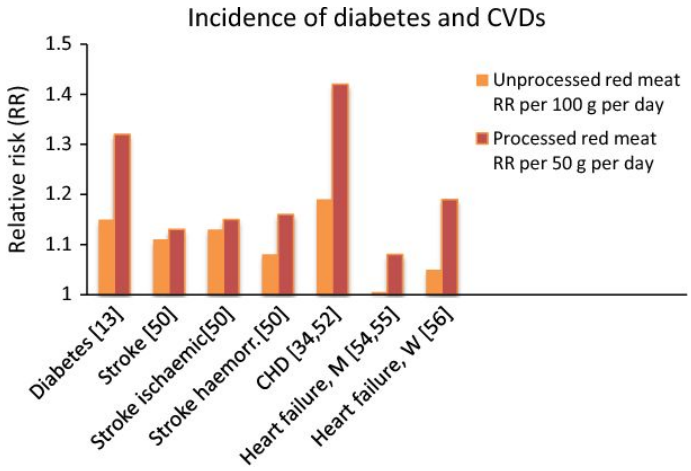
[49] Figure 5. CDC,"U.S. Diabetes Surveillance System," Centers for Disease Control and Prevention, https://gis.cdc.gov/grasp/diabetes/DiabetesAtlas.html#.

[50]"Lean Meat," Lean Meat - What Is a Lean Meat, Health Benefits, Dangers & Hygiene, https://www.diabetes.co.uk/food/lean-meat.html.

cancer and cardiovascular disease.[51] Choline helps your body's metabolism, fat transportation and acetylcholine production, an important neurotransmitter for motor functions.[52] Vitamins B3 and B6 are good for energy, skin and blood.[53] The few downsides to leaner meat are the antibiotics used in farming that can affect people who might ingest them and not cooking the meat all the way through or letting it rot before preparing it which is a well known source of diseases like salmonella. Lean meat is comparatively much healthier for the human body than red meat.

Animal-Based Food's Health Complications

Unfortunately, red meat is much worse for people's health but is still regularly eaten as a main source for protein in the USA. Red meat can be found in beef, lamb and pork products; moreover, processed meats are red meats that have gone through even more manipulation such as bacon, salami, and hamburgers, all of which are made easily accessible in modern-day America. While rich in protein, zinc, and iron, much research has proven links to bowel and colon cancer, type 2 diabetes, and cardiovascular diseases, and more included on Figure 6 below.[54] A study by Professor Tim Kay, Dr. Kathryn Bradbury and Dr. Neil Murphy from Cancer Research UK scrutinized the correlation between amounts of red and processed meats eaten and cancer prevalence. They examined middle age



[51]Jillian Kubala, "7 Science-Based Health Benefits of Selenium," Healthline, December 29, 2019, https://www.healthline.com/nutrition/selenium-benefits.
[52]Mary Jane Brown, "What Is Choline? An Essential Nutrient With Many Benefits," Healthline, December 7, 2018, https://www.healthline.com/nutrition/what-is-choline.
[53] "B Vitamins and Folic Acid," NHS Choices, March 3, 2017, https://www.nhs.uk/conditions/vitamins-and-minerals/vitamin-b/.
[54] Figure 6. Alicja Wolk, "Potential health hazards of eating red meat," Journal of internal medicine 281 2 (2017): 106-122.

men and women concluding that per 50 grams of red meat and per 25 grams of processed meats, there was a 19-20% increase of risk of developing colon cancer in a person's lifetime. According to Tim Kay:

> Our results strongly suggest that people who eat red and processed meat four or more times a week have a higher risk of developing bowel cancer than those who eat red and processed meat less than twice a week. There's substantial evidence that red and processed meat are linked to bowel cancer, and the World Health Organisation classifies processed meat as carcinogenic and red meat as probably carcinogenic.[55]

Colon cancer is only one of the few known problems to come with red meat intake. Heart disease is another and is the leading cause of death in the United States, killing approximately 635,260 people per year.[56] Red meat has an incredibly high amount of saturated fat in it that it can lead to plaque build up causing blockages of blood flow leading to stroke and/or heart attack. Advanced studies, however, show that there are additional factors of red meat that lead to heart problems. A study led by Dr. Stanley L. Hazen has shown that levels of Trimethylamine N-oxide (TMAO), a substance produced by intestinal bacteria in humans, rise when on a high red meat diet.[57] TMAO increases cholesterol deposits in the bloodstream and can impact the erythrocytes causing them to bloat and clog arteries similar to that of plaque build-up. The study also concluded that lean meats and plant-based protein were unaffecting on the TMAO byproduct.

Type II Diabetes, otherwise known as adult-onset diabetes, is another huge risk factor when eating red and processed meats. Professor Frank Hu concluded this risk factor when analyzing three

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[55] "Even Moderate Red and Processed Meat Eaters at Risk of Bowel Cancer," Cancer Research UK, April 16, 2019, https://www.cancerresearchuk.org/about-us/cancer-news/press-release/2019-04-17-even-moderate-red-and-processed-meat-eaters-at-risk-of-bowel-cancer.

[56] "FastStats - Leading Causes of Death," Centers for Disease Control and Prevention, March 17, 2017, https://www.cdc.gov/nchs/fastats/leading-causes-of-death.htm.

[57] NIH, "Eating Red Meat Daily Triples Heart Disease-related Chemical," National Institutes of Health, January 15, 2019. https://www.nih.gov/news-events/nih-research-matters/eating-red-meat-daily-triples-heart-disease-related-chemical.

longitudinal studies spanning 14 to 28 years that monitored the dietary habits and the likelihood of diabetes onset. He inferred that the daily serving of red meat increased risk by 19% while the daily serving of processed meat increased risk by 51%.[58] The reasoning behind this is because diabetes occurs when there is poor regulation of glucose via insulin in the bloodstream and red meat contains sodium and nitrate, two causes of insulin-resistance. Alongside iron which can cause further complications with those who have hereditary hemochromatosis such as cell damage and inflammation.[59]

Dairy is a product of animal's milk such as cheese, cream, butter, etc. Nutrients in dairy include protein and calcium which are, as discussed, important for the nutrition of human bodies, however in excess dairy can be a problematic source of these. Dairy contains a compound known as lactose, which is known to cause digestive tract issues when incapable of being broken down by the body. This affliction is known as lactose-intolerance and approximately 65% of people have it.[60] This coincides with the belief that humans should not consume another animal's milk. We as a human race are the only mammal to ingest another's milk which could not be good for our bodies, and evolutionarily, we have not been able to adapt to it.

Personal Dietary Solutions

With all this information, it begs the question of what to do if someone would like to start eating healthier as to avoid these life-threatening diseases. As we have seen, adherence to daily recommendations have been proven to be futile, if not hazardous to health. It is suggested to lower this daily recommendation and set better standards of red and processed meat consumptions if

[58] Jonathan Shaw, "A Diabetes Link to Meat," Harvard Magazine, March 03, 2014, https://www.harvardmagazine.com/2012/01/a-diabetes-link-to-meat.
[59] Ibid.
[60] "Lactose Intolerance - Genetics Home Reference - NIH," U.S. National Library of Medicine, https://ghr.nlm.nih.gov/condition/lactose-intolerance#statistics.

incapable of living without it. Turning to lean meat is also a good step in the right direction and beginning to eat more unsalted nuts and legumes in place of red meat would be a good source of plant-based protein. Vegetarian and vegan lifestyles are also viable options, and have been on a steady popularity rise in the 21st century. Recent studies have proven that they decrease risks of heart problems and other dietary-related health diseases. Researchers from the Physicians Committee for Responsible Medicine have found that these diets decrease heart disease and cardiovascular risks by 40%, drop cholesterol and blood pressure levels, and reduce risks of obesity and type II diabetes.[61] Most people are actually switching to vegan diets due to health as shown by Figure 7 above.[62] These plant-based diets are often dismissed for being protein-light and not being able to cater to all food groups. As stated, there are many protein sources that do not come from animals such as soy, dark leafy greens, nuts, and legumes. There is a huge misunderstanding that soy products heavily influence people's hormonal balances when this is definitely not the case. Where most misconceptions about soy products come from is that soy has natural isoflavones levels, a type of phytoestrogen. These are plant-based hormones that do not affect the human endocrine system as many people would believe. On top of that, this sort of plant protein is heavenly for our renal system, as the energy exertion levels

Why are you vegan?	
Health	69%
Taste preference	52%
Animal protection	68%
Feelings of disgust about eating animals	63%
Concern for the environment	59%
Cost	21%
Social influence (peers, family, etc.)	11%
Social justice / world hunger	29%
Religious/spiritual beliefs	22%
Wanting to follow a food trend	7%

[61]Tim Newman, "Vegetarian Diet Reduces Heart Disease Death Risk by 40 Percent," Medical News Today, June 01, 2018, https://www.medicalnewstoday.com/articles/321992.php.
[62] Figure 7. Kristina DeMuth, "Vegan Demographics 2017 - USA, and the World," Vegan Bits, May 19, 2018, http://veganbits.com/vegan-demographics-2017/.

are much lower than for animal protein.[63] As for dairy, the most important component of why we need it is calcium which can be taken via supplement; even protein supplements are available if the plant-based options are undesirable.

Overall, we can see that there is a huge benefit to cutting red meat out of our diets completely. Decreased risks of diabetes, heart disease and cancer all by eliminating a certain type of meat is incredibly advantageous and having a better balanced diet is imperative to health and long lives. With all the extensive research that scientifically proves its disadvantages heavily outweigh its benefits, it is severely important to reconsider what to order when eating out next time.

[63] "Soy," NutritionFacts.org, https://nutritionfacts.org/topics/soy/.

CHAPTER 3: ECONOMY

The meat industry is a driving factor in the US economy. Americans are known for eating fat, juicy burgers, and fast food; however, the amount of red meat consumers buy has a negative effect on our country. The animal agriculture industry is very successful but it comes at a price.

In this chapter, we discuss how the industry helps the economy by providing workers jobs. We will also discuss how the cost of raising a cow is very expensive and how many corporations cut corners when it comes to proper care for their livestock and how this can cause diseases in their product and negatively affect consumers. We will mention the ability of the US to become a prime example of a proper leader in agriculture, aiding to world hunger, and issues with false advertising and product placement when it comes to the meat industry. Lastly, we will talk about ways that we can solve the current issues in animal agriculture without disrupting the economy such as lab grown meat, plant-based agriculture, and the elimination of subsidies.

Impacts of Beef in the Food Industry and the Economy

The meat industry in the United States is driven by a complex network of economic, political and socioeconomic factors. For example, it is common for many US corporations such as McDonald's, Cargill Meat Solutions, JBS Tolleson, and Tyson Foods to portray animal agriculture in a positive light due to their objective to profit off of the industry, rather than encouraging healthy practices of cow farming in the US and advocating for change.[64] They are motivated by profit rather than traditional animal care values because the US meat industry alone is one of the largest segments

[64] D. Fraser, "The 'new perception' of animal culture: legless cows, featherless chickens, and a need for genuine analysis," *Journal of Animal Science*, Volume 79, Issue 3, 2001, https://academic-oup-com.ezproxy.bu.edu/jas/article/79/3/634/4625881.

in US agriculture. According to an analysis by John Dunham & Associates in 2016, the US meat and poultry industry accounts for $1.02 trillion in total economic output or 5.6 percent of gross domestic product (GDP).[65] One of the reasons the industry does so well in America is because of the demand for meat. In 2017, US meat production totaled 52 billion pounds. In the same year, US meat companies produced 26.3 billion pounds of beef, 25.6 billion pounds of pork, 5.9 billion pounds of turkey, 80.2 million pounds of veal, 150.2 million pounds lamb and mutton and 42.2 billion pounds of chicken.[66]

Demand and corporations' obligations often conflict with ethical considerations with respect to treatment of animals and the detrimental impact of the industry on the environment. Although all of this meat production comes at a price for the animals and for the environment- corporations tend to not reveal the negative sides of animal agriculture including how they mistreat the animals or how their process affects land because the company's goals are to stay as "lucrative" as possible. Many people look the other way when it comes to actual practices of the meat industry because of their want for meat and the number of jobs the corporations provide. It is true that the meat industry benefits the economy. In the US, the meat industry is responsible for 5.4 million jobs and $257 billion in wages, and these figures do not include meat exports.[67] However, what is also true is that these specific practices hurt the US in the long run. Overall, the meat industry does provide jobs and makes money but it would be economically more sound to distribute the assets in the cattle industry to healthier food alternatives such as vegetable farming.

Animal agriculture is much more resource intensive than plant agriculture. When we reviewed USDA reports we found that plant agriculture generates 1.5 trillion more pounds of product

[65] Beef Checkoff, "North American Meat Institute," *Cattlemen's Beef Board*, North American Meat Institute, 2017, https://www.beefboard.org/.
[66] Ibid.
[67] Checkoff, *North American Meat Institute*.

than animal agriculture. This is due to the fact that animal agriculture uses 115 million more acres of land than plant agriculture.[68] Animal agriculture does generate $35 billion more dollars in sales than plant agriculture, however, that is not much more considering the fact that expenses generated in order to produce meat products are $55.8 billion more than it takes to produce plant products because animals require more care.[69] If everyone in the US switched to a plant-based diet, it would be beneficial to the environment, the animals, human health and the economy, for the USDA report concludes that "plant-based agriculture grows 512% more pounds of food than animal-based agriculture on 69% of the mass of land that animal-based agriculture uses."[70] Although it may be unrealistic to expect all consumers to adopt purely plant-based diets a commitment to changing consumer habits would have a substantial impact on consumption. One could begin slowly to reduce the consumption of red and other meats, as well as implement laws to assure safety and protection for animals and individuals. Eventually, a strong reduction in consumption would make a significant contribution to helping to alleviate world hunger.

Food: US Relations, Hunger, Affordability

The US economy plays a critical role in helping to address world hunger and provide affordable food in America as well as globally. In the book review of *Agriculture in the Global Economy: Hunger 2003*, by Barbara Jendrysik, it is argued that the reason for world hunger is due to the current agricultural system.[71] The agricultural system in the US is made up of both the meat, poultry, dairy and crop industries. However, in using resources disproportionately for animal

[68] J. Sigler, "Animal-Based Agriculture Vs. Plant-Based Agriculture: A Multi-product Data Comparison," *Faunalytics*, Human Herald, 2017, https://faunalytics.org/farming-animals-vs-farming-plants-comparison/.
[69] Ibid.
[70] Sigler, *Animal-Based Agriculture Vs. Plant-Based Agriculture: A Multi-product Data Comparison*.
[71] Barbara Jendrysik, "Agriculture in the Global Economy: Hunger 2003," *Journal of Nutrition Education and Behavior*, 36.1, (2004): 50, Web, http://web.b.ebscohost.com.ezproxy.bu.edu/ehost/pdfviewer/pdfviewer?vid=1&sid=a8b56143-5080-4838-a884-b48eef2cfdde%40pdc-v-sessmgr03.

farming, agricultural policies in the US are contributing to world hunger. However, if the US reformed agricultural policies it would allow for many hungry families in rural areas of developing countries to receive higher prices for what they produce. It would encourage investment in ways that would raise their productivity.[72] Jendrysik states that "today's global agriculture system produces more than enough food to feed everyone… yet 840 million people remain undernourished." Subsidies can have a negative effect on the meat industry when it comes to farming and can play a big role in world hunger. A way that we could try to fix world hunger is through the elimination of subsidies and protection in industrialized countries. Subsidies reduce incentives for farmers to increase efficiency. In addition, price supports can distort global commodity markets. Eliminating subsidies would potentially allow developing countries to triple their annual net agricultural trade (exports minus imports) from $20 billion to $60 billion.[73] This equates to two-thirds the value of all humanitarian and development aid provided by industrial countries like the US.[74] According to the International Monetary Fund, for all countries, the estimated gains from the elimination of trade-distorting subsidies and tariffs in developed countries would be $100 billion.[75]

Law: False Advertising, Meat Regulations, Safety

As a result of its economic and political power, the meat industry has significantly influenced enforcement of legislation addressing industry practices such as safety and product labeling. For example, for consumers examining the contents of meat products, it is important to view the labeling before purchasing the meat. However, labeling has become very misleading due to ambiguous laws that our government has enforced. Legally, the law relationship between the United States Department of Agriculture (USDA) regulated products and state and federal laws is complex. Food

[72] Jendrysik, *Agriculture in the Global Economy: Hunger 2003.*
[73] Ibid.
[74] Ibid.
[75] Ibid.

categories in the USDA include meat, meat products, poultry, poultry products, eggs, and egg products.[76] For federal law, the Federal Meat Inspection Act (FMIA) regulates meat and meat products. This form of inspection (FMIA) allows the USDA to regulate labels and label inspections. This act prohibits states from creating label requirements that are in addition to, or, different from the federal requirements. However, as long as their requirements match the federal requirements, the state does retain concurrent enforcement jurisdiction.[77] There are laws in the US such as the Federal Trade Commission Act or The Packers and Stockyards Act which are supposed to outlaw deceptive labeling of products, however, they are not very successful. In the US, the Federal Trade Commission Act outlaws deceptive, unfair, acts or practices via labeling, however, the act is intentionally written vaguely so that it covers product labels that are deemed to be deceptive.[78] The Packers and Stockyards Act prohibits deceptive practices or devices concerning meat food products. In this act, the statutory language is so broad that the USDA could claim jurisdiction under certain circumstances for false meat advertising.[79] Reform is needed so that legislation is effective and enforced. Until this happens consumers are in danger and legislation intended to protect individuals will fail.

One consequence of lack of proper enforcement of regulation is that consumers are often deceived as to the true origins of meat products. For example, this leads to considerable controversy concerning the legal point-of-view when discussing food products that are not easily categorized as either labeling or advertising. Purchase displays that are in point-of-view of the product are

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[76]Donald R. Stone, "The Federal-state Relationship concerning USDA Regulated Foods - Advertising: The FTC, the States, and Others," *Food Drug Cosmetic Law Journal* 44.4 (1989): 315-23, Web, https://heinonline-org.ezproxy.bu.edu/HOL/Page?lname=&public=false&collection=journals&handle=hein.journals/foodlj44&men_hide=false&men_tab=toc&kind=&page=315.

[77] Stone, *The Federal-state Relationship concerning USDA Regulated Foods - Advertising: The FTC, the States, and Others*.

[78] Ibid.

[79] Ibid.

considered labels because they "accompany" the product, even though many customers will not actually read the signs if they are not directly on the package. Lots of problems arise with false advertising sometimes when the label is not in the point-of-view, is not actually a label for the food and rather something the retailer made, or if the product label is pictured in the advertisement rather than on the back of the product.[80]

In addition, many corporations use certain terminology that is misleading when it comes to labels on meat packages, thus allowing American consumers to buy and consume false products. According to a study conducted by *Their Turn*, with 1,000 Americans, 65% of consumers believe that the label "free-range" means that farm animals spend time on pastures, which is an accurate definition, however, in reality it is a lie. Most animals do not have the freedom and there is no law which says that farmers have to provide proof that animals have access to the outdoors.[81] Another term that is found of packaged meat is "cage-free." In addition, 63% of the survey participants believe that the term means that the animals have access to the outdoors when it actually means that the animals are not raised in cages.[82] Instead of cages of steel, corporations have replaced the cages with "flesh," meaning that animals are overcrowded in warehouses with very little space to move. The company Animal Equality states that "over 56 billion animals are slaughtered each year by the animal agriculture industry."[83] In order to address the lack of humane treatment for all animals, one of the first steps is to accurately represent the sources of animal products, including conditions

[80] Stone, *The Federal-state Relationship concerning USDA Regulated Foods - Advertising: The FTC, the States, and Others.*
[81] Shimon Shuchat, "Deceptive Advertising by Animal Products Industry Fools Consumers; Advocates Fight Back," *The Social Justice Movement of Our Time*, Their Turn, 2016, https://theirturn.net/2016/08/09/deceptive-advertising-animal-agriculture/.
[82] Shuchat, *The Federal-State Relationship*
[83] Shuchat, *Deceptive Advertising by Animal Products Industry Fools Consumers; Advocates Fight Back.*

surrounding their origin. Until this happens, consumers are not provided with information that will legally enable them to make informed decisions with respect to what products they want to purchase.

The dangers of inhumane treatment of animals significantly impacts not only the animals but also the health and welfare of consumers. Outbreaks of illness and contamination are evidence of this. For instance, in meat industry conditions where animals have very little space to move, it causes them stress which can lead to diseases because of the failure of their immune system. In September of 2019, the CDC, public health and regulatory officials in several states, and the U.S. Department of Agriculture's Food Safety and Inspection Service investigated a multistate outbreak of Shiga toxin-producing *Escherichia coli* O26 (*E. coli* O26) infections.[84] They conducted fourteen interviews of people that were affected, all reported eating ground beef a week before they became ill, they purchased ground beef from several different grocery stores. The illness spread to 18 people across four states and one person in Florida died. Laboratory, epidemiologic, and traceback evidence indicates that the ground beef from Cargill Meat Solutions is the source of the outbreak.[85] Many outbreaks of E. coli and other harmful diseases have occurred in other American meat companies as well, massive corporations like Tyson Foods (plastic in their meat), and JBS Tolleson (recalled roughly 6.5 million pounds of ground beef due to salmonella concerns, causing 57 people to fall ill) have been recalled numerous amounts of times.[86] If such corporations chose to not cut corners initially and pay to properly take care of their animals, the animals would not be diseased, people would not die from E. coli and other diseases in meat, and these companies would not lose profits because they would not have to recall their meat if their process was correct the first time. The

[84] CDC, "Outbreak of E. coli Infections Linked To Ground Beef," 2018 Outbreaks, Centers for Disease Control and Prevention, Sep 2018, Web, https://www.cdc.gov/ecoli/2018/o26-09-18/index.html.
[85] Ibid.
[86] Chris Fuhrmeister, "Maybe Don't Eat Ground Beef Right Now," *Eater*, Vox Media, 2019, Web, https://www.eater.com/2018/10/4/17933928/ground-beef-recall-salmonella-e-coli-jbs-tolleson.

bottom line is that not only are animals raised in inhumane conditions due to money-making commodities but also that retail stores falsely advertise how animals are treated and what is actually in the meat via labels which thus results in consumers purchasing and consuming lies.

Lab Grown Meat Alternative

A possible solution to the ongoing problem with cow agriculture is the production of Lab Grown Meat. Lab Grown Meat is one of the leading solutions for the replacement of cow products due to its various applications to not only solving the cow agriculture issue, but also almost any animal products that are farmed. The implication of lab grown animal products are essentially reducing any harmful environmental impacts to an unprecedented low.[87] Along with environmental impacts, the process of developing lab grown meat is adaptable to fit the growing population size and the demand for meat as the population rises. Costs for making lab grown meat used to be extremely expensive. The first ever lab-grown patty costed $325,000, however, after some years of development the cost has plummeted to Burger King levels.[88] In 2015 the cost of the same burger was less than $12.[89] That figure is decreasing as the years pass. Further development in this exciting process to make lab grown meat for commercial use is estimated to be roughly $160 million.[90] Investors must be incentivised to make this a viable solution to conventional cow agriculture. In a capitalist economy, cash is king. Making the lab grown animal products industry a mass production industry would create the drive needed to commercialize the products produced. There are many benefits that come with commercializing lab grown meat.

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[87] Neil Stephens, Lucy Di Silvio, Illtud Dunsford, Marianne Ellis, Abigail Glencross, and Alexandra Sexton, "Bringing Cultured Meat to Market: Technical, Socio-political, and Regulatory Challenges in Cellular Agriculture," Trends in Food Science & Technology, August 2018, https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6078906/.
[88] Sara Brown, "Will Lab-Meat Get Cheap Enough to Buy?" Ag Web, July 09, 2018, https://www.agweb.com/article/will-lab-meat-get-cheap-enough-to-buy/.
[89] Ibid.
[90] Hanna L. Tuomisto and M. Joost Teixeira De Mattos, "Environmental Impacts of Cultured Meat Production," *Environmental Science & Technology* 45, no. 14 (2011): 6117-123, doi:10.1021/es200130u.

Lab grown meat is great, but what does it entail? Generally speaking the process is still at its fetal stages with much more to develop for mass production, however, there is a positive in how the beef can be mutated. Through certain methods scientists can produce genetically superior beef. Since the beef is grown from a stem cell, the resulting product can be controlled. The control over the beefs genetics can be used to produce beef that has more or less fat, protein, growth rate, taste, etc. Perfecting the technology in the future could lead to increased growth levels just like giving cows hormones to induce growth, but through genetics instead of harmful hormones.

Currently, the capability for producing lab grown meat is only in certain labs. The production of lab grown meat is simple, but is becoming more complex with increasing benefits from the product. Stem cells from calves are taken to be developed. From that point they are stimulated with various chemicals and cycles to produce a large yield from one culture. One stem cell can be effective at producing 1000 kg of meat product.[91] That yield, however, is only half food. Fifty percent of the yield is used as food for human consumption and the other fifty percent is sent off for other products such as animal food. Forming 1000 kg of minced beef from one stem cell is more efficient than developing a cow for a large amount. Overall, lab grown meat is a better solution in terms of volume produced.

Lab grown meat not only has the capability to end world hunger, but also cuts down on the use of natural resources and spending. In comparison to conventional farming methods, lab-grown meat is much more effective at efficiently using mankind's limited natural resources without causing a large impact to the ozone layer in the Earth's atmosphere. Current farming methods in the cattle industry alone account for the use of eight percent of the world's freshwater supply. In terms of water use per 1000 kg of beef produced, conventional farming uses 531m^3 while lab grown meat only uses

[91] Brown, *Will Lab-Meat Get Cheap Enough to Buy?*

21.24m^3.[92] Water usage is reduced ninety-six percent by using lab grown meat to produce our beef. The surplus of water would mainly be in irrigated farm land. With more water, large scale farming can increase production of grain and other farmed crops.

Energy consumption is also reduced. Using the same medium as with water, farming uses 33 GJ of energy.[93] While lab grown meat uses only 18.15 GJ for the same amount of product.[94] Energy is not a primary item of concern because as technology progresses so does the ability to harvest energy from better sources. Not only does the initial save on energy is applied, but so too does transportation. Moving lab grown meat is easier because there is more product and less waste meaning only the meat is moved and not blood, excess fat, and bones. Transporting blocks of pure product is much more efficient then stacking animal parts on top of eachother or making mince meat out of cows. Due to the nature of lab grown meat, refrigeration costs go down as well because there is only pure product to freeze.

Cattle are a large animal and therefore require a large space to be housed and, in some cases, graze. As of 2013 the farming industry alone accounted for thirty percent of habitable land in the world. The application of lab grown meat would reduce the space needed for production and storage exponentially. We believe that the space needed to replace all meat products through lab grown meat would require a fraction of the space. Lab grown meat requires 2.3m^2 to create 1000 kg of produce, however, conventional farming requires, on average, 230m^2 to produce the same amount[95]. Conventional farming uses so much land because the cattle need space to graze and be kept. A

[92] Brown, *Will Lab-Meat Get Cheap Enough to Buy?*
[93] Ibid.
[94] Ibid.
[95] Ibid.

ninety-nine percent reduction in land usage would benefit not only producers, but also the ozone layer.[96]

Farming for animal feed is the leading driver for deforestation in places such as the Amazon Rainforest. The industry is also accountable for eighteen percent of the total greenhouse gas emissions on the planet.[97] Thirty four percent of the pollution comes from deforestation.[98] Twenty five percent from methane gas emissions produced by the cattle and thirty one percent to manure management. Lab grown meat reduces the amount of greenhouse gasses per 1000 kg of beef by ninety six percent.[99] We have already stated how cattle have a negative impact on the ozone layer. To rapidly change the output of greenhouse gases for one product is unprecedented and would help the ozone layer recover. Also, because there is not a need to create more farmland the rainforests get spared from deforestation. This estimate does not include transportation of the final product. The only process that pollutes in the production of lab grown meat is the growth stage where CO_2 is released back from growing cells.

After analyzing the possible solutions to cow agriculture and proving that both solutions are effective at replacing their farming we need to show that it is also economical to do so. Cows are not cheap to feed in bulk. Cows require a large amount of forage and formula a day. The average consumption of forage for one cow per day is roughly twenty-seven pounds per day totalling 9855 pounds per year for one cow.[100] In 2017 USA Today news reported that Americans consumed an

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[96] Brown, *Will Lab-Meat Get Cheap Enough to Buy?*
[97] Stephens, *Bringing Cultured Meat to Market: Technical, Socio-political, and Regulatory Challenges in Cellular Agriculture.*
[98] Brown, *Will Lab-Meat Get Cheap Enough to Buy?*
[99] Ibid.
[100] Rick Rasby, "Determining How Much Forage a Beef Cow Consumes Each Day," UNL Beef, April 2013, https://beef.unl.edu/cattleproduction/forageconsumed-day.

average of 55.6 pounds of beef annually.[101] Currently the population of the United States is 327.2 million people. The average amount of beef consumed annually x population of the U.S is shows that on average 18.2 billion pounds of beef are consumed on average in the U.S annually. Lab grown meat is clearly the better option to support the population of the U.S and the world due to the fact it will be produced quickly and is an environmentally friendly alternative to conventional farming. Switching to a vegetarian diet is a viable solution due to the health benefits and ease of farming the crops.

Cattle farming is also becoming less sustainable economically. Cow farming is an expensive process in bulk and yet there is not much to gain from cow farming. The fixed annual variable cost of producing one 1200 lb cow is estimated in 2019 at $556.[102] With that cost in mind, The University of Tennessee's data projected the total cost of a single cow-calf to be $1064 in 2019. Their calculations estimate a loss of $275 in revenue per head.[103] The estimate shows that the cow industry is not completely sustainable economically with the current degree to which the population is rising.

The agricultural impact of reducing conventional cattle feed farming is extremely positive for the U.S market. Livestock feed accounts for most of the grain production in the U.S. A study done by the Cornell Professor David Pimentel says that the U.S could feed 800 million people through the crop dedicated to livestock feed.[104] That number is increasing every year as the demand for meat increases with a growing population. The consumption of beef will have doubled from the year 2000

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[101] Zlati Meyer, "Beef Is Back on the Grill and Its Sales Are Heating Up, Too." USA Today. July 05, 2017. https://www.usatoday.com/story/money/2017/07/03/americans-eat-more-beef-and-meat-trend-thats-expected-continue/435331001/.

[102] Andrew P. Griffith, "Cattle Prices and Profitability in 2019," Drovers, 2019, https://www.drovers.com/article/cattle-prices-and-profitability-2019.

[103] Rasby, *Determining How Much Forage a Beef Cow Consumes Each Day*.

[104] "U.S. Could Feed 800 Million People with Grain That Livestock Eat, Cornell Ecologist Advises Animal Scientists," Cornell Chronicle, August 7, 1997, http://news.cornell.edu/stories/1997/08/us-could-feed-800-million-people-grain-livestock-eat.

to the year 2050 meaning so to does the amount of feed cows need.[105] At that rate 1.6 billion people could be fed with the amount of potential food going towards livestock by 2050.

Economic Boost

The U.S is trillions of dollars in debt as of now. If the U.S were to export all the food sent to the livestock it would have boosted the trade deficit by $80 billion in 1997.[106] Exporting what could be livestock feed would help to produce more economic output for the U.S. In the case of replacing conventional farming with lab grown meat, economic output would be dramatically increased because there is relatively no need for feeding livestock other than collecting samples for lab grown meat. Vegetarian motives would benefit from a rapid increase in available farm land to produce food for, at the current rate, double the U.S population.

The price of beef has been on the rise for decades. While the population grows, the cattle industry cannot keep up with the rising demand. This demand leads to higher prices in the cattle industry as supplies get lower. In November of 2017, "retail prices rose 1 percent, and wholesale prices per 100 weight jumped 12.7 percent" for beef.[107] Keeping the cattle industry around is costing Americans more money for beef. The price is estimated to keep increasing due to the growing demand for beef.

In a perfect switch from beef to vegetarian or lab grown meat alternatives, we believe there would be relatively no impact on the fast food industry. The fast food industry in the U.S has revenues of $200 billion which is more than most countries. By producing more reliable and

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[105] Brown, *Will Lab-Meat Get Cheap Enough to Buy?*.
[106] Griffith, *Cattle Prices and Profitability in 2019.*
[107]Helena Bottemiller Evich, Doug Palmer, Sarah Ferris, and Maya Parthasarathy, "Beef Prices, and Production, Are Rising," POLITICO. December 19, 2017, https://www.politico.com/newsletters/morning-agriculture/2017/12/19/beef-prices-and-production-are-rising-056957.

easy-to-produce alternatives for the industry, that number would grow by increasing the efficiency of the transportation and readily available produce.

Solutions

If the farming industry decreased animal agriculture it would solve many solutions in America. First, corporations would pay less for land and the process of animals because they would be producing more plant-based crops. In addition, they would not have to cut costs to make money and treat the animals poorly. This would also clear up any false advertising and the misleading of meat labels to the consumers. Corporations could use the money that they used to spend on land and the care of animals and put it towards their workers and producing more vegetables and dairy products. This would not have a negative effect on the economy as the animal agriculture workers would now become just dairy or plant-based agriculture workers, and corporations would no longer lose revenue from having to recall meat do to unsanitary environments and diseases. Having more plant-based farms would also allow the US to aid in the fight of world hunger. If everyone in the US switched to a low meat diet and heavier plant-based diet, as a world superpower we could set the standard. Though this idea is very aggressive, if everyone in the world switched to a plant-based diet we would alleviate world hunger. In addition, the elimination of subsidies and protection in industrialized countries would also aid to the solution of world hunger.[108] The ultimate solution to the negative sides of animal agriculture would be to switch over to dairy and plant-based agriculture which ultimately would not affect the economy negatively over time and help the society, environment, and animals in the long run. The lab grown meat alternative has benefits beyond just improving the way mankind gets it beef. Due to the multitude of applications to produce any food for

[108] Jendrysik, *Agriculture in the Global Economy: Hunger 2003.*

consumption, lab grown meat is a front-runner solution to reduce the negative impact cattle farming has on the economy and the environment.

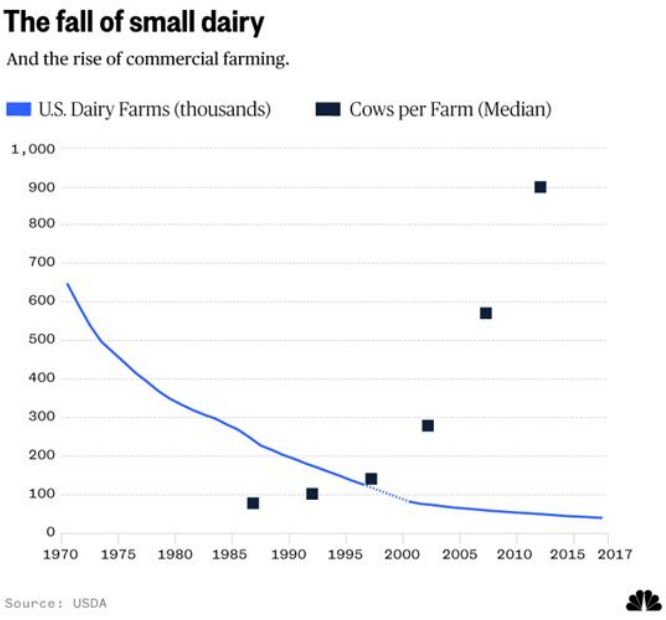
CHAPTER 4: ANIMAL WELFARE

The welfare of cows plays a role in the US economy, in the environment, and is growing in importance as an ethical issue. The United States is a developed country, but this does not mean that they do not have practices that are dangerous to the welfare of animals. Disease is prevalent on farms with high populations of cows, causing a myriad of debilitating issues for their health. This can in turn slow down rates of production and retard profitability. The treatment of animals during their lives on the farm is also a crucial aspect to the environment. Cows are a part of our ecosystem, and they are one of our many options as food sources; however, it has been argued that we torture them before we use them as a food source by keeping them in deplorable conditions on farms. We excessively milk the female cows, diminish their health, and keep them in unsafe and stressful environments leading to suffering and occasionally premature death. There are serious repercussions to our actions, but there are ways to adjust our practices so that the cows and us have a mutually beneficial relationship.

Animal Welfare: Spread of Disease

Beef, milk and other dairy products, including cheese, ice cream and yogurt are a staple in the diet of many Americans. Production of these items starts on dairy farms where farmers must milk thousands of cows to supply American demand. Big corporations no longer look to small farmers for their supplies, and cow farms have become widely monopolized as companies have shifted to manufacturing their own farms to produce dairy. Dean Foods, a supplier for Walmart, recently cut ties with the small farmers who provided for them and instead manufactured its own farm to produce all its goods without outsourcing from other locations. This put small farms, who on average would have 80 cows to look after, out of business and replaced them with super farms that hold 900 cows at

any given time. Between 2000 and 2018, "more than 42,000 dairy farmers...have gone out of business…[they are] casualties of an outdated business model, pricey farm loans and pressures from corporate agriculture."[109] Figure 11 is a graph from NBC News that illustrates the decreasing number of dairy farms correlated with an increase in the amount of cows per farm.[110] The added pressures on smaller local farmers allows these bigger corporations to dominate the industry and use their distasteful practices to run their farms.



Small dairy farms are rapidly disappearing. (The dotted line shows years with missing data for U.S. dairy farms.)

As a result, complications arise because of the potential for widespread disease and mistreatment of the animals on larger farms. With 80 cows, managing space, waste, and disease is less complicated; however, with 900 cows, conditions can become detrimental to the health of the herd, as it is an arduous task for veterinarians to ensure the health of each cow. Disease is dangerous to battle on farms due to many bovine diseases having long incubation periods, causing little early detection. The close proximity with which these animals are kept additionally facilitates the spread of infection. Diseases like Bovine Leukemia Virus, Bovine Immunodeficiency Virus and Johne's disease can run rampant in large herds. Bovine Leukemia virus affects an estimated "44% of dairy

[109] "'Sell out as Fast as You Can': The Death of America's Family-run Dairy Industry," NBCNews.com, 2018, https://www.nbcnews.com/news/us-news/best-advice-u-s-dairy-farmers-sell-out-fast-you-n887941.
[110] Figure 11 Ibid.

cattle and 10% of beef cattle" in the United States.[111] Bovine immunodeficiency virus causes cattle to have a lower immune response, making them susceptible to other potentially life threatening diseases.[112] Johne's disease is a contagious infection that targets the intestines, gradually weakening the cow and can ultimately lead to death. These are just a few of the various diseases that can plague a farm, reeking havoc on life and productivity.

The spread of disease occurs specifically in places with high populations of cows in limited amounts of space where transmission is easily facilitated. An example of this type of atmosphere are feedlots. Feedlots are plots of land on which livestock are fattened for market. The farmers feed cows high grain, high energy diets which alone have detrimental effects to the health of the cows. Thousands of cows from different farm locations are brought to feedlots, where they are exposed to disastrous weather conditions, poor diets, and a variety of diseases.[113]

Why is it important for farmers to try and manage disease? It becomes mutually beneficial for farmers and cows to avoid poor health. Infectious disease can have a pernicious effect on productivity and profit. If cows are suffering from widespread disease, farmers in turn suffer from loss of assets. If the United States takes the forefront in sanitary farm locations, we solidify our spot in domestic and foreign markets. Management of the spread of infectious disease entails improving the conditions on these large factory farms. With more than 900 cows in confined areas, who are not able to be assessed by veterinarians consistently, the risk of disease is iminent. It is important for farmers to take precautions like vaccinating their cows, keeping them in low risk locations, and

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[111] University News Release, "Bovine Leukemia Virus Control," AgWeb, December 16, 2014, https://www.agweb.com/article/bovine-leukemia-virus-control-university-news-release/.
[112] Sandeep Bhatia, et al. "Bovine Immunodeficiency Virus: A Lentiviral Infection," *Indian Journal of Virology*, December 24, 2012-September 27, 2013. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3832697/.
[113] G. D. Snowder, et al. "Bovine Respiratory Disease in Feedlot Cattle: Environmental, Genetic, and Economic Factors," *Journal of Animal Science* 84, no. 8 (August 2006): 1999-2008. https://academic.oup.com/jas/article/84/8/1999/4777251.

providing them with comfortable, sustainable living environments. The Bovine Alliance on Management and Nutrition offer a number of solutions for protecting biosecurity. “Biosecurity and biocontainment... are programs for infectious disease control that reduce/prevent the introduction of new diseases onto an operation from outside sources and reduce/prevent the movement of infectious diseases on the operation.”[114] Precautions can be taken at every step of the process when caring for a cattle farm. Before cows are ever introduced to a location, they should be thoroughly checked for possible disease that could spread then quarantined before integrating them with the rest of the herd. Ensuring each of the cows is up to date with its vaccinations and ensuring that any sperm or egg embryos purchased are from reliable sources. Removing generally useless practices like dehorning and using safe and sterile medical materials for each legitimate procedures. In addition, farmers could adjust the cows diets from high energy feeds to grass feeds, the diet that their digestive systems were built for.[115] Lastly, all of these practices can be difficult to instill on excessively large farms, so downsizing may be beneficial while attempting to limit disease. It is of the utmost importance that farmers take all precautions necessary to avoid disease on their farm for the best possible outcome, profitability and overall health of the herd.

Animal Mistreatment

The United States is not notorious for it’s reputable farm animal welfare. In fact, more recently farms have come under scrutiny for their mistreatment of animals, and consumers are becoming more willing to pay for higher quality treatment of the animals.[116] Conditions that cows suffer from are now being seen as inhumane, as it is deemed as torturous for the animals. Female

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[114] “Biosecurity and Control of Infectious Disease Outbreaks," *An Introduction to Infectious Disease Control on Farms (Biosecurity)*, 2014, doi:10.1016/b978-1-4557-0891-8.00062-2.
[115] Ibid.
[116] Christopher A. Wolf, et al. "Cow Welfare in the U.S. Dairy Industry: Willingness-to-Pay and Willingness-to-Supply," *Journal of Agricultural and Resource Economics*, 2017, 164-79, https://ageconsearch.umn.edu/record/257996/.

cows are used for dairy production. In order to produce milk, the cows need to be impregnated, a disadvantage of this is excessive breeding. Over breeding cows is correlated with a negative effect to the health and fertility of these cows as certain health defects can be seen in the new borns.[117] Mastitis is the inflammation of the mammary gland and udder tissue and is a major endemic disease of dairy cattle. Milk-secreting tissues and various ducts throughout the udder can be damaged by bacterial toxins and sometimes permanent damage to the udder occurs. This in turn means that milk production would be lowered due to damage to the mammary glands. In addition, as soon as the cows deliver their calves, they are removed from them, ending the mother-child relationship before it had a chance to begin. The female cows are milked endlessly, and are constantly being impregnated to continue their lactation, resulting in a tireless and stressful existence of solely being used for human consumption. After they have served their purpose of producing dairy, they are sent to slaughter. For male cows, their life is no more glamorous. They are bred and born simply for meat, as they cannot produce milk like female cows. They are either sent to a veal farm fairly quickly or are raised on feedlots and then slaughtered for other beef sales.[118]

In the United States, there are over 9 million dairy cows being used for consumerism.[119] Many of them are not fed with a regular grass fed diet, but rather a diet that is high in energy enabling them to produce higher quantities of milk. On average, a high energy fed cow will produce 100 pounds of milk each day, but this diet and production is not sustainable for the cows. They can often develop disorders like ketosis or laminitis which could lead to the cow becoming lame or even dying. We continue to feed them these high energy feeds to sustain human demand, but it comes at

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[117] Windig, J. J., M.P.L. Calus, and R. F. Veerkamp, "Influence of Herd Environment on Health and Fertility and Their Relationship with Milk Production." *Journal of Dairy Science* 88, no. 1 (January 2005): 335-47, Accessed April 13, 2019. https://www.sciencedirect.com/science/article/pii/S002203020572693X.
[118] MSCPA,"Farm Animal Welfare: Cows • MSPCA-Angell," MSPCA, 2018, https://www.mspca.org/animal_protection/farm-animal-welfare-cows/.
[119] Ibid.

the price of the wellbeing of our cows and possibly tarnishes our food source. These high-energy feeds often contain agricultural chemicals, which can manifest itself in the tissue of the cows. Cows stomachs are built for grass fed diets, so when their digestive systems are introduced to the high energy chemically altered foods, it gives way for a digestive complications.[120]

What we as consumers must consider is; what is the superior way to care for our animals so that we maintain a mutually beneficial relationship? As of now, our practices are fairly selfish. We allow these farm conditions to persist on the contingency that we are supplied the amount of dairy and beef we want, but do not necessarily need. If we reduce our intake of dairy and beef, then a domino effect of positivity may be seen. A lower demand for milk allows farmers to decrease the amount of cows they keep, lowering the risk for widespread disease. It is easier to manage the health of the herd when there are less cows to observe, and disease transmittance is reduced if they are further spread apart on the land. Implementing biosecurity programs on these farms will further eliminate the risk of infectious disease and increase production. Diseases like mastitis and milk fever will dissipate as farmers will not need to excessively milk their cows. Farmers can also allow cows to return to their normal grass fed diets, promoting overall health for the cows.

The well being of cows is an environmental issue. During a cows life, they may be subjected to numerous painful and stressful events used to manipulate the cows for our consumption. However, it is our duty as the human race to not abuse our power in a way that negatively affects our prey. Decreasing our consumption, and altering the way we raise our dairy and beef cattle can positively impact the lives of cows who are as of now strictly considered as a commodity for human consumption. They are animals who suffer from pain, stress and disease just as we do. To alleviate

[120] MSCPA, *Farm Animal Welfare*.

that in anyway that we can by adjusting our practices does not only means an increase in productivity for humans, but a higher quality of life for the cows.

CONCLUSION

We at the Moo-vement believe that the evidence to change how humanity goes about cow agriculture shows costs outweigh the benefits and calls for a change to the industry. The costs of cow agriculture are increasing exponentially as the population rises. For the sake of humanity's health, reducing cow agriculture would improve living conditions for the future. By reducing cow agriculture we also reduce deforestation, water use, methane and carbon emissions to the atmosphere and the health of the general population by changing to a healthier diet. It is imperative to start portioning daily intake by cutting out the majority of meat intake, specifically red meat such as beef in order to decrease risk of cancer, diabetes and heart disease.

Moreover, eliminating all meat intake is not as dangerous as many people think since there are supplemental sources of protein and calcium in other foods like legumes, nuts and leafy greens. The sources of healthy alternatives are plentiful with a vast range of farmland to consume where cows once stood. Another solution is to produce lab grown meat, which not only eliminates the need for cattle farming, but of almost the whole animal agriculture industry. Economically, reducing the cow industry through any of our solutions would help solve world hunger and create a higher average revenue per cow. This would make the industry more profitable off of fewer cows while lowering the cost to feed them with bountiful crop harvests each year. We believe this is a win-win scenario for both change and the industry. Furthermore, the economical benefits of reducing the industry would have a positive impact on the economy. For example, if the U.S decided to export more crops it would reduce the annual trade deficit.

Animal welfare is a concern for the industry currently. Due to poor conditions, disease spreads like locus through cow farms which ultimately end up affecting humans. For the current industry, biosecurity programs need to be enforced on farms to limit the spread of disease which threatens profitability. Additionally, reducing the size of farms ensures the cattles safety is handled with better care. Smaller farms also allow farmers purchase feed their cows can stomach creating a healthier cow and therefore a more profitable cow. There is a growing need for change every day. Mankind needs to find a solution to cow agriculture before nature takes us out of the equation and fixes itself.

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