THE COW IN THE ROOM: REGULATING THE ENVIRONMENTAL HARMS OF INDUSTRIAL ANIMAL AGRICULTURE

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CHAPTER ONE: INTRODUCTION

“Human beings and the natural world are on a collision course. Human activities inflict harsh and often irreversible damage on the environment and on critical resources. If not checked, many of our current practices put at serious risk the future that we wish for human society and the plant and animal kingdoms, and may so alter the living world that it will be unable to sustain life in the manner that we know. Fundamental changes are urgent if we are to avoid the collision our present course will bring about”

(“1992 World Scientists’ Warning”)

In 1992, 1700 of the world’s leading scientists penned and signed the infamous Warning to Humanity, calling for global citizens and leaders alike to take action to save the dying planet. This letter will appear throughout this thesis because more than two decades later, their warning rings even more pertinent. There is overwhelming scientific evidence that the earth is in a state of distress and, unfortunately policy has not risen to match it. Temperatures are rising to unprecedented levels, creating the adverse effects of climate change. Natural resources are being exploited at unsustainable levels, and the carrying capacity of the biosphere is being expended beyond repair. Meanwhile, the human population continues to boom while the ecosystem we depend on deteriorates. The greatest destruction to biological communities has occurred over the last 150 years; a time period characterized by rapid human population growth. During this time, the human population has exploded from 1 billion people to the current 7 billion. Each of those 7 billion humans needs to eat (Dessler).

Of all consumer products in the United States, food has the single largest carbon footprint (Hillman et al.). The lifecycle of food\(^1\) has intensified on every level. Agriculture has intensified immensely, requiring fossil fuels for farm machinery, petroleum-based fertilizers, massive fleets for transport, millions of belching ruminants,

\(^1\) The lifecycle for food typically includes agricultural production, processing and packaging, transportation, retail, use, and waste disposal (“Scientific Report”).
intensive processing, transport to grocery stores, storage, cooking, and disposal— all of it adding to the human population’s exponentially growing ecological footprint with every meal.

Due to rising incomes and urbanization, diets around the globe are transitioning away from traditional norms, and meat consumption is skyrocketing. Between 1980 and 2002, global meat consumption has more than tripled (“Livestock’s Long Shadow”). In the meantime, the world is experiencing the highest temperatures ever recorded, widespread deforestation, and the sixth mass extinction episode (Fox). While there are several factors that contribute to this widespread environmental degradation (like fossil fuel combustion for energy and transportation), diets play a substantial but largely unacknowledged role.

But not all diets are created equal. A recent study conducted by the Audubon Society reported that the earth could sustain 10 billion people who eat as the citizens of India do, but only 2.5 billion people eating as Americans do. Attempting to feed the world on an American diet would require “more grain than the world can grow and more energy, water, and land than the world can supply” (Riebel and Jacobsen). The fundamental difference between these two diets comes down to a single element: meat.

Feeding and raising the 1.37 billion cattle (Velten) in the world to be consumed as meat generates a plethora of environmental disasters that seep into the microcosms of the Earth’s oceans, lands, and atmosphere. According to the World Bank, global animal agriculture is responsible for 91% of Amazon destruction (Margulis). The EPA, Food and Agriculture Organization of the UN, and Worldwatch have all declared animal

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2 Chapter Three will provide a side by side comparison between plant-based and carnivorous diets to highlight the gaping contrast of their environmental impacts.
agriculture as the leading cause of global species extinction, ocean deadzones, water pollution, and habitat destruction (“What Is a Dead Zone?”). In the United States, agriculture is responsible for up to 90% of fresh water consumption with livestock consuming 50% of that, approximately 55% of erosion, 37% of pesticide use, 50% of antibiotic use, and 33% of nitrogen and phosphorus loadings that pollute freshwater resources (“Irrigation”) (“Livestock’s Long Shadow”). Agriculture is listed as the principal habitat threat affecting endangered species in the U.S, with livestock grazing specifically accounting for 22% of habitat destruction (Primack).

Beyond what the eye can see, industrial animal agriculture accounts for a substantial amount of global and national greenhouse gas emissions. Different analyses report that livestock are responsible for between 18% and 51% of annual worldwide greenhouse gas emissions (Goodland and Anhang). Raising livestock is the most significant contributor of anthropogenic methane emissions, and is responsible for a striking 84% of global nitrous oxide emissions (Smith et al.). Both of these greenhouse gases are extremely dangerous in the context of climate change, as methane has a global warming potential roughly 21 times more powerful than carbon dioxide, and nitrous oxide is about 296 times more powerful than carbon dioxide (“Livestock’s Long Shadow”). Despite these alarming numbers, the global warming policy focus is centered on combatting emissions from energy and transportation sectors. Meanwhile, livestock remain in the background unnoticed by policymakers, rapidly clouding the atmosphere and destroying the surrounding biomes and beyond.

The year 2015 was the hottest year ever recorded, and fittingly, it was also the year of the highly-anticipated United Nations Paris Climate Agreement. It was the 21st
Convention of the Parities of the United Nations Framework Convention on Climate Change, and tens of thousands of people, including 150 official heads of state, delegates, NGOs, activists, scientists, and concerned citizens gathered outside Paris to create and sign an international political agreement to combat climate change. The conference resulted in a universal consensus that warming must be kept 2 degrees Celsius below pre-industrial temperatures, with the goal of eventually keeping levels below 1.5 degrees Celsius. Now each of the 195 signing nations must follow through with their commitments and start reducing their global greenhouse gas emissions, more of which will be examined and discussed in Chapter Seven.

In the Paris Agreement, the United States committed to reducing its greenhouse gas emissions by 26-28% below 2005 levels by 2025, with a goal of economy-wide emission reductions of 80% or more by 2050 (“US INDC”).

![The US Emissions Target Graph (“US INDC”)](image)

The US plans to use existing legislation to achieve these targets, which includes previously-adopted measures regarding reductions in transportation and energy sectors.
Authority has also been delegated to the US Environmental Protection Agency (EPA) to develop standards to address methane emissions from landfills and the oil and gas sector (“US INDC”). However, largely missing from the United States emissions reduction commitment is anything related to agriculture. The same is true of the majority of other countries. As this thesis will reiterate, this is a missed opportunity for easy and large emissions reductions.

To gain an understanding of the breadth of the problem, Chapter Two follows the history of agriculture in the United States, exploring the policy-facilitated transition from small-scale farms to industrialized agriculture and rapidly growing numbers of livestock. This chapter shows the ways in which policy and legislation have guided American agriculture; creating the system we have today. In Chapter Three, the extensive environmental impacts that Confined Animal Feedlot Operations (CAFOs) and industrial animal agriculture create will be analyzed. The first part of this chapter focuses on the inefficiencies of producing animal vs. plant-based foods\(^3\), comparing factors like water consumption and land use. The subsequent sections discuss pollution, habitat destruction, and species extinction, highlighting how these environmental degradations can be traced back to the animal agriculture industry. Chapter Four will expand on the most significant harbinger of environmental consequence-- greenhouse gas emissions. The focal point of this analysis will be livestock as the largest source of global anthropogenic methane emissions, and their strikingly large carbon footprint. Different types of greenhouse gasses will be analyzed and the science behind their effects in the atmosphere will be

\(^3\) This thesis will frequently refer to plant-based foods or diets. A plant-based diet is synonymous with a vegan (absolutely no animal products) or vegetarian (no meat) diet, and consists of foods like fruits, vegetables, grains, legumes, etc.
explained. This chapter also provides a comprehensive look at the entire emissions portfolio of the United States and shows how industrial animal agriculture fits into it.

Chapter Five will take an in-depth look at climate scientists’ recommendations for addressing global warming. The science behind greenhouse gas limits, radiative forcing, and committed warming will be explained in order to build an understanding of why greenhouse gas reductions are necessary, and how immediate methane reductions, including reductions from livestock, are highly beneficial at this point.

Following the hard science will be a discussion of the policy it has shaped. Chapter Six explains the politics behind climate change limits, examining past global climate agreements and providing a firsthand analysis of the results and implications of the most recent United Nations climate summit, the 21st Convention of Parties (COP21). Chapter Seven looks specifically at the Intended Nationally Determined Contribution (INDC) the United States submitted at COP21, and analyzes the text from the Agreement to show why animal agriculture must be addressed and controlled. Chapter Eight delves into the existing world of policy, outlining current standards and subsidies that are perpetuating the massive problems created by industrial animal agriculture, and what tools are present that may be used to curb the detrimental externalities. Finally, Chapter Nine provides a myriad of policy recommendations, suggestions, and outlets to create top-down change in a sector that has gone unchecked for too long. Concluding remarks will leave the reader with a lasting impression on the widespread effects of this industry but with tangible solutions for addressing the problem.

If the world and the United States are serious about keeping anthropogenic warming below catastrophic levels, animal agriculture can no longer be ignored. While
meat may currently serve as a significant food source, its cultivation from start to finish is
destructive, inefficient, and unsustainable. It is time that the ramifications associated with
meat-based diets and industrial animal agriculture be addressed and controlled.

This thesis seeks to present the comprehensive ecological impacts and carbon
footprint of industrial animal agriculture within the United States and pose solutions to
the associated environmental degradation. Specifically, it provides a comprehensive
analysis of the greenhouse gas footprint from animal agriculture, as well as an
explanation for why this industry needs to be included in emissions reductions efforts.
Because methane is a short-lived greenhouse gas, the nation could make drastic
reductions in warming contributions by focusing on this sector, and it may have to rely on
these reductions if we reach a dangerous temperature threshold. Furthermore it certainly
will have to make these reductions if we are to achieve a 1.5 degree Celsius warming
limit. If the US is to comply with the 2015 Paris Agreement, it must make economy-wide
greenhouse gas reductions and include animal agriculture in its emissions reductions
efforts.

The scope of this thesis is so large because I believe it is critical to not only hold
this industry accountable for their carbon footprint, but for all of the harmful ecological
impacts it creates. The negative externalities of the industry are so widespread that all of
the effects must be well understood in order for policymakers to first realize they need to
control the industry, then for proposed policy to comprehensively address the magnificent
problem. Addressing the entire ecological footprint provides more policy vehicles and
creates space to reduce both tangible environmental impacts, as well as greenhouse gas
emissions. It is understood that policy aimed at reducing greenhouse gas emissions from
this sector will indirectly reduce other negative environmental impacts. In turn, policies aimed at controlling the adverse ecological impacts of livestock will indirectly reduce greenhouse gas emissions. However, the goal of this thesis and policy should not be simply create technological band-aids to cover up the symptoms of the industry. The root cause must be addressed: the industry’s actual existence. As will be demonstrated in upcoming chapters, the United States is obligated to facilitate a dramatic shift to sustainable agriculture. The Union of Concerned Scientists, who penned the Letter to Humanity, explained sustainable agriculture as follows:

“Sustainable agriculture views a farm as a kind of ecosystem- an ‘agroecosystem’- made up of elements like soil, plants, insects, and animals. These elements can be enriched and adjusted to solve problems and maximize yields. This integrated approach is both practical and scientific: it relies on modern knowledge about the interactions within natural systems, as well as cutting edge technologies, to achieve its results. It is a powerful approach that can produce high yields and profits while protecting human health, animal health, and the environment” (Angelo).

As will soon be explained in Chapter Two, the United States government has been guiding and shaping agriculture for centuries. It is time to reevaluate policies and practices, and bring an end to unsustainable and ecologically damaging agriculture. Policy should be driven by this underlying goal of transitioning our current resource intensive, environmentally destructive, and inefficient food system to a sustainable food

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4 By definition, sustainability is the desire to meet the current needs of society while still preserving sufficient resources for future generations to meet their needs (Angelo)
production system. If the globe is to persevere in a state that can sustain human, animal, and plant life, the ruthless meat industry must be butchered.
CHAPTER TWO: A BRIEF HISTORY OF AMERICAN AGRICULTURE

In order to improve the system in place today, understanding the evolution of the animal agriculture industry is critical. This chapter is mainly focused on historical events and policy responses that created the current American agricultural production system.

Thousands of years ago, humans transitioned from a hunter-gatherer society to one based upon settled farming. People domesticated animals and kept them in close proximity for food, fiber, and labor (Rifkin). This shift forever altered the course of human development and the environment.

Fast forward several centuries to the boom of the American cattle industry in the late 1870s. Ranchers and investors joined forces to create the foundation of what is now an extremely powerful and wealthy industry (Velten). Two key technological developments led to their success: barbed wire and refrigeration. Before the invention of barbed wire, open grazing was the primary form of raising cattle. With the development of this simple but effective fencing mechanism, ranchers began to claim and confine their land granted by the Homestead Act of 1862, which would serve the primary purpose of supporting their cattle (Wilkinson). Meanwhile, international demand for beef grew as every transcontinental steamship was newly equipped with refrigeration technology. This allowed meat to travel across North America and all the way to Europe in perfect condition (Velten). With the passing of the 19th century, the demand for meat continued to increase. Ranchers sought to utilize the Great Plains that served as habitat for wild bison and other native animals for cattle production. And utilize they did. Between 1800 and 1950, nearly 98% of North America’s tallgrass prairie was converted to farmland (Primack).
This rapid and unchecked expansion was not without consequence. Throughout the Midwest, the ground had become heavily ravaged by cattle, sheep, and sod-busting farmers (Wilkinson). When the Dust Bowl engulfed the 1930s and swept away the valuable soil, the government finally established a Grazing Service through the Department of Interior (DOI) to regulate all grazing on federal lands. Congress enacted the Taylor Grazing Act (Taylor Act), establishing 80 million acres of land to be administered by the Grazing Service and DOI (Wilkinson). The Taylor Act set a critical precedent in establishing the high priority role of grazing in the United States. Powerful Western stock interests who heavily influenced the Taylor Act demanded no grazing fees. The program was therefore intentionally completely underfunded, excluding the possibility of any on-the-ground management or enforcement, making regulation virtually impossible. A second significant precedent set by the Taylor Act was its definition of the term range as “land dedicated to domestic stock”. This definition declared outright that these public lands were primarily for livestock, and ignoring the native deer, trout, ducks, raccoons, and other species that naturally inhabited the biome (Wilkinson). The final precedent of significance set by the Taylor Grazing Act occurred in determining land distribution. When allocating herbage on federally leased land, the Bureau of Land Management set aside 97% of herbage for livestock, and the mere 3% remaining was allocated to wildlife (Rifkin). Beyond the disregard for the surrounding ecology, the Taylor Act perpetuated and legitimized the notion of public land being controlled by private interests, thus increasing the meat industry’s power and setting it on an authoritative pedestal for years to come.
Since the 1930s, the federal government has continued guiding agricultural practices in efforts to feed a growing population and stabilize the economy: “the combination of the Great Depression and the Dust Bowl era of the 1930s led to the first significant economic intervention by the government into what previously had been a relatively free agricultural marketplace. Initially, government intervention was aimed at stabilizing prices by limiting production to limit supply” (Angelo). The stabilization mechanism of choice was to subsidize commodity crops through the Agricultural Adjustment Acts of 1933 and 1938, “which continue to serve as the foundation for the current commodity price and income support programs” (Angelo). These subsidies limited the amount of land farmers were allowed to produce on, thus controlling the amount of crops headed to market and keeping prices high. This policy did not change until the Nixon Administration of 1973 when the new Secretary of the Department of Agriculture, Earl Butz, changed policy dramatically by “encouraging farmers to grow the maximum amount of possible of commodity crops… thereby incentivizing the maximum production”(Angelo). This sudden shift was driven by a multitude of factors, but mainly because of a severe grain production failure in the Soviet Union, threatening their food supply and own cattle production. In the summer of 1972, the Soviets made trade deals worth more than $7.6 billion in today’s dollars with the five biggest American grain companies (Ganzel). This deal came at a time of niche policy window, as President Nixon administration sought reelection and found it favorable to bolster US farm incomes (Ganzel). Nixon delegated this task to Butz, who became the driving force behind this boom in production:
“In 1973, he reduced the number of acres ‘set aside’ – or taken out of grain production – from 25 million acres in 1972 to 7.4 million acres in ‘73. He went on a speaking tour and encouraged farmers to ‘plant fence row to fence row’ to meet global demand. He also advised farmers to ‘get big or get out… adapt or die,’ in the belief that bigger farms were more productive.” (Ganzel)

This drastic shift in industrialization of agriculture was enabled by The Green Revolution that began in the 1940s and progressed through the 1960s as technological innovations replaced human labor, and fossil fuels drove the food production processes (Angelo). Mechanization led to increased yields of commodity crops, and production skyrocketed. The government began subsidizing farms to grow the maximum amount of crops possible, incentivizing this intensive and destructive process and putting family farms and traditional practices out of production (Angelo). Farmers would benefit by “substituting the heavily subsidized commodity crops for their previous variety of vegetable crops and grazing lands” (Angelo). This policy shift created a self-perpetuating cycle known as a feedback loop, and agricultural researchers set out to develop techniques and technology that would further maximize the per-acre yield of corn and other crops to maximize profit (Angelo).

Couple the powerful cattle industry and the dramatic increase in animal feed availability, and the American livestock sector flourished. Food production skyrocketed as crop agriculture continued to increase yields, and the distribution and production of livestock changed completely. Traditionally, raising livestock was dependent upon locally available feed resources. However, with the ease of transport and the
specialization of agriculture, the co-dependents decoupled and the result is the current Confined Animal Feedlot Operations system in place today. Confined Animal Feedlot Operations, or CAFOs, are large concentrated areas that contain a certain amount of animals being raised for slaughter. The national standards for amounts of animals that constitute a CAFO are 1,000 head of beef cattle, 2,500 swine, or 125,000 broiler chickens according to the USDA Natural Resources Conservation Service (“Animal Feeding Operations”). In the United States, alone, there are approximately 450,000 CAFOs. This translates to half of the 48 contiguous states being devoted to animal agriculture for grazing, growing feed, and confining animals (Glaser et al.). Powerful companies utilize this half of the country, raising approximately 9 million dairy cows, 90 million cattle, 67 million pigs, 9 million sheep and goats, and 9 million poultry birds annually for slaughter (“A Closer Look”) (“Pork Facts”). Worldwide, more than 6 million animals are slaughtered every hour for consumption, with 70 billion animals raised for slaughter annually (“Factory Farms”).

These staggering numbers are a product of vertical integration and industrialization of agriculture. Between 1935 and 2002, the total number of farms in the United States declined by 70%, while the total acreage of farmland remained the same. This is a result of larger farms buying out family farms (Angelo). Factory farms are the primary method of production as agribusiness continues to vertically integrate. Currently, the poultry industry is 98% vertically integrated, which means that almost all poultry produced in the country is bred, owned, butchered, and marketed by a handful of corporations (Verheu). In 1998, only four companies accounted for 87% of beef output in the entire country (Verheu). By increasing the scale of their operation, there is greater
efficiency of production and cost of output declines ("Economies of Scale"). These high concentration operations, or economies of scale, make the cost of production, and thus, price to consume, cheaper. However, as will be explained in Chapter Eight, much of this production is heavily subsidized. Therefore, these cheap prices do not reflect the true costs of production.

If current global consumption of meat and dairy products continues, the amount of total meat demanded in 2030 will be 72% higher than 2000 levels (Sall). As previously stated in the introduction, it was found that 7.5 billion more people could be fed on a mostly vegan\(^5\) diet rather than a heavily carnivorous one. Simply put, this rise in demand and consumption is completely unsustainable given future population projections. Therefore, environmental regulation and policymakers can no longer ignore this powerful industry and inefficient food production system.

\(^5\) Recall from Chapter One that a vegan diet contains no animal products, omitting not only meat, but all dairy as well.
CHAPTER THREE: ENVIRONMENTAL IMPACTS OF INDUSTRIAL ANIMAL AGRICULTURE

“Our massive tampering with the world’s interdependent web of life—coupled with the environmental damage inflicted by deforestation, species loss, and climate change—could trigger widespread adverse effects, including unpredictable collapses of critical biological systems whose interactions and dynamics we only imperfectly understand” (“1992 World Scientists’ Warning”)

Only upon a sound scientific foundation can proper change be enacted. In order to create effective targeted policy, the impacts of industrial animal agriculture must be thoroughly understood. This chapter highlights the links between industrial animal agriculture and widespread environmental degradation. Issues of inefficiency, water consumption, land use, desertification, pollution, habitat destruction, and species extinction will be examined as they can be traced back to this one powerful industry.

SECTION 1: INEFFICIENCY IN ANIMAL PROTEIN PRODUCTION

Despite its low cost and prevalence as America’s seemingly favorite source of protein, meat is an incredibly inefficient form of nutrition and caloric intake. The basis of this inefficiency stems from basic biological principles of energy conversion through trophic levels. Ecologists call the percentage of energy transferred from one trophic level to the next ecological efficiency, or food chain efficiency:

“Many studies of ecological efficiencies have led to the generalization that 10% of energy is passed from one trophic level to another… A simple and surprising consequence of this 10% rule of thumb is that only 1% of the total energy assimilated by primary producers ends up as production on the third trophic level. Very little energy is available
to support consumers at even higher trophic levels. Thus, the pyramid of energy narrows very quickly as one climbs from one trophic level to the next. These observations suggest that humans, who already command such a large proportion of the earth’s total primary production, can increase their food supplies primarily by eating lower on the food chain.” (Ricklefs)

This means that humans only receive 1% of the energy produced by the plants grown for cattle. For efficiency’s sake, the middle trophic level can be bypassed by eating more plant products and fewer animal products.

Beyond basic biological governance, another major inefficiency stems from the decoupling of where the livestock feed is grown, and where the animals are fed. Animal agriculture used to work in a symbiotic relationship, with the animals’ waste fertilizing the ground from which they were fed. Under the current industrialized system, CAFOs are typically hundreds, if not thousands, of miles away from the farms that grow their food. Without the manure once used to nourish the land, feed crop farms require massive amounts of commercial fertilizers as they are unable to recycle nutrients back to the land (Magdoff and Tokar). Transitively, producing beef requires large amounts of fertilizer, largely because it takes so much feed to sustain cattle. In fact, about half of fertilizer applied in the US is applied to land used to grow feed grains for livestock (Jacobson). Not only is this fertilizer highly pollutive, its production is extremely energy intensive. The energy needed to manufacture that fertilizer could provide almost one year’s worth of power for 1 million Americans (Jacobson). Once all the fertilizers, forms of
transportation, and mechanical components of production are summed, it requires almost 1600 calories of fossil fuels to produce 100 calories of grain fed beef (Jacobson).

Of all the types of animal proteins (chicken, turkey, lamb, eggs), beef is the most inefficient. Producing one calorie of beef requires approximately 28 times as much land, 3-50 times as much water, and produces five times as much greenhouse gas as other animal proteins. A grown steer consumes about 1000 pounds of grain per month, as it takes 7 pounds of feed to add just 1 pound of weight to a feedlot cow (Jacobson). The waste produced by a cow includes over 50 pounds of urine and manure a day, which is typically left untreated in massive waste lagoons (Velten).

It is evident that beef is by far the least environmentally efficient food source in the animal category. But when compared to plants, the differences are even more stark. Evidence consistently shows that a diet “higher in plant-based foods, such as vegetables, fruits, whole grains, legumes, nuts, and seeds, and lower in animal-based foods is more health promoting and is associated with lesser environmental impact (GHG, emissions and energy, land, and water use)” (“Scientific Report”). Compared to food crops like potatoes, wheat, and rice, beef requires 160 times as much land for production, 8 times as much water, and 11 times the greenhouse gasses (Eshel et al.). Even compared to a processed food (pasta), beef creates 20 times the amount of land alteration, 17 times the water pollution from waste, and 5 times the toxic water pollution from chemicals (Riebel and Jacobsen). Also, it only requires 50 calories of fossil fuels to produce 100 calories of plant-based foods (compared to the 1600 needed to produce an equivalent amount of beef) (Jacobson). The following figure provides a visual representation of the gaping differences between animal products and plant-based products.
Units of land, water, and greenhouse gases from producing 100 calories of plant-based food:

Units of land, water, and greenhouse gases for producing 100 calories of beef:
According to the U.N. commissioned 2004 Millennium Ecosystem Assessment, 15 out of the 24 natural system that humans need for survival are currently being used unsustainably\(^6\), and it is estimated that Earth’s ability to sustainably support humanity was surpassed in the late 1980s (Reid et al.). On a planet with a growing human population and increasingly finite resources, these types of inefficiencies cannot persist. As will be explained in Chapter Seven, the United States must make strides to become more sustainable in consumption and production practices as obliged under the Paris Agreement, and these types of inefficiencies within the food production system will have to be controlled.

SECTION A1: INEFFICIENCIES: WATER CONSUMPTION

“Heedless exploitation of depletable ground water supplies endangers food production and other essential human systems. Heavy demands on the world’s surface waters have resulted in serious shortages in some 80 countries, containing 40 percent of the world’s population. Pollution of rivers, lakes, and groundwater further limits the supply” (“1992 World Scientists’ Warning”)

To sustain life on earth, fresh water is perhaps the most vital resource. Yet the planet is facing the drastic problem of freshwater depletion, with 64% of the world’s population expected to live in water-stressed areas by 2025 (“Livestock’s Long Shadow”). Not only are freshwater sources being depleted, they are also becoming increasingly degraded in their ability to support human, plant, and animal life. It is estimated that half of the world’s wetlands were lost in the 20th century due to

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\(^6\) These ecosystem services being degraded include capture fisheries, water supply, waste treatment and detoxification, water purification, natural hazard protection, regulation of air quality, regulation of regional and local climate, regulation of erosion, spiritual fulfillment, and aesthetic enjoyment. (Reid et al.)
conversion and destruction for agriculture and urbanization ("Livestock’s Long Shadow"). What remains of freshwater is in high demand for water intensive crops and products, as well as drinking water. The 2004 Millennium Ecosystem Assessment reports that the use of fresh water is “now well beyond levels that can be sustained at even current demands, much less future ones” (Reid et al.).

According to the United States Department of Agriculture, agriculture accounts for 80-90% of fresh water consumption in the nation ("How Much Water"). Irrigated land requires vast amounts of water, and demand increases at a rate of 2% per year to supply increased crop yields ("Livestock’s Long Shadow"). This rate of use is completely unsustainable and has dramatic consequences on already-strained water resources. As irrigation often takes place in the context of water scarcity, this wasteful practice is only expected to worsen as water competition increases whilst population grows and the climate changes ("Livestock’s Long Shadow").

In the United States, 50% of all fresh water goes to livestock (Riebel and Jacobsen). Cows and their feedstock are thirsty organisms, and it takes 4,500 gallons of water to produce a quarter pound of raw beef (Jacobson). Nearly half of the nation’s grain-fed cattle is raised in Midwestern and Western states that rely on a single underground aquifer, the Ogallala. It is one of the world’s largest underwater reserves, but farmers are now withdrawing more water from the aquifer each year than the annual flow of the Colorado River (with an unmatched recharge) (Rifkin). Currently, it is estimated that the reserve is already halfway gone in three states, and in less than 40 years the irrigated areas of the Great Plains will have shrunk by 30% (Rifkin).
Beyond the Ogallala, the state of California faced one of the worst droughts it has ever experienced in 2015. In this largely agricultural state, over 42% of irrigation water goes to produce feed grain or drinking water for cattle and other livestock, and geologists have shown that the state is actually sinking due to exploited water tables (Rifkin). Meanwhile, the California government focused its conservation policy efforts on its smaller water consumers, mandating restrictions for watering lawns and encouraging citizens to take shorter showers.

How is animal agriculture so water intensive? A major fraction of meat’s water footprint comes from growing feed for the animals. Irrigated agriculture accounts for the largest share of the nation’s water use, and comes with its own slew of environmental problems (“USDA ERS”). Most feed crops require enormous amounts of water and are typically grown in arid regions, meaning the irrigation systems depend on vast amounts of energy (almost exclusively fossil fuels) to pump, transport, and apply the water (Magdoff and Tokar). Once applied, much of this water goes to waste via evapotranspiration, the main mechanism by which crops and grasslands deplete water resources (“Livestock’s Long Shadow”).

Beyond feed, the animals themselves demand large amounts of water. In warmer temperatures, one cow will drink upwards of 30 gallons of water per day (“How Much Water”). Multiply that by the 90 million cattle in the United States for 2.7 billion gallons of freshwater consumed by cows in a single day. To paint a picture, the amount of water that goes into a single 1000 pound steer over its lifetime could float a destroyer (Rifkin). Unfortunately, the water cycle does not play a large part in replenishing the biosphere with this precious resource. Most of the water used in livestock production returns to the
earth in the form of manure and wastewater. Their excreta can cause severe
environmental harm, as they “contain a considerable amount of nutrients (nitrogen,
phosphorous, potassium), drug residues, heavy metals, and pathogens. If these get into
the water or accumulate in the soil, they can pose serious threats to the environment”
(“Livestock’s Long Shadow”). In CAFOs, the toxic waste typically sits in massive
lagoons that leach greenhouse gases and pose great environmental threats themselves,
further contributing to inefficiency within the current food production system.

When reading these arguments, one might attempt to justify the strikingly large
amounts of water use by declaring that the human population must eat, and meat is an
essential component in our diet. While meat has definitely become a center to the
American lifestyle, it is a non-essential food item (as all necessary nutrients can be
acquired through a plant-based diet (“Scientific Report”) and is statistically the least
efficient form of protein available. One study found that producing a single pound of
beef requires up to 15 times more water than producing an equivalent amount of plant
protein (Rifkin). Satiating America’s palate with plants could drastically improve water
tables and should become a vital role in water conservation efforts. Policymakers should
acknowledge these statistics and realize that shifting the American diet towards plants is
quite literally a low-hanging-fruit option when it comes to conserving water.
SECTION A2. INEFFICIENCIES: LAND USE

“Loss of soil productivity, which is causing extensive land abandonment, is a widespread by-product of current practices in agriculture and animal husbandry” (“1992 World Scientists’ Warning”).

Agricultural systems now occupy up to 45% of earth’s total land surface (Primack) (Thornton et al.) with livestock production accounting for 70% of that, thus making it the single largest anthropogenic user of land by far (“Livestock’s Long Shadow”). This vast amount of land use is the main contributor of global deforestation. In Latin America, 70% of once-forested land is now occupied by pastures and feed crops. In Central America, the area of the forest has been reduced by almost 40% over the past 40 years to accommodate a growing cattle population (Velten). Not only is animal agriculture occupying a substantial percentage of earth’s land, it is also degrading it. Over the past 50 years, almost 85% of the world’s agricultural land has degraded via erosion, salinization, compaction, nutrient depletion, biological degradation, and pollution (“Livestock’s Long Shadow”). About 20% of the world’s pastures, and 73% of rangelands in dry areas have been degraded to some extent from overgrazing, compaction, and erosion caused by livestock (“Livestock’s Long Shadow”).

In the United States, over 200 million acres of land are devoted to producing grains, oilseeds, and hay for livestock (Jacobson). Cultivating these crops requires about 180 million pounds of pesticides and 22 billion pounds of fertilizer per year (Jacobson). The massive demand for feed grains facilitated by federal crop-commodity subsidies has led to the modern problem of monoculture. Most farmers now either raise a single crop or use limited rotations, where two crops destined to become livestock feed are raised in alternative years (Jacobson). Corn is one of the most energy, water pesticide, and
fertilizer intensive crops grown in the United States (Angelo). It and soybeans are two of the primary crops raised in the US today, and both comprise the majority of feed given to livestock. About 59% of corn is rotated with soybeans, and 16% of corn is raised without any rotation at all (Jacobson). This creates the ecologically destructive phenomena known as monoculture.

While specializing and growing a single crop may appear efficient at first glance, it is actually highly ecologically destructive. With very little nutrition to replenish it, monoculture exhausts the soil, requiring farmers to use vast amounts of chemical fertilizers (Riebel and Jacobsen). Large stands of single crops also attract pests, and in response, growers must use more pesticides to protect their harvest (Riebel and Jacobsen). This type of intensive agriculture also negatively impacts diverse and critical wildlife habitats. Thus, wild fauna who once occupied the grasslands and prairies of the midwestern United States are mostly absent from these intensive croplands (“Livestock’s Long Shadow”). As seen by the precedents set in Chapter Two, ecosystem services and biodiversity are almost entirely ignored when it comes to land use in American food production and policy.

SECTION A3. INEFFICIENCIES: DESERTIFICATION

The effect of this widespread intensive land use is soil erosion and desertification. The chief characteristics of desertification are loss of topsoil through erosion and wind, salinization of surface water, and loss of native vegetation (Wilkinson). 200 years ago, most cropland in the United States contained about 21 inches of topsoil. It is now estimated that the country has lost nearly a third of its prime topsoil to overgrazing, overcropping, and deforestation, with only six inches of soil remaining in some areas of
the country (Rifkin). Depending on conditions, one single inch of topsoil takes between 200 and 1000 years to form naturally (Rifkin). This means that without natural topsoil and hundreds of years to spare, all of the vital nutrients required for productive farmland like nitrogen, phosphorous, and potassium, must be manufactured, shipped in, and applied as fertilizer (Magdoff and Tokar).

There is a theory that cattle can actually help promote growth and keep soil healthy by pruning plants and loosening turf if they are present in the right numbers and kept moving (Wilkinson). This theory is famously promoted by Allan Savory, who ranchers and cattlemen champion as the spokesman for intensive rotational grazing (IRG). Savory claims that IRG promotes plant growth and healthy soil, and results in net positive environmental benefits. However, the scientific journal Agricultural Systems disproved him: “The vast majority of experimental evidence does not support claims of enhanced ecological benefits in IRG compared to other grazing strategies, including the capacity to increase storage of soil organic carbon. IRG has been rigorously evaluated, primarily in the US, by numerous investigators at multiple locations and in a wide range of precipitation zones over a period of several decades. Collectively, these experimental results clearly indicate that IRG does not increase plant or animal production, or improve plant community composition, or benefit soil surface hydrology compared to other grazing strategies” (Monbiot). The International Journal of Biodiversity further disproved this theory, finding that livestock grazing in arid lands is more likely to destroy grass and vegetation than protect it: “Published comparisons of grazed and ungrazed lands in the western US have found that rested sites have larger and more dense grasses, fewer weedy
forbs and shrubs, higher biodiversity, higher productivity, less bare ground, and better water infiltration than nearby grazed sites” (Monbiot).

The Worldwatch Institute estimates that each pound of feedlot steak costs about 35 pounds of eroded topsoil (Rifkin), resulting in 10% of all land in the American West in a state of severe desertification due directly to overgrazing (Wilkinson). High concentrations of animals in delicate areas like stream banks, trails, watering points, and feeding sites causes compaction of wet soil and physically disrupts dry and exposed soils. The effects ripple downstream:

“Compacted and or impermeable soils can have decreased infiltration rates, and therefore increase volume and velocity of runoff. Soils loosened by livestock during the dry season are a source of sediments at the beginning of the new rainy season. In riparian areas, the destabilization of streambanks by livestock activities contributes locally to a high discharge of eroded material. Furthermore, livestock can overgraze vegetation, disrupting its role of trapping and stabilizing soil, and aggravating erosion and pollution.” (“Livestock’s Long Shadow”)

The costs of desertification are widespread. Primarily, there is the loss of ability for arid land to support life. The southwestern US is witnessing a severe reduction in plant populations, with a corresponding loss of biodiversity attributable to the large quantity of livestock in the region (“Livestock’s Long Shadow”). The loss of biodiversity is not only detrimental to the natural ecosystem, but creates negative implications for cattle and crops. Lack of biodiversity dramatically weakens a system’s resilience, therefore reinforcing desertification in a destructive feedback loop (“Livestock’s Long Shadow”).
Desertification also impacts vital water storage. This excerpt from Crossing the Next Meridian provides an illustrative example of the effects of cattle disruption:

“When cows beat down the stream banks and destroy the vegetation in the riparian zones, the creek’s flow is scoured out with soil and rocks. The scouring effect continued until the stream bottom cut down to bedrock. With no spongy soil to hold the water, the groundwater table was not recharged. The top aquifer declined, dropping below the reach of streamside trees. Valuable willows, whose root systems helped stabilize the soil, died out. The flow pattern rapidly changed. The snowmelt, much of which was once stored by the riparian zone, flushed down the rocky chute in a rush, leaving little or no flows for the dry mouths of summer and fall.” (Wilkinson)

This degradation is the result of poor management, and the ecological consequences of rearing livestock ripple well beyond the soil they trample upon. Beyond the physical degradation of the environment, the indirect and direct economic costs of soil erosion and runoff to farmlands, waterways, health, and infrastructure totals nearly $44 billion annually (Rifkin). Livestock’s overlooked land and water impact must be controlled.

SECTION B. WASTE POLLUTION

Runoff of pesticides, fertilizers, and waste from farms and feedlots is the nation’s largest source of water pollution (Riebel and Jacobsen). Over the past 40 years, “pollution has emerged as one of the most important drivers of ecosystem change in terrestrial, freshwater, and coastal ecosystems” (“Livestock’s Long Shadow”). Pollution, coupled with climate change, is wreaking havoc on biomes and leading to devastating
declines in biodiversity. Industrial animal agriculture is one of the leading causes of pollution because of its heavy use of pesticides, herbicides, fertilizers, antibiotics, and the sewage it creates.

As seen in this chart, agriculture is the primary freshwater polluter in the US ("National Water Quality")

When animals are kept in close proximity to the farms that produce their feed, manure fertilization is often used improperly as a waste diffusion strategy. When the primary function sought from manure application is as a cost-effective waste management strategy, crop farmers tend to apply manure at rates that are excessive in intensity and frequency and may also be timed improperly and exceeding the vegetation demand. Over-application is mainly driven by high transport and labor costs, which often
limit the use of manure as an organic fertilizer to the direct vicinity of industrialized livestock production systems. As a result, manure is applied in excess, leading to accumulation in the soil and water contamination through runoff or leaching ("Livestock’s Long Shadow").

However, most CAFOs do not witness this type of manure application because of the decoupling of farms. Due to the missing symbiotic relationship of animals fertilizing the lands where the crops are grown and loss of nutritious soil, 22 billion pounds of fertilizer are used to grow feed for American livestock every year (Jacobson). Through surface runoff and overland flow, fertilizer and other various chemicals applied to fields can contaminate freshwater resources as a source of nonpoint pollution. One study estimates that about 40-60% of nitrogen applied to crops is left in the soil or lost by leaching: “The leaching of nitrate from soils to water systems leads to increased concentrations in drinking water and contamination of ground and surface water systems, which threaten human health and natural ecosystems” ("Livestock’s Long Shadow").

When these fertilizers contaminate waterways, eutrophication occurs. Eutrophication creates thick blooms of algae so dense that they “shade out bottom-dwelling plant species needed as food by many fish and other aquatic animals” (Primack). As the bloom thickens, it condenses, sinks to the bottom, and dies. Bacteria and fungi then decompose the dying algae and consequently absorb all of the oxygen in the water. The result is plant and animal life dying off from lack of oxygen. These

7 As defined by the EPA, nonpoint source pollution generally results from land runoff, precipitation, atmospheric deposition, drainage, seepage or hydrologic modification. Nonpoint source (NPS) pollution, unlike pollution from industrial and sewage treatment plants, comes from many diffuse sources.
occurrences create “dead zones”, sometimes with fish visibly floating at the top of the surface (Primack). Other adverse effects of eutrophication include:

- Shifts in habitat characteristics contributing to change in mix of aquatic plants
- Replacement of desirable fish by less desirable species (and the associated economic losses)
- Production of toxins by certain algae
- Replacement of desirable fish by less desirable species (and the associated economic losses)
- Production of toxins by certain algae
- Increased operating expenses of public water supplies
- Infilling and clogging of irrigation canals
- Loss of recreational use opportunities
- Impediments to navigation due to dense weed growth (“Livestock’s Long Shadow”).

Livestock themselves produce vast amounts of waste, with 3.3 trillion pounds of manure produced annually from livestock alone (Jacobson), which is 13 times the amount of yearly waste produced by humans in this country (Riebel and Jacobsen). One analysis found that in the year 2007, all cattle, hogs, and chickens maintained in feedlots in the United States produced an estimated 20.3 million metric tons of nitrogen, 50% of which is lost as ammonia gas within 1-2 days after release (Magdoff and Tokar). When this waste is not properly managed, it is a devastating source of water pollution. It is not uncommon for excreta or wastewater from livestock to flow into streams through discharge, runoff, or overflow of lagoons (“Livestock’s Long Shadow”). One disaster in 1995 spilled 25 million gallons of hog waste, fouling over 22 miles of river (Riebel and Jacobsen). Instances like this lead to the previously described dead zones, degradation of coral reefs, human health problems, and antibiotic resistance (“Livestock’s Long Shadow”).
Shadow”). However, this type of pollution is not just a result of accidents, it is actually commonplace. Many deadzones are recurring, with the largest being in the Gulf of Mexico, where 1.7 million tons of phosphorus and nitrogen are dumped each year from agricultural runoff (“What Is a Dead Zone?”). The Mississippi River serves as a drainage path for 41% of the contiguous US, and flows through the heart of US agribusiness. Through groundwater flows and other contamination paths, fertilizer and nutrients flow into the river and are then dumped into the Gulf of Mexico causing this massive and devastating dead zone (“What Is a Dead Zone?”).

It is completely nonsensical that though cows and other animals raised for meat produce 13 times more waste than humans do in the United States, there is virtually no regulation or requirements for treatment. In fact, it is acceptable and commonplace for their waste to pollute the nation’s waters and create massive deadzones. I will discuss why and how the government must regulate and control this magnificent pollution problem.

SECTION C. HABITAT DESTRUCTION

Beyond the waters, the most important direct driver of terrestrial ecosystem change during the past 50 years is the alteration of land cover, particularly the conversions of ecosystems to agricultural land (Wirsenius et al.). Over 85% of all threatened species are affected by habitat destruction, fragmentation⁸, and degradation. These threats to biodiversity can all be traced back to large-scale agriculture. Over 70% of globally threatened birds are affected directly from intensive agricultural activities

⁸ When human activities or natural events divide a large, contiguous area of habitat into several smaller habitat patches, the habitat has been fragmented. This results in declines in species richness. (Ricklefs)
(“Livestock’s Long Shadow”), and about 37% of terrestrial ecoregions identified by the Worldwide Fund for Nature reported livestock as one of their current threats (“Livestock’s Long Shadow”). Along the same line, Conservation International reported that 23 out of 35 global biodiversity “hotspots” are adversely affected by livestock production (“Livestock’s Long Shadow”). Finally, an analysis by the World Conservation Union shows that the majority of Red List threatened species are suffering habitat loss where livestock are prevalent (“Livestock’s Long Shadow”). As previously mentioned, current practices have ravaged the existing land already in production, and meat production can only continue to grow if there is crop and pasture expansion, meaning it will continue to destroy any remaining natural habitat and extinguish biodiversity (“Livestock’s Long Shadow”).

Some ecosystems can naturally co-exist with agriculture; however intensified practices and monoculture have all but eradicated those relationships. Clear cutting, along with excessive use of fertilizers and pesticides, native flora and fauna are intentionally killed off to accommodate livestock, creating a trickle down effect that impairs the rest of the ecosystem from functioning properly. Rangelands have been heavily degraded as well due to mismatches in livestock density and capacity of the pasture to support grazing and trampling. This excessive pressure on dryland ecosystems “leads to fragmentation of herbaceous cover and an increase in bare soil” (“Livestock’s Long Shadow”). This destruction of vegetative cover not only leads to biodiversity loss, but enables terrestrial carbon release which fuels climate change.

Habitat is the most vital component to species survival, and the dramatic changes to the land to support livestock are destroying native habitats in devastating numbers.
Land-use change is listed as the leading cause of biodiversity loss, and with animal agriculture as the single largest anthropogenic user of land, the species-killing culprit is clear (“Livestock’s Long Shadow”).

SECTION D. SPECIES EXTINCTION

The planet is currently in the midst of the sixth mass extinction episode. What sets this era apart is that it is a predominantly human caused episode. Current extinction rates are 100-1000 times greater than natural background rates, and more than 99% of species gone extinct in modern times can be linked to human activity (Primack). Habitat destruction is one of the major contributors to species extinction, and as made clear in the previous paragraph, agriculture is one of the principal drivers of habitat destruction. There are nine major threats affecting endangered species in the US. Not surprisingly, agriculture comes in first place affecting 38% of endangered species, followed by commercial developments (35%), water projects (30%), outdoor recreation (27%), and livestock grazing in 5th place, affecting 22% of endangered species in the United States (Primack).

Livestock now account for roughly 20% of total terrestrial animal biomass, and occupy approximately 30% of land that was once habitat strictly for wildlife (“Livestock’s Long Shadow”). The three dimensions of biodiversity (genes, species, and ecosystems) are all interconnected, and when one dimension is impacted, the others will inevitably be impacted as well: “the disappearance of one species can break the balance between the different wildlife population species, which may in turn affect ecosystem functioning” (“Livestock’s Long Shadow”). As such, habitat destruction threatens genetic diversity by reducing the total area and carrying capacity of wildlife habitat, isolating
populations from one another, narrowing the genetic pool and making them more vulnerable to disappearance ("Livestock’s Long Shadow"). As previously discussed in Chapter One, livestock is the main driver of global deforestation, and one of the largest entities responsible for land degradation, pollution, climate change, overfishing, sedimentation of coastal areas, and invasion by alien species ("Livestock’s Long Shadow"). If the world is to avoid a biological collapse, the intensive animal agriculture sector must be reined in.

As previously stated, determining both the ecological and carbon footprints of this industry is vital to constructing comprehensive policy that addresses the root cause of the issue- the existence of the industry itself. This chapter sought to map the widespread ecological effects from industrial animal agriculture to show why the industry needs to be regulated, and the next chapter will be the greenhouse gas analysis of the industry.
CHAPTER FOUR: GREENHOUSE GASES FROM LIVESTOCK

About 16 kilometers above the Earth’s damaged surface exists a larger, invisible threat from livestock: greenhouse gases. Anthropogenic greenhouse gases are of utmost concern in society today, as they are the primary cause of global warming and climate change. Scientists have been issuing warnings about the implications of our unchecked emissions for several decades now, with policymakers and the public only finally starting to listen. This chapter will discuss three main greenhouse gases and their relation to the livestock sector of the United States and globally. Following that is an analysis of the various sources of emissions that arise throughout meat’s lifecycle within this powerful industry. Once all of the sources are accounted for, the overall numbers of greenhouse gases contributed on national and global levels will be stated to demonstrate why this sector needs to be controlled and included in emissions reductions efforts.

SECTION A: BACKGROUND ON GREENHOUSE GASES

There are three main greenhouse gases of concern pertaining to industrial animal agriculture: carbon dioxide, methane, and nitrous oxide. Carbon dioxide is the most prevalent greenhouse gas in climate change discussions, as it has the most direct warming impact and its atmospheric concentration is much higher than other gases (Dessler). Prior to the industrial revolution (the benchmark for anthropogenic warming and emissions), in the mid eighteenth century, carbon dioxide was present in the atmosphere at 280 parts per million (ppm) (Fox). Since then, there has been more than a 70% increase in greenhouse gas emissions, creating the unprecedented warming effect seen today with carbon dioxide being the primary pollutant (Fox).
Carbon Dioxide is a product of the burning of fossil fuels, and it is often the target of emissions reductions efforts because of its sheer quantity in the atmosphere. The IPCC states that carbon dioxide has an atmospheric life of 5-200 years, and the EPA explains this variation saying:

“Carbon dioxide's lifetime is poorly defined because the gas is not destroyed over time, but instead moves among different parts of the ocean-atmosphere-land system. Some of the excess carbon dioxide will be absorbed quickly (for example, by the ocean surface), but some will remain in the atmosphere for thousands of years, due in part to the very slow process by which carbon is transferred to ocean sediments.”

(“Climate Change 2014”)

Reducing atmospheric CO2 concentrations is vital in combating long-term climate change.

Methane is the second most important greenhouse gas in the climate discussion, but is of utmost concern in this thesis as it is one of the primary products of livestock production. Methane has a much shorter atmospheric life than carbon dioxide, residing in the stratosphere for only 9-15 years before it is destroyed (“Livestock’s Long Shadow”). However, methane has a global warming potential 21 times that of carbon dioxide over a 100 year period, meaning it is far more potent and traps more heat (“Livestock’s Long Shadow”). Atmospheric concentrations of methane have increased by roughly 150% since preindustrial times, largely fueling the unprecedented warming experienced today (“Livestock’s Long Shadow”). Its extreme potency but short atmospheric life means that
reductions in methane emissions will result in more immediate warming reductions\textsuperscript{9}. Utilizing methane’s short atmospheric life should be an essential tool for policymakers working to reduce global warming. Focusing on immediate methane reductions would allow the vital window of time necessary to transition the global economy off of its fossil fuel path dependencies. Immediate methane reductions will also be imperative if temperatures begin to approach catastrophic levels. As will be explained in Chapter Seven, these types of fast-action reductions will be necessary if the world is serious about keeping warming below 1.5 degrees Celsius as discussed in the Paris Agreement.

Nitrous oxide is the third major greenhouse gas of interest in the animal agriculture conversation. With an atmospheric life of 150 years, it is a very persistent greenhouse gas. Though not as prevalent; it has one of the strongest warming potentials of all greenhouse gases, boasting a potency that is a striking 296 times that of carbon dioxide (“Livestock’s Long Shadow”). Not only does it contribute to global warming by trapping heat in the atmosphere, nitrous oxide is also involved in the depletion of the ozone layer, which “protects the biosphere from the harmful effects of solar ultraviolet radiation (“Livestock’s Long Shadow”). Because of its severe global warming potential, reductions in these emissions will have a large impact in reducing radiative forcing\textsuperscript{10} and will be vital in combating long term climate change.

Since the industrial revolution these anthropogenic greenhouse gases have increased the concentrations in the atmosphere resulting in trapping of more heat\textsuperscript{11}. This chapter will describe the sources of the greenhouse gases in question and analyze

\textsuperscript{9} See Chapter Five for the science behind methane reductions.

\textsuperscript{10} See Chapter Five for an explanation on radiative forcing.

\textsuperscript{11} Chapter Five will get into the science behind radiative forcing and global warming.
different methods of quantifying the emissions from global and national animal agriculture.

SECTION B: THE TWO MAJOR GREENHOUSE GAS LIVESTOCK STUDIES

As the economy slowly shifts towards decarbonization, many businesses, industries, and individuals are calculating their carbon footprints in efforts to reduce their ecological impacts. There are a variety of methods to calculate a greenhouse gas inventory because there are a plethora of sources that release greenhouse gases.

Because of the vast array and amount of data required for this type of calculation, I have to rely on available, pre-existing data and studies to arrive at a greenhouse gas determination for this industry. There are two major comprehensive studies that are commonly cited regarding global greenhouse gas emissions of livestock. Yet their calculations of emission totals differ by 33%. This gap is due to the differences in data and sources included.

The first study calculated emissions from mostly direct sources of emissions. The responding study took a much more in-depth approach to include nearly every ounce of emissions it could attribute to the industry. This chapter will discuss those discrepancies in order to get an accurate analysis of the greenhouse gas emissions emitted from the American livestock industry.

The first study of interest is called Livestock’s Long Shadow and was conducted by the Food and Agriculture Organization of the United Nations (FAO) in 2006. It takes a more conservative approach by only counting direct sources of emissions. The second most commonly referred-to study was a follow up that addressed problems and discrepancies in the FAO’s report. It is titled Livestock and Climate Change, and was
conducted by the Worldwatch Institute in 2009 in response to the FAO’s report. The Worldwatch analysis incorporates more emission sources than the FAO inventory. Recall from Chapter One that the lifecycle for food typically includes agricultural production, processing and packaging, transportation, retail, use, and waste disposal (“Scientific Report”). The Worldwatch report includes more of these lifecycle factors in its emissions calculations than the FAO. Both reports acknowledge that data on livestock varies dramatically, and that there is unavoidable imprecision in their calculations. This chapter will clarify the sources of the discrepancies between the two major reports before presenting their final estimates.

First, Livestock and Climate Change (also identified as the Worldwatch report) argues that they FAO overlooked nearly 25,048 million tons of CO2e\textsuperscript{12}. The first overlooked source of these added CO2 emissions comes from a misreported number of tonnage of worldwide livestock products. Livestock’s Long Shadow based their calculations on the statistic that 33 million tons of poultry were produced worldwide in 2002. But in a subsequent report the organization published just one year later, they reported that 72.9 million tons of poultry were produced worldwide in 2002 (a 39.9 million ton difference for the same year) (Goodland and Anhang). Another discrepancy comes from a reported figure in the amount of livestock raised worldwide. The FAO reported a total of 21.7 billion head of livestock were raised worldwide in 2002, while “many nongovernmental organizations report that about 50 billion head of livestock were raised each year in the early 2000s” (Goodland and Anhang). If the true number is closer to 50 billion, then the percentage of greenhouse gas emissions would increase.

\textsuperscript{12} CO2e, or carbon dioxide equivalent, is a standard unit for measuring carbon footprints. The idea is to express the impact of each different greenhouse gas in terms of the amount of CO2 that would create the same amount of warming (“What Are CO2e?”)
substantially (Goodland and Anhang). The final major discrepancy in the reports is that the Worldwatch Institute included several more in-depth sources of greenhouse gas emission than the FAO did, all culminating in the 33% difference in their total greenhouse gas numbers.

SECTION C. THE EMISSION SOURCES INCLUDED IN THE STUDIES

There are a wide variety of sources that contribute to the overall greenhouse gas footprint of animal agriculture both globally and nationally. Everything from belching ruminants, animal manure (which emits carbon dioxide, methane, nitrous oxide, and ammonia), land use for feed crops, the vast amount of fossil fuels required to keep the industry moving, all the way down to the refrigeration of hamburger patties, the charcoal grills used to cook them, and the landfills that contain their remains can all be attributed to the livestock industry’s impact on the global carbon balance. This section will break down the various sources that the two reports account for.

SECTION C1: SOURCES INCLUDED IN BOTH STUDIES:

FOSSIL FUEL USE: Worldwatch ✓, FAO ✓

Surprisingly, feeding livestock accounts for more than half of the total energy expenditure of livestock production (“Livestock’s Long Shadow”). Everything from raising the crops to getting them into the mouths of cows requires a tremendous amount of energy, and emits greenhouse gas emissions every step of the way. In total, agriculture accounts for approximately 20% of US fossil fuel usage (Eshel et al.). Growing crops
accounts for 7% of total energy usage in the United States and about 33% of this energy is explicitly for machine operation (Magdoff and Tokar).

Once meat is packaged, it is refrigerated and transported throughout the country and all over the world. Food related transportation accounts for 5% of total energy in the United States (Magdoff and Tokar), and because of high volumes and low utilization of transport capacity, animal products claim the highest amounts of carbon dioxide emissions from food processing and transport, exceeding 8 million tons of CO2 per year (“Livestock’s Long Shadow”).

**FERTILIZER: Worldwatch ✓, FAO ✓**

Another large portion of meat’s greenhouse gas footprint comes from fertilizer: “conventional farming, particularly meat production, is increasingly energy-intensive. A key reason is that, in contrast to organic agriculture systems, it relies on the manufacture of artificial fertilizers, mainly nitrogen-based, which use considerable amount of fossil fuels” (Hillman et al.).

About 97% of nitrogen fertilizers are derived from synthetically produced ammonia, which is largely manufactured using natural gas, except in China where almost 60% of nitrogen fertilizer is produced by burning coal (“Livestock’s Long Shadow”). It is estimated that anthropogenic rates of nitrogen entering the land-based nitrogen cycle have already doubled and continue to grow: “synthetic fertilizers now provide about 40% of all the nitrogen taken up by crops. Unfortunately crop, and especially animal, production uses this additional resource at a rather low efficiency of about 50%. The rest is estimated to enter the so-called nitrogen cascade and is transported downstream or downwind where the nitrogen can have a sequence of effects on ecosystems and people”
(“Livestock’s Long Shadow”). On an atmospheric level, nitrogen changes the balance of nitrogen species in the atmosphere and other reservoirs, creating air pollution (“Livestock’s Long Shadow”). Other adverse effects of excessive nitrogen pollution include deadzone-creating eutrophication episodes.\(^\text{13}\)

**MANURE: Worldwatch ✓, FAO ✓**

Another major source of livestock’s greenhouse gas footprint is derived from manure. In the United States, it would take approximately 33 million fossil-fuel-driven cars to produce the same amount of emissions from their waste (Jacobson). In traditional livestock raising, animal waste would be applied and utilized as fertilizer for the crops that would feed the animals. But as discussed previously, this trend is largely absent from current animal protein operations. Instead, there is no use made of the vast amounts of the toxic waste, and it sits in waste lagoons for extensive amounts of time. As a result, it ferments and generates methane through the process of anaerobic decomposition (Jacobson) (“Livestock’s Long Shadow”). Methane emitted from these lagoons has increased by 31% over the past two decades (Jacobson). On a global scale, the United States ranks the highest in emissions from livestock manure with 1.9 million tons of CO2e being emitted per year (“Livestock’s Long Shadow”).

**PROCESSING CROPS: Worldwatch ✓, FAO ✓**

Processing crops contributes another major share of direct emissions. According to the FAO, “the largest emissions result from soybean processing and are a result of physical and chemical methods to separate crude soy oil and soybean meal from these

\(^{13}\) See Chapter Three, Section B for more information on the effects of nitrogen pollution.
raw beans (“Livestock’s Long Shadow”). Considering that 85% of world soybean production goes directly to animal feed, approximately 66% of these emissions can be attributed to the livestock sector (Flinn) (“Livestock’s Long Shadow”).

TRANSPORTING LIVESTOCK FEED: Worldwatch ✓, FAO ✓

Transporting crops also accounts for a large amount of emissions from the livestock sector. Bulky raw ingredients meant for concentrate feed are shipped on planes, trains, and automobiles from all over the nation and even around the world, and they add significant carbon dioxide emissions to the livestock balance (“Livestock’s Long Shadow”).

LAND USE: Worldwatch ✓, FAO ✓

Raising livestock is one of the largest anthropogenic land users globally and nationally. Internationally, grazing land is a major cause of deforestation, and therefore a major contributor of carbon emissions. Trees and vegetation store carbon, and when destroyed and uprooted they release all of that carbon, and those emissions are then attributed to the livestock sector.

CARBON SOIL RELEASE: Worldwatch ✓, FAO ✓

Soil is the largest carbon reservoir of the terrestrial carbon cycle, and it stores twice as much carbon dioxide than in living vegetation or in the atmosphere (“Livestock’s Long Shadow”). Hence “even relatively small changes in carbon stored in the soil could make a significant impact on the global carbon balance” (“Livestock’s Long Shadow”).

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14 See Chapter Three, Section 1 for statistics on animal agriculture’s land use.
Long Shadow”). The estimated release from cultivated soils is approximately 28 million tons of CO2 per year (“Livestock’s Long Shadow”).

**DESERTIFICATION: Worldwatch ✓, FAO ✓**

The carbon emissions from desertification arise from calculations from an estimated 8-12 tons of soil carbon loss per hectare for desertified land area of 100 billion hectares, amounting in 8-12 million tons of released soil carbon. Additionally, the researchers add degradation of aboveground vegetation, amounting to an estimated carbon loss of 10-16 billion tons (“Livestock’s Long Shadow”). Adding all of these together, the total loss from desertification attributed to livestock would be around 100 million tons of carbon per year (“Livestock’s Long Shadow”).

**ELECTRICITY USE: Worldwatch ✓, FAO ✓**

Electricity can account for the largest share of the carbon footprint in animal agricultural production. Many animal farming operations rely heavily on electricity for production and manufacturing, resulting in high carbon emissions depending on fuel sources (“Livestock’s Long Shadow”).

**SECTION C2: SOURCES INCLUDED IN ONLY ONE STUDY**

**FOREGONE PHOTOSYNTHESIS: Worldwatch ✓, FAO x**

The Worldwatch report goes further in depth than just counting land use. They also calculate foregone photosynthesis stating:
“the amount of annual GHG reductions from photosynthesis that are foregone by using 26 percent of land worldwide for grazing livestock and 33 percent of arable land for growing feed, rather than allowing it to regenerate forest. By itself, leaving a significant amount of tropical land used for grazing livestock and growing feed to regenerate as forest could potentially mitigate as much as half (or even more) of all anthropogenic GHGs.” (Goodland and Anhang)

This is a missed opportunity for capturing carbon.

**DECOMPOSITION: Worldwatch ✓, FAO x**

Going beyond carbon release, the Worldwatch analysis includes humans’ disturbance effect on decomposition and mineralization, accounting for 50% of soil organic carbon lost over the past 50-100 years from crop cultivation (Goodland and Anhang). It also estimates that livestock-induced desertification totals about 100 million tons of CO2 per year (“Livestock’s Long Shadow”).

**RESPIRATION: Worldwatch ✓, FAO x**

One of the largest discrepancies between the reports regards inclusion of CO2 emissions from respiration. The Worldwatch study attributes 21% of global anthropogenic greenhouse gases to cattle respiration (Goodland and Anhang). The reason the Worldwatch Institute decided to incorporate livestock respiration is as follows:

“livestock (like automobiles) are a human invention and convenience, not part of pre-human times, and a molecule of CO2 exhaled by livestock is no more natural than one from an auto tailpipe… Today, tens of billions
more livestock are exhaling CO2 than in preindustrial days, while Earth’s photosynthetic capacity has declined sharply as the forest has been cleared… if it’s legitimate to count as GHG sources fossil-fuel-driven automobiles, then it is equally legitimate to count livestock respiration.” (Goodland and Anhang)

The inclusion of cattle respiration coupled with the misreported total number of livestock is largely responsible for the dramatic gap between the two emissions analyses.

MEDICAL TREATMENT: Worldwatch ✓, FAO x

Another potentially-overlooked source of emissions that the Worldwatch Institute incorporated into their greenhouse gas inventory, but the FAO did not, is that of medical treatment. In the densely populated and filthy CAFOs, illness and disease run rampant among the animals. Medical treatment for sick animals is highly energy (and therefore carbon) intensive, and the researchers added the creation and operation of livestock-specific pharmaceutical and medical industries to the emissions footprint15 (Goodland and Anhang).

PROCESSING: Worldwatch ✓, FAO x

Processing is another major source at the end of the meat’s lifecycle. Processing and packaging food products consumes a total of 7% of total US energy (Magdoff and Tokar).

15 I believe this inclusion is justified. For example, Boettcher Health Center is an outsourced business that Colorado College nonetheless utilizes for its operations. Its energy intensive practices are still counted in the school’s carbon footprint.
**FLUOROCARBONS: Worldwatch ✓, FAO x**

The Worldwatch analysis chose to incorporate the fluorocarbons used in refrigeration needed for cooling meat. Refrigeration is necessary beginning at the slaughter of the animal all the way until it is consumed. Fluorocarbons have a global warming potential several thousand times higher than carbon dioxide, making them extremely dangerous emissions (Goodland and Anhang). While many food products require refrigeration, meat products require it far more than plant-based options, and it is required throughout its entire lifecycle.

**PACKAGING: Worldwatch ✓, FAO x**

Worldwatch also decided to include the emissions from the production, distribution, and disposal of packaging used for livestock foods, which is more extensive than alternative products for sanitary reasons (Goodland and Anhang). These uncounted factors account for approximately 5.6 billion tons of greenhouse gases per year (Goodland and Anhang).

**COOKING: Worldwatch ✓, FAO x**

Cooking meat typically requires higher temperatures and longer periods than cooking plant-based foods (like fruits, vegetables, and legumes) and require fuel sources like charcoal, kerosene, propane, wood, and electricity that all release substantial greenhouse gas emissions (Goodland and Anhang). Worldwatch included estimates from the use of these cooking methods in their greenhouse gas inventory, and the FAO did not.
FOOD WASTE: Worldwatch ✓, FAO x

The remnants of the animal product (bones, fat, spoiled and uneaten products) emit high amounts of greenhouse gases when disposed of in landfills, incinerators, and waterways (Goodland and Anhang). Again, the FAO chose not to include food waste in their emissions calculations though they are technically part of the food lifecycle.

SECTION D. THE OVERALL EMISSIONS NUMBERS FROM GLOBAL LIVESTOCK

Once all of the sources are factored in, the overall emissions numbers were calculated.

- Livestock’s Long Shadow, Food and Agriculture Organization of the UN:
  - Animal agriculture accounts for 18% of global greenhouse gas emissions (“Livestock’s Long Shadow”)
- Livestock and the Environment, Worldwatch Institute:
  - Animal agriculture accounts for 51% of global greenhouse gas emissions (Goodland and Anhang)

Because of reliance on different data sets, estimations made, and potential double-countings, the true amount is likely somewhere between these two numbers.

SECTION E. THE US EMISSIONS PORTFOLIO

The two main reports calculate the global carbon footprint of worldwide livestock production. Within the United States, the precise number is difficult to determine. Unfortunately, there are not many comprehensive studies regarding American meat emissions, so we must rely on the EPA’s inventory for data. The EPA attributes 9% of total US greenhouse gas emissions to agriculture, but they omitted several factors that the
U.N. and Worldwatch included in their greenhouse gas inventories. See chart on following page:
<table>
<thead>
<tr>
<th>Emissions Source</th>
<th>Worldwatch</th>
<th>FAO</th>
<th>EPA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fossil Fuel Use</td>
<td>✓</td>
<td>✓</td>
<td>x</td>
</tr>
<tr>
<td>Fertilizer</td>
<td>✓</td>
<td>✓</td>
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<tr>
<td>Manure</td>
<td>✓</td>
<td>✓</td>
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</tr>
<tr>
<td>Enteric Fermentation</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Processing Feed Crops</td>
<td>✓</td>
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<tr>
<td>Transporting Feed</td>
<td>✓</td>
<td>✓</td>
<td>x</td>
</tr>
<tr>
<td>Land Use</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Soil Carbon Release</td>
<td>✓</td>
<td>✓</td>
<td>x</td>
</tr>
<tr>
<td>Desertification</td>
<td>✓</td>
<td>✓</td>
<td>x</td>
</tr>
<tr>
<td>Electricity Use</td>
<td>✓</td>
<td>✓</td>
<td>x</td>
</tr>
<tr>
<td>Foregone Photosynthesis</td>
<td>✓</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Decomposition</td>
<td>✓</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Respiration</td>
<td>✓</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Medical Treatment</td>
<td>✓</td>
<td>x</td>
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<tr>
<td>Processing</td>
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<td>x</td>
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<tr>
<td>Fluorocarbons</td>
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<tr>
<td>Packaging</td>
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<td>x</td>
</tr>
<tr>
<td>Cooking</td>
<td>✓</td>
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</tr>
</tbody>
</table>
In their greenhouse gas inventory for animal agriculture, the EPA only incorporated “enteric fermentation in domestic livestock, livestock manure management, rice cultivation, agricultural soil management, and field burning of agricultural residues” (“Inventory of US Greenhouse”). Omitted from their calculations were “carbon dioxide emissions and removals from agriculture-related land-use activities, such as liming of agricultural soils and conversion of grassland to cultivated land”, as well as all the other factors as seen in the chart above. Had they conducted a more comprehensive analysis and included factors like fossil fuel combustion used throughout meat’s lifecycle (which can account for up to 50% of meat’s footprint), feed crop production, respiration, fluorocarbons needed for refrigeration, cooking, disposal, etc. animal agriculture’s emission percentage would increase substantially within the overall US emissions portfolio. Despite these missing factors, animal agriculture remains the number one methane emitter in the United States.

Looking at US methane emissions, animal agriculture is responsible for at least 36% of all methane emitted (“Methane Emissions”). 26% of it comes from enteric fermentation, and the remaining 10% comes from manure management (“Methane Emissions”). Combined, this makes animal agriculture the primary methane polluter in the United States.
These charts show the total US greenhouse gas emissions by sector, as well as the various sources of US emissions (“Methane Emissions”)

SECTION F: CHAPTER CONCLUSION

Two different analyses of worldwide livestock emissions result in numbers varying from 18% to 51% of global emissions (or 7.5 - 32.6 billion metric tons per year of CO2e (“Livestock’s Long Shadow”) (Goodland and Anhang). The Worldwatch Institute utilizes a much more comprehensive calculation approach, choosing to include more sources of meat’s lifecycle than the FAO did. As a result, they arrived at a much larger estimate. Within the United States, animal agriculture accounts for the majority of methane emissions, and represents a minimum of 9% of the nation’s total greenhouse gas emissions.

It cannot be disputed that animal agriculture has a significant carbon footprint and can no longer be ignored or omitted in discussions of global climate change and
greenhouse gas reductions. It is the leading anthropogenic source of methane, so significant reductions in livestock raised nationally and worldwide would reduce greenhouse gas emissions relatively quickly compared with measures involving renewable energy and energy efficiency (“Livestock’s Long Shadow”). The United States must create policy targeted at controlling emissions from animal agriculture.
It is critical to identify the sources and amounts of greenhouse gases being produced by the meat industry in order to know how to make effective emissions reductions. The previous section showed that the meat industry are responsible for 18-51% of global greenhouse gas emissions, and produce the majority of methane emissions within the United States. Therefore, this sector must be controlled in order to combat encroaching climate change.

Climate change refers to a change in the statistics of the atmosphere over the past several decades (Dessler). Over the past two and a half centuries, 500 billion tons of human-created carbon has been released into a vital global commons, the atmosphere. In May 2013, the atmosphere reached 400 ppm CO2 levels (Fox). The last time atmospheric carbon levels were that high, “horses and giant camels roamed the swamplands of the Arctic” (Fox). The most direct impact of addition of these excessive greenhouse gases into the atmosphere is a warming planet (Dessler). At a rate of .13 degree Celsius increase per decade, global average temperatures have already increased an unprecedented 1.4 degrees Fahrenheit since the industrial revolution (Dessler).

If emissions go unchecked, projections of the future are quite shocking. Without international political cooperation and top-down intervention, the current tonnage of atmospheric carbon is expected to double over the next 40 years (Fox). If emission scenarios continue on a “business as usual” track, the world could face up to 7.4 degrees Celsius of warming by 2100 (Fox).

The consequences of such warming are stark. With an additional 4 degrees Celsius, the world would experience deadly heat waves, declining global food supply,
sudden rise in sea level of 10+ feet, oceans acidifying and coral reefs dissolving and bringing marine ecosystems down with them (Fox). At 6 degrees Celsius, the earth would “catapult into extreme greenhouse state not seen for 100 million years, when dinosaurs grazed on polar rainforests and deserts reached into the heart of Europe. It would cause a mass extinction of almost all life and probably reduce humanity to a few struggling groups of embattled survivors clinging to life near the poles” (Fox).

To avoid such a dismal future society, scientists and politicians have agreed upon a critical 2 degree Celsius cap on temperature rise above pre-industrial averages. Most scientists agree that this is the tipping point “between climate change humans can adapt to and something that will result in global chaos” (Fox). As described in the projection scenarios in the previous paragraph, higher than 2 degrees Celsius would result in economic, ecological, and potential societal collapse in the world.

The following climate model walks through the science behind emissions reductions and radiative forcing. Radiative forcing is the change in energy for the planet as a result of some change imposed on the planet before the temperature of the planet has adjusted in response (Dessler). The model explains the physics of keeping global warming below 2 degrees Celsius.

- Assume that the goal is to limit warming to 2 degrees Celsius above pre-industrial temperatures. The best estimate of the climate sensitivity is .75 degrees Celsius (W/m^2), which means that for every watt per square meter of radiative forcing, the global average temperature increases by .75 degrees Celsius. A limit of 2 degrees Celsius temperature increase means that radiative forcing that is due to human activity must be limited to 2.7 W/m^2.
This is approximately 1.1 W/m^2 above today’s value of 1.6+ W/m^2

- Even with aggressive reductions of CO2 emissions, the radiative forcing from CO2 is expected to increase by +0.6 W/m^2
- In addition, strong actions around the world to reduce air pollution will reduce the abundance of reflecting aerosols, which will further increase radiative forcing by +0.8 W/m^2
- These changes will increase radiative forcing by +1.4 W/m^2, which would break the total radiative forcing limit of +2.7 W/m^2
- In order to keep net radiative forcing below +2.7 W/m^2, other greenhouse gas agents- in particular methane, ozone precursors, and black carbon- must therefore be aggressively reduced
- To achieve this, global emissions must be reduced by 50-80% from today’s levels

(Dessler)

In order to keep temperature rise below 2 degrees Celsius, global emissions must be reduced by 50-80% (Dessler). One way to make drastic reductions in temperatures is to focus on methane:

“On average, a molecule of methane is destroyed 12 years after it was emitted. If we stopped emitting methane today, within a few decades all of the human emitted methane would be gone, and the atmosphere abundance would be back down to pre-industrial amounts. This is quite different from carbon dioxide, which can stay in the atmosphere for centuries or millennia.” (Dessler)
Because of its relatively short atmospheric life, reductions in methane emissions would lead to reductions in radiative forcing in a decade or two (Dessler).

As the climate model explains, it is essential to reduce short lived greenhouse gases to keep radiative forcing below its critical limit. Because livestock is the primary source of global and national methane emissions, controlling this industry will “not only achieve quick reductions in atmospheric GHGs, but can also reverse the ongoing world food and water crises… A 25% reduction in livestock products worldwide could be achieved between now and 2017… and would yield at minimum a 12.5% reduction in global anthropogenic GHGs emissions” (“Livestock’s Long Shadow”). Targeting this industry as a low-hanging fruit option for methane reductions must be brought forth in the policymaking process.

This analysis does not include the 296 times more powerful NO2 emissions that would also be reduced, nor the vast amounts of 1000 times more powerful fluorocarbons required in refrigerating meat. If meat production and consumption drops, it is assumed that these associated potent gases will be indirectly reduced as well. Making large reductions in these short-lived greenhouse gases is critical if we are to stay within our radiative forcing limits while we work to transition our national (and global) economy and infrastructure off of fossil fuels.
CHAPTER SIX: CLIMATE POLITICS

SECTION A. FOUNDATION OF INTERNATIONAL CLIMATE POLITICS

With implications like threatened food supply, strengthened storms, and displacement of populations due to sea level rise, climate change is an incubator of potentially disastrous international conflict. Former US Secretary of Defense Chuck Hagel declared climate change as the single greatest threat to national security, citing rapid depletion of natural resources coupled with increasing strength and unpredictability of weather patterns and storms. Climate change heightens global inequality as those who suffer the worst outcomes are typically those who contribute the least amount of greenhouse gas emissions. For example, the small island nation of Kiribati is expected to completely disappear over the next few decades due to sea level rise caused by climate change. The average resident of the island nation emit less than 1 ton of carbon dioxide per year, which is just 7% of the global average citizen’s emissions (Worland). Yet these citizens are watching their homes and livelihoods literally disappear due to the actions of people oceans away.

The only solution to keep warming under 2 degrees Celsius is international political cooperation and collective action. This past December, a historic international climate agreement was made in Paris as a result of decades of negotiations and failures at an attempt.

This chapter provides a brief history of the origins of climate politics before delving into the monumental COP21 agreement. In the 1970s when climate scientists began to make the connections of human-caused greenhouse gas emissions and their
warming effects, they urged global leaders to convene and address this universal issue. It took some time, but eventually the United Nations Framework Convention on Climate Change (UNFCCC) was created in 1992 in order to address the oncoming dangers of the greenhouse effect. Its objective is to “stabilize greenhouse gas concentrations in the atmosphere within an ecologically and economically acceptable timeframe” (“Livestock’s Long Shadow”).

For two decades the UNFCCC convened in attempt to reach an agreement to reduce global greenhouse gas emissions without success. The UNFCCC has been likened to a “velvet glove” rather than an iron fist because of its lack of enforceability, weak language, and division of parties. Therefore, the UNFCCC and the Kyoto Protocol will be “flawed because [they do] not bind all states that have the economic and technical resources to cause the collapse of the commons” (Kannan, “Mitigating”). After struggling to create agreements in Kyoto and Copenhagen, this past December, at the 21st Convention of the Parties, a universal climate consensus was finally agreed upon under which all 195 nations accepted voluntary limits on greenhouse gas emissions. This chapter will dissect COP21 and its global implications, while the next section will focus specifically on the text of the agreement and why the United States must incorporate animal agriculture in its climate action plan.

The purpose of COP21 was to reach a universal agreement to keep global warming temperatures from rising above 2 degrees Celsius over pre-industrial averages. As discussed in the previous section, 2 degrees is a political compromise. There is no scientific evidence that proves that an exact 2 degrees is the most appropriate target for capping warming, but it is a point at which scientists believe society can persist in a
relatively similar fashion without catastrophic consequences. On the outskirts of Paris, thousands of heads of state and their diplomats from 195 countries gathered, marking it the largest gathering of world leaders to ever convene over a single issue. The 195 countries had to agree unanimously on the text of the agreement, which is why the outcome is heralded as such a feat. The agreement contains several provisions, but mainly consists of binding countries to their INDCs (intended nationally determined contributions), an establishment of a Green Fund, a ratcheting mechanism, and a transparency provision.

Prior to the two-week conference, each country had to submit an intended nationally determined contribution, or INDC. The INDC contains the country’s emissions reductions commitments, and when all of the INDCs come together they are supposed to reduce emissions to such a level to keep warming under 2 degrees. The INDCs are the main substance of the agreement, as they are what bind countries to their emissions reductions. The combined INDCs are set such that “estimated aggregate greenhouse gas emission levels in 2025 and 2030 resulting from the intended nationally determined contributions do not fall within least-cost 2 degree Celsius scenarios but rather lead to a projected level of 55 gigatons in 2030” (“US INDC”). These INDCs are not legally binding commitments. The Paris Agreement is not a legally enforceable, top-down treaty, but a self-determined accord. The use of voluntary INDCs is heralded as a success because it got 195 countries to pledge to emission reductions (compared to just 37 in Kyoto in 1997), but there are no sanctions or diplomatic punishment if countries fall short on their pledges. Instead, each country’s efforts will have to be closely monitored and held accountable through public and international pressures (Davis). In regard to its
enforceability, that lack of legal enforceable sanctions is not unusual in international political agreements.

Because of the aforementioned disparities in unequal contributions and consequences of global warming, COP21 established a Green Fund to provide a sufficient pool of money to aid developing parties in bypassing “dirty” technology and energy development, and instead allowing them to invest in renewables and more sustainable development practices (“Paris Agreement”).

In order to ensure that the Parties are on track with their emissions reductions commitments and to keep up with the latest science as climate change progresses, a ratcheting mechanism was implemented in the agreement. The mechanism legally requires the 195 signing countries to convene every five years to share their progress, holding them accountable to their commitments by assessing their reductions efforts and current temperature levels. It also mandates that every five years the parties must have a more ambitious INDC than the previous, facilitating progress and innovation. Because there is no world court or legally binding outlet, the agreement relies on transparency mechanisms to ensure accountability (“Paris Agreement”).

After two decades of attempting to agree upon a universal consensus on climate change, COP21 is heralded as a relative success. 195 world leaders unanimously agreed upon a climate commitment while allowing flexibility in emissions reductions depending on economic and development status, which is a feat in itself. However, as famed environmentalist Bill McKibben stated, the agreement “didn’t save the planet, but it may have saved the chance of saving the planet” (Sutter and Berlinger). COP21 is just a first
step in the massive undertaking of combating global warming, and now it is time for putting policy into action.

The agreement does not outline specific ways in which emissions should be reduced, it instead leaves that to individual countries to determine their methods, and when all the commitments come together they must reach a specific target in order to keep temperature rise under 2 degrees Celsius. The following chapter breaks down important text from the agreement as well as the United States’ INDC to show why the meat industry must be regulated.

SECTION B: THE ROLE OF AGRICULTURE IN THE PARIS AGREEMENT

Agriculture-related emissions are not mentioned in the agreement at all. The discussion of livestock’s role in climate change was brought up in the previous UNFCCC conference (COP20 in Lima) in hopes that agriculture would be addressed in Paris, but because the universal agreement is so broad, individual countries choose the means by which they will reduce their emissions. Only a handful of countries addressed emissions from agriculture in their INDCs. Ethiopia, for example, noted that livestock and crop cultivation are responsible for more than half of their total emissions, and therefore their government estimates that 86% of the countries emission reductions to meet their climate commitments will come from agriculture and forestry sectors (McArthur). Brazil noted similar statistics, declaring in their INDC that they will restore 15 million hectares of degraded pasturelands, and that they plan to “enhance 5 million hectares of integrated cropland-livestock forestry systems by 2030” (McArthur). Indonesia is the world’s largest emitter in land-use change and forestry, and pledged a 29% decline from land use change related emissions by 2030. Since half of the 48 contiguous United States is
devoted to animal agriculture for grazing, growing feed, and confining animals raised for meat the US could make significant strides in its land-use policy to reduce emissions while simultaneously reducing environmental degradation (Glaser et al.). There are also a variety of other ways the United States can control the ecological impact of meat by simultaneously reducing greenhouse gas emissions and environmental degradation. This next chapter extracts specific sections of the Paris Agreement to show policymakers and US leaders that they are obliged to address animal agriculture to ensure an ecologically sound future.
CHAPTER SEVEN: UNITED STATES’ INDC AND THE PARIS AGREEMENT

As explained in Chapter Six, the structure of the Paris agreement does not outline specific quantities or ways in which emissions should be reduced. It instead leaves those determinations to individual countries based upon their economies and global warming contributions. When all the voluntary commitments are summed they must reach a specific emissions target in order to keep temperature rise under 2 degrees Celsius, which as of October 2015, they did not achieve. This section will delve into the Intended Nationally Determined Commitment of the United States, exploring its declared emissions reductions methods. It will also analyze the text of the agreement to show why industrial animal agriculture needs to be included in the United States’ climate plan.

The United States represents 5% of the world population, but contributes 25% of the world’s carbon dioxide emissions (Fox). Hence it plays an important role in international climate agreements as it carries a heavy burden of reducing emissions (Fox). The United States’ INDC declares that it “intends to achieve an economy-wide target of reducing its greenhouse gas emissions by 26-28% below its 2005 levels in 2025 (“US INDC”). After 2025, the US strives for “deep, economy-wide emission reductions of 80% or more by 2050” (“US INDC”). See graph on following page:
This graph shows the projected targets for US emissions reductions ("US INDC").

To achieve such reductions, the US INDC states the selected methods it plans to implement or has already instated. Policy vehicles included are the Clean Air Act, the Energy Policy Act, and the Energy Independence and Security Act. The actual reduction measures included to get the US to its 2025 emissions target include:

- The Clean Power Plan: regulations to cut carbon pollution from new and existing power plants under the Clean Air Act
- Fuel economy standards for light and heavy-duty vehicles under the Clean Air Act
- Standards to control methane emissions from landfills and the oil and gas sector under the Clean Air Act
- Approval of a new alternative to high-global warming potential hydrofluorocarbons used in certain appliances through the Significant New Alternatives Policy program
• Measures to reduce building sector emissions by promulgating energy conversion standards for a broad range of appliances and equipment

Missing from this INDC list of actions is anything related to agriculture. Despite it being the number one methane emitter in the United States, it is not present as a means to reduce emissions. This breakdown of the Paris Agreement text shows why animal agriculture must no longer be absent from emissions regulations.

SECTION A: ANALYSIS AND CRITIQUE OF PARIS AGREEMENT TEXT

The Paris Agreement, in both the annex and the articles, create objectives applied to all parties of the agreement. In this thesis I argue that the widespread environmental impacts of industrial animal agriculture must be addressed in the United States. The following sections break down provisions pertaining to food production and oblige the US to control the meat industry.

SECTION A1: ANALYSIS OF THE ANNEX

1. In the annex of the Paris Agreement, one statement reads that parties recognize “the fundamental priority of safeguarding food security and ending hunger, and the particular vulnerabilities of food production systems to the adverse impacts of climate change” (“Paris Agreement”).

As shown in Chapter Three, meat is statistically the most inefficient food source, requiring up to 160 times more land, 8-50 times as much water, and creates 11 times the greenhouse gases as well as 5 times the toxic pollution of plant-based foods (Eshel et al.). As mentioned in Chapter One, the earth could sustain 10 billion people who eat a typical Indian diet (mostly vegetarian), and only 2.5 billion on an American diet (a heavily
carnivorous diet) (Riebel and Jacobsen). The amount of cereal and grain currently being fed to global animals being raised for food could feed 3 billion people on a mostly vegetarian diet, enough to end world hunger (Riebel and Jacobsen) (Gimenez), Each year an estimated 41 million tons of plant protein is fed to US livestock, where only 1% of that makes its way through the trophic levels as energy for humans\(^{16}\) (“US Could”). Meat cannot feed a growing population as resources become more strained than they already are, and this inefficiency must be addressed. As the population grows and resources continue to deplete, it is evident that meat is an unsustainable and inefficient food choice and consumption should be reduced.

It is also ironic that the current industrialized, fossil fuel intensive, and monocultural agriculture is actually fueling the climate change that threatens its very existence. If parties are to truly recognize the fundamental priority of safeguarding food security and ending hunger, they would acknowledge the need and feasibility of shifting the current resource intensive and inefficient food production system to a more sustainable and efficient means.

2. Another statement of significance from the annex reads the **parties note “the importance of ensuring the integrity of all ecosystems, including oceans, and the protection of biodiversity” (“Paris Agreement”).**

As explained in Chapter Three, the livestock sector is largely responsible for vast reductions in global and national biodiversity. Statistics of importance include:

\(^{16}\) See Chapter Three, Section 1 for an explanation on trophic levels and ecological efficiency.
• Animal agriculture is responsible for 91% of Amazon destruction (Margulis)

• Animal agriculture as the leading cause of global species extinction, ocean deadzones, water pollution, and habitat destruction (“What Is a Dead Zone?”)

• In the United States, livestock are responsible for approximately 55% of erosion, 37% of pesticide use, 50% of antibiotic use, and 33% of the loads of nitrogen and phosphorus polluting freshwater resources (“Livestock’s Long Shadow”).

• Agriculture is listed as the principal habitat threat affecting endangered species in the U.S, with livestock grazing specifically accounting for 22% of habitat destruction (Primack)

Therefore, if the parties (including the US) are to “ensure the integrity” of all ecosystems and are serious about protecting biodiversity, more action and attention must be paid to the animal agriculture. Policymakers are obligated to hold the meat industry accountable for their destruction of ecosystems and species, and must work to reduce and prevent this type of destructive behavior while facilitating a shift to less impactful food production system.

3. The concluding remark of the annex reads “recognizing that sustainable lifestyles and sustainable patterns of consumption and production, with developed country Parties taking the lead, play an important role in addressing climate change” (“Paris Agreement”).
Because of basic biological governance as well as its massive scale of production, the current global and American consumption and production of meat is completely unsustainable. This annex statement holds power by making developed countries accountable for taking the lead in converting to sustainable practices with the intent that developing countries will follow suit. Since animal agriculture is the leading driver in Amazon deforestation and causes widespread environmental degradation in developing nations, the US must lead by example and begin controlling the meat industry to mitigate its effects within its own borders. As a leading global power the US has the responsibility to lead by example, and only until it begins to recognize the harms and risks of industrial meat production, the rest of the world will continue to follow a similar destructive trajectory. By shifting the United States’ diet off of meat and onto more sustainable means of caloric intake, developing countries will follow suit and the globe will breathe a sigh of relief as global emissions drop and vital resources are conserved.

SECTION A2: ANALYSIS OF THE ARTICLES IN THE PARIS AGREEMENT

1. Article 2.1a of the agreement states “holding the increase in the global average temperature to well below 2 degrees C above pre-industrial levels and to pursue efforts to limit the temperature increase to 1.5 degrees C above pre-industrial levels, recognizing that this would significantly reduce the risks and impacts of climate change” (“Paris Agreement”).

If the parties are committed to keeping warming under 1.5 degrees Celsius, emissions from agriculture will absolutely have to be reduced. The inclusion of a 1.5

See Section 1 of Chapter Three for an in-depth analysis of the inefficiency of the current US meat production system.
degree “target” shocked many as it is a highly ambitious goal, though could be much safer than a 2 degree limit. An analysis led by the Columbia Earth Institute produced a selection of “choices” for the US to achieve 80% carbon emissions reductions by 2050, and to almost zero by 2070 that would be necessary to help achieve a 1.5 degree target. This would require:

- Increasing wind and solar energy capacity by 30 times current production output
- Increasing nuclear capacity by 400%
- Achieving fuel economy standards of more than 100 miles per gallon while shifting most of the nation’s fleet to alternative fuels (electricity or hydrogen) (Carlson)

These options do not allow for reliance on natural gas as a “bridge fuel” away from coal or oil, as it risks “locking in” our energy system to one that does not achieve deep decarbonization after 2030 (Carlson). Judging by the current political status of the country, these options are almost obscene to consider attempting. This is where agriculture needs to be included as an option. Since emissions from livestock in the US account for at least 9% of the country’s greenhouse gas emissions and 36% of US methane emissions, it is a low-hanging fruit option for reducing emissions because of methane’s high potency but short atmospheric life. Given the United States’ path dependencies and infrastructure based upon fossil fuel consumption, ridding of a couple hundred million belching animals should be regarded as an easy solution. Meat could be a nonessential component of the American diet, and efforts to shift to a plant-based
consumption lifestyle will go a long way in achieving decarbonization while simultaneously reducing meat’s detrimental widespread ecological impact.

2. Article 4.1 states “parties aim to reach global peaking of greenhouse gas emissions as soon as possible... and to undertake rapid reductions thereafter in accordance with the best available science” (“Paris Agreement”).

When the best available science points to all of the widespread environmental destruction and vast amounts of greenhouse gases that result from industrial animal agriculture, the parties are obligated to make reductions in this sector. Methane’s short atmospheric life of 9-15 years would yield more immediate radiative forcing results than reductions in carbon dioxide, as discussed in Chapter Five.

3. Article 4.3 states “Each Party’s successive nationally determined contribution will represent a progression beyond the Party’s then current nationally determined contribution and reflect its highest possible ambition, reflecting its common but differentiated responsibilities and respective capabilities, in the light of different national circumstances” (“Paris Agreement”).

Currently, the United States’ INDC does not reflect its highest possible ambition, as it is missing a large portion of its emission percentage and there are great strides and reductions to be made in that sector. The current INDC addresses methane emissions from oil and gas sectors, even though they only comprise 29% of total US methane emissions while animal agriculture represents 36% (“Methane Emissions”). Therefore, in order to “represent a progression” and “reflect its highest possible ambition”, the United States must include animal agriculture in its successive INDC.
4. Article 4.4 states “Developed country parties shall continue taking the lead by undertaking economy-wide absolute emission targets” (“Paris Agreement”)

   Currently, the only economic sectors included in the United State’s emission reduction plan come from the oil and gas industry, from transportation, and from the energy sector. Agriculture and all the operations it consists of plays a major economic role in the United States, yet is entirely absent from the current INDC. Agriculture comprises about 5% of the American economy and receives billions of dollars in federal subsidies each year, and it should be subject to regulation just like other American industries (“Ag and Food Sectors”).

5. Article 5.1 reads “Parties should take action to conserve and enhance, as appropriate, sinks and reservoirs of greenhouse gases as referred to in Article 4” (“Paris Agreement”)

   Recall from Chapter Three that agricultural systems now occupy up to 45% of earth’s total land surface (Primack) (Thorton et al.) with livestock production accounting for 70% of that, making it the single largest anthropogenic user of land by far (“Livestock’s Long Shadow”). This vast amount of land use is the main contributor of global deforestation. In Latin America, 70% of once-forested land is now occupied by pastures and feed crops. In Central America, the forest area has been reduced by almost 40% over the past 40 years to accommodate a growing cattle population (Velten). Over the past 50 years, almost 85% of the world’s agricultural land has degraded via erosion, salinization, compaction, nutrient depletion, biological degradation, and pollution (“Livestock’s Long Shadow”). About 20% of the world’s pastures, and 73% of
rangelands in dry areas have been degraded to some extent from overgrazing, compaction, and erosion caused by livestock (“Livestock’s Long Shadow”). All of this land use reduces photosynthesis production and carbon storage, and actually releases carbon from the soil. Land sinks are the largest reservoirs of the terrestrial carbon cycle, and this vast amount of agricultural disturbance is releasing CO2 emissions at dangerous rates. Policymakers should recognize that animal agriculture requires far more land than producing plant foods\textsuperscript{18}. By shifting our food production system vital carbon sinks can be conserved while reducing the environmental effects that livestock bring. Because developing nations are tasked with leading by example, the United States must acknowledge that if it wants to protect global land sinks and reduce deforestation, it must begin to conserve its own.

In order to uphold the Paris agreement that the United States signed onto, it must include plans for reducing emissions from the agriculture sector in its successive INDC. As explained in the following chapter, there are several obstructions to regulating agriculture in the US; however there are also a plethora of outlets for government intervention and top down control.

\textsuperscript{18} About 160 times less lend to be precise. See Chapter Three, Section B2 for land use inefficiency.
CHAPTER EIGHT: CURRENT US ENVIRONMENTAL REGULATIONS AND POLICIES PARTICULAR TO AGRICULTURE

SECTION A: INTRODUCTION

This chapter aims to analyze the current regulations, standards, and subsidies in place regarding animal agriculture. In order to move forward with policy recommendations, it is important to understand what policies are already in place as they can serve as both tools and hindrances. Several environmental laws exist that provide strong ground for regulating the meat industry, but as will be shown there are several loopholes and exemptions that this industry benefits from, making it difficult to utilize existing policies and legislation for effective management. This chapter will be broken down into current regulations and standards, the industry’s exemption from such regulations, the loopholes that exist, and problems with current voluntary programs targeting animal agriculture that sustain its very existence.

SECTION B: CURRENT REGULATIONS, STANDARDS, AND SUBSIDIES

There are several regulations and policies directed at agriculture in the United States, but they are often violated, rarely enforced, and riddled with loopholes. There are also many government incentives and subsidies for animal agriculture.

SUBSIDIES

Agriculture is one of the most heavily subsidized sectors in the nation. From 1995-2006, the US government paid out nearly $178 billion in agricultural subsidies, with $140 billion of that in commodity payment programs alone (Angelo). These
subsidies distort prices at the input and product level, and almost never consider environmental costs ("Livestock’s Long Shadow"). In fact, many subsidies generate negative environmental effects ("Livestock’s Long Shadow"). American animal agriculture benefits from widespread government assistance for everything from cheap prices of water, to federally crafted artificial demand for beef.

**LAND**

There are currently 2-3 million heads of cattle grazing on over 300 million acres of public land in the far 11 western states (Rifkin). As seen in Chapter Two, a vital precedent was set in the mid 20th century that gave preference to cattle grazing over wildlife throughout the nation. The Bureau of Land Management has upheld this precedent throughout time. When allocating herbage on federally leased land, the BLM set aside 97% of herbage for livestock, and the remaining 3% was allocated to wildlife (Rifkin). Not only are farmers and their cattle receiving the majority of land, they are getting it for almost no cost. As of 1991, federal agencies charged a fee of $1.97 per month per cow for grazing on public lands, compared with an average private cost of $8.70 (Wilkinson). As Chapter Three explained, cattle grazing is the major driver behind desertification. Essentially the federal government is funding this poorly managed sector and in doing so, destroying the vital ecosystems it freely tramples upon.

**WATER**

Cattle ranchers, farmers, and livestock operations are largely dependent upon “first come first serve” water rights that were established long ago during western expansion (Rifkin). Yet despite their longstanding domination of water rules and holdings
of water rights, water for livestock production continues to be highly subsidized by the federal government. Congress estimates that federal subsidies of over $2.2 billion go to western water projects annually, nearly $1 billion of which going to feed and fodder growers alone (Rifkin). Recall from Chapter Three that agriculture is responsible for 80-90% of freshwater consumption in the United States. At a time where water conservation should be a top political priority, subsidizing the most water-intensive food production system is counter-productive and wasteful. Some further example of the precious resource being heavily subsidized include:

- The federal government has borne the cost of over 50% of all irrigation facilities in the US (Rifkin)
- In Pueblo, Colorado, one project was allocated $500 million from the federal government to help farmers grow sorghum, corn, and alfalfa strictly for livestock feed. Delivering the water cost $0.54 per acre-foot, though the farmers were only charged $0.07 per acre-foot, an 87% subsidy (Rifkin).
- Due to the Bonneville Water Project in Utah, farmers pay $18 per acre-foot for water, while the government pays $306 per acre foot to deliver the water (Rifkin).
- In New Mexico, Kansas, and Texas, landowners are allowed a depletion allowance on the groundwater to compensate for the fact that their pumping costs rise as the groundwater extraction lowers the water table. The purchasing costs of drilling equipment and sinking wells are also tax deductible (Rifkin).
Not only is the government fueling one of the most inefficient uses of water\textsuperscript{19}, it often does so unfairly. In California alone, more than 1.5 million acres of federally subsidized water is illegally controlled by powerful corporate and family concerns (Rifkin). Throughout the nation, 25% of federally subsidized irrigated land is owned by only 2% of landholders (Rifkin). As discussed in Chapter Three, it takes 15 times less water to grow the same calories of plant protein instead of beef. Instead of subsidizing the vast majority of water to this resource intensive sector, the government should shift policy to encourage more sustainable and less resource intensive food production systems.

**BEEF: IT’S WHAT’S FOR DINNER**

Instead of subsidizing and promoting the growth of grains or vegetables for human consumption, the government has manufactured an artificial demand for beef. In the 1980s, family farmers and ranchers experienced a farm crisis, leading Congress to create the beef “check-off” program:

“The idea was to help struggling ranchers by creating a program to pool their money and use it to promote demand for beef. Under a bill passed in 1985, cattle producers were required to pay $1 per head to qualified state beef councils. These councils in turn contributed to a national program supervised by the USDA dedicating to promoting the beef industry.”  
(Mahanta)

\textsuperscript{19} See Chapter Three, Section A for an in depth analysis and comparison on water use in food production.
Almost 99% of the money collected went to the hands of the National Cattlemen’s Beef Association (Mahanta). However, the organization favors large packers and corporate giants who now all but run the industry, instead of helping the lower impact small scale ranchers and farmers.

In an increasing food and water crisis, with desertification wiping out masses of habitat and species, it is time for the government to reassess its funding distributions into a more climate-smart and sustainable agricultural system that boasts more efficiency and higher production of less destructive and intensive foods.

SECTION C. THE ENVIRONMENTAL POLICY TOOLBOX

Because of certain shifts in public mood and policy agenda, the United States does boast a handful of extremely stringent and powerful environmental policies. Regarding CAFOs and industrial animal agriculture, it is evident that the EPA has the “authority under its most prominent environmental laws to regulate air and water pollution from animal agriculture”. Three strong outlets include the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), the Clean Air Act (CAA), and the Clean Water Act. The three policies address different means of pollution like greenhouse gases, manure and waste runoff, and pesticide and fertilizer pollution of water and are useful when combating the environmental externality of animal agriculture.
CERCLA

The Comprehensive Environmental Response, Compensation, and Liability Act is “a federal law designed to fund the cleanup of releases or threatened releases of hazardous substances that may endanger public health or the environment” (Verheu). Under CERCLA, a trust fund is established where potential sources of industrial hazardous emitters pay into, which is then used to clean up abandoned or uncontrolled hazardous waste sites. While CERCLA does not specifically impact CAFOs, “several courts have held that these operations are emitters of hazardous pollutants and are subject to CERCLA reporting requirements” (Verheu). In 2003, the city of Tulsa brought suit against major food corporation Tyson Foods when the company’s waste polluted several area lakes. A US Federal District Court held that “the phosphates emitted by the poultry facilities were hazardous substances under CERCLA” (Verheu). One year later in *Sierra Club v. Seaboard Farms, Inc.* it was ruled that farm complexes as a whole, rather than each individual barn, lagoon, or land application, constituted a single facility for the purpose of CERCLA reporting requirements (Verheu). In doing so, the US Court of Appeals for the Tenth Circuit found that the facility in question was housing 25,000 swine and exceeding the “Reportable Quantity” of ammonia emissions per day, subjecting it to immediate reporting requirements (Verheu). Such case law is useful in holding other CAFOs accountable for reporting, and subjecting them to CERCLA’s regulations.

CLEAN WATER ACT

The Clean Water Act is intended for “the protection and maintenance of the chemical, physical, and biological integrity of the nation’s waters” (Verheu). The Clean
Water Act is a powerful and important piece of environmental legislation that has eradicated vast amounts of pollution from the nation’s waterways by regulating industry. However, agriculture enjoys several exemptions from the Act and lack of enforcement, which is deplorable considering the quantities and effects of agricultural pollution within the United States. Agricultural runoff is exempt from permitting requirements, even though agricultural runoff is considered to be the greatest challenge of water pollution control efforts (Angelo). CAFOs are legally permitted to dump toxic manure into US waterways “so long as the operations comply with state imposed standards for water quality” (Mitchell). However, the EPA estimates that only 30% of CAFOs are submitting proper information to the agency, leaving 70% of operations uncontrolled and unenforced (Mitchell). Even so, the EPA can hardly enforce those 30% who do report due to recent agricultural legislation that diminishes the EPA’s “capacity to control the increasingly unruly and unregulated facilities” (Mitchell).

CLEAN AIR ACT

For controlling greenhouse gas emissions, there is no stronger regulatory tool than the Clean Air Act (CAA). In January 2010, a critical “cause or contribute” rule was added to the Act making it a powerful piece of climate change legislation. The Endangerment Finding reads as follows: “the Administrator finds that the current and projected concentrations of the six key well-mixed greenhouse gases-- carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride--in the atmosphere threaten the public health and welfare of current and future generations” (Verheu). Therefore, the EPA is now required to list the three main air

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20 See Chapter Three, Section B for pollution statistics and effects.
pollutants of the meat industry (carbon dioxide, methane, and nitrous oxide) as criteria pollutants under the CAA. After listing them, the EPA must set national pollution limits “sufficient to protect public health and welfare”, as well as set National Ambient Air Quality Standards (NAAQS) to “protect public welfare encompassing environmental and economic interests” (Verheu). The Clean Air Act is a vital tool under which the federal government can reduce the greenhouse gas emissions from industrial animal agriculture.

SECTION D: VOLUNTARY PROGRAMS

The government has started to recognize some of the problems associated with industrial animal agriculture and established some voluntary programs in an attempt to mitigate the adverse effects. Established by the EPA and USDA, these programs attempt to coerce companies in the livestock industry to reduce greenhouse gas emissions. Listed on the EPA is a series of measures that “could improve a livestock operation’s production efficiency and reduce greenhouse gas emissions”, and it includes actions like “improving grazing management, soil testing, supplementing cattle diets with needed nutrients, developing a preventative herd health program, providing appropriate water sources and protecting water quality, and improving genetics and reproductive efficiency” ("Livestock’s Long Shadow"). By providing mere suggestions and little to no incentive, there is little effectiveness in this voluntary approach.

For a more technological approach to reducing methane emissions from these operations, there is the option of utilizing anaerobic digesters. These devices “compost organic waste in a machine that limits the access to oxygen and encourages the generation of methane and CO2 by the microbes in the waste itself. The gas is then
burned as fuel to make electricity (Verheu). The USDA created the Environmental Quality Incentives Program (EQIP), which is a “voluntary conservation program that promotes agricultural production and environmental quality” (Verheu). The program encourages farmers and ranchers to install anaerobic digesters on their own budgets. However, according to the EPA, there are only 150 anaerobic digesters in operation today, an insignificant fraction of the 450,000 CAFOs existing in the country. It is evident that a voluntary approach will not do enough to reduce emissions and effects at significant levels, which is why I suggest a top-down approach to mitigating the environmental effects of industrial animal agriculture.
CHAPTER NINE: PROPOSED POLICY RECOMMENDATIONS AND SUGGESTIONS FOR CONTROLLING INDUSTRIAL ANIMAL AGRICULTURE

“We all have but one lifeboat. No nation can escape from injury when global biological systems are damaged. No nation can escape from conflicts over increasingly scarce resources. In addition, environmental and economic instabilities will cause mass migrations with incalculable consequences for developed and undeveloped nations alike. Developing nations must realize that environmental damage is one of the gravest threats they face, and that attempts to blunt it will be overwhelmed if their populations go unchecked. The greatest peril is to become trapped in spirals of environmental decline, poverty, and unrest, leading to social, economic, and environmental collapse.”
(“1992 World Scientists’ Warning”)

As seen thus far throughout this thesis, the environmental impacts of industrial animal agriculture are far too destructive to slide under the radar of regulation. Being the leader in methane emissions that fuel global climate change, the main driver of desertification that leads to habitat loss and species extinction, and the main consumer of unsustainable amounts of water and land, this industry cannot go unchecked any further. Solely pointing out the problems is not enough to effect necessary change. This chapter, and transitively this thesis, provides a wide variety of plausible solutions (and justification for their implementation) to combat the widespread environmental degradation caused by the meat industry.

This chapter will be broken into several sections. Following a brief introduction begins a section recommending changes to existing laws and policies, and includes a re-emphasis on the clauses of the COP21 agreement. The next section focuses on the utilization of pricing mechanisms to facilitate behavioral change. Subsidies are of major focus, and carbon taxes, water prices, and other fees are also discussed as strong options to mitigate their associated effects. Section D focuses on regulatory approaches,
providing policy suggestions to control varying types of pollution and degradation caused by livestock. Under regulations comes suggestions for creating standards and adopting best management practices that should be implemented. The final section provides a more creative approach of reducing national meat consumption as an indirect means of mitigating the environmental impacts from the industry.

All of these suggestions adhere to a top-down approach, which I believe is the only way to combat such widespread problems from a very powerful industry. Voluntary measures have already proven insufficient to reduce the greenhouse gases and pollution necessary because in the current unregulated system, it is far cheaper (basically free) to pollute. Hence, farm owners and corporations are not going to incur unnecessary cost burden if they are not required to. Therefore regulations must be imposed and enforced.

The ultimate goal of regulation should not serve to apply technological band-aids to the symptoms of a harmful industry. Regulations must get to the root of the problem: the existence of such an environmentally damaging and unsustainable food production system. Even if all of the methane is captured and fossil fuels are replaced with renewables in meat production, cows and other livestock are always going to require vast amounts of fresh water and grain that could instead be feeding the growing population of humans. Policies implemented should not only work to reduce the adverse effects of industrial animal agriculture, but facilitate the essential shift to an entirely revised and sustainable food production system.

SECTION A: INTRODUCTION

The United States has a strong environmental regulatory framework, however agriculture has somehow fallen through the cracks of control. In fact, “one would be hard
pressed to identify another industry with as poor an environmental record and as light a regulatory burden” (Ruhl). While other environmentally destructive industries (like coal power plants and industrial operations) face stringent government intervention, animal agriculture has evaded the grasp of control for decades. With the nation committed to global warming reductions and struggling to conserve land, water, and native species, agriculture is a necessary target for environmental regulation. As seen in Chapters Three and Four, there are many sources of the industry’s degradation. This chapter provides solutions to address several of those sources, with the understanding that changes and reductions in one area will ripple throughout the supply chain and typically have indirect and direct benefits in other areas. For example, implementing a national carbon tax that includes agriculture will make the cost meat production increase. Any reductions in meat production or consumption will have widespread benefits like conserving natural resources, reducing greenhouse gasses, create less habitat damage, and result in less water use and pollution, etc. Conversely, creating standards and mandating ecosystem management will not only benefit the surrounding ecosystem but will reduce greenhouse gasses by breaking up these economies of scale, conserving land sinks, and reducing detrimental waste handling.

SECTION B: LOW-HANGING FRUIT

For too long, agriculture as a cause of environmental degradation has been ignored. For example, controlling animal agriculture is not included in the widely cited Mckinsey analysis of the costs of abatement and pollution for 42 different emissions reductions strategies. Following along the theme seen throughout this chapter, controlling animal agriculture is not included as an option for carbon abatement. If it were included,
it would likely be in the bottom left of the chart as an extremely low cost solution that abates large amounts of pollution. For example, a farmer could invest A dollars in fencing and save B dollars in avoided environmental harm. The net result (A-B) would be negative, meaning the benefits of abating this pollution largely outweigh the costs invested. It makes economic and environmental sense for policymakers to invest more money in this low cost option that yields high returns, rather than constantly investing in high cost and low impact means of reducing emissions.

*The McKinsey analysis includes 42 means of reducing greenhouse gas emissions, but has no option for animal agriculture (“Greenhouse Gas Abatement Cost”)*
Another way to visualize the economic and environmental incentive for controlling industrial animal agriculture is through a marginal abatement curve. The Y-axis represents amount of money spent on pollution control, and the X-axis is the quantity of pollution abated. The optimal level of pollution is where the marginal damage and marginal abatement cost intersect. However, because regulating animal agriculture is an inexpensive outlet that reaps widespread benefits (greenhouse gas reductions, reduced ecological destruction, increase in natural resource availability and conservation, etc.), this policy option is a low cost solution with a high marginal rate of return, therefore making it a desirable vehicle for policy makers.

\[ \text{Optimal level of pollution} \]

\[ \text{Marginal Abatement Cost (MAC)} \]

\[ \text{Marginal Damage} \]

\[ \text{Quantity of Pollution} \]

\[ \text{S} \]

\[ \text{P} \]

\[ \$ \]

SECTION C: THE POLICY VEHICLE

Many of the policies and recommendations brought forth here could be adopted under the spending power of the US Constitution; that is, the government could make its subsidies to agriculture dependent on farmers reducing their environmental harms. This approach of making government subsidies dependent on improved conduct is the basis of
Title IX. Title IX is a portion of the United States Education Amendments of 1972, and requires that “no person in the United States shall, on the basis of sex, be excluded from participation in, be denied the benefits of, or be subjected to discrimination under any education program or activity receiving federal financial assistance” (“Title IX”). The Act was a means by which the federal government sought to end national gender discrimination in schools. In order to make this anti-discrimination policy applicable and enforceable throughout the nation, policymakers included the clause seen in the last line quoted, that any school receiving federal funding is subject to this law. The Act has since been upheld several times in court, holding that the federal government may use this authority since it provides funding to the entities it seeks to control. The same clause and jurisdiction can be applied to animal agriculture, requiring any farm, corporation, or CAFO receiving federal funding to comply with the environmental standards and regulations proposed here. Those entities who do not comply would lose their federal funding, likely making them unable to survive on their own.  

This chapter will also largely focus on the use of ecosystem management as a means to foster sustainable farming practices. Ecosystem management strives to preserve and restore biodiversity utilizing the best available science to improve understandings of the ecosystem. It promotes sustainable resource use and gives consideration to all factors in a functioning ecosystem (Kannan, “Management”). For ecosystem management to function properly, jurisdictional boundaries must not be controlling, there must be broad public participation, and all decisions must incorporate scientific, environmental, economic, and social analyses (Kannan, “Management”). Federal agencies are allowed to

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21 See Chapter Eight for a list of subsidies this industry receives, showing it is largely dependent on government assistance to function.
impose Best Management Practices (BMPs), though currently most BMPs are mere suggestions, not requirements. Through legislation that would contain clauses similar to Title IX, ecosystem management can be required and upheld in farms and CAFOs nationwide.

A transformative policy shift is required to address the connections between food production, energy, and climate change. Because there are so many sources of environmental degradation throughout the lifecycle of meat\(^2\), there are countless opportunities for top-down control. It will take a combination of these suggestions to truly control the industry, and by providing a diverse array of recommendations I will show that mitigating the environmental effects of the meat industry is completely achievable.

SECTION D: CHANGING EXISTING LAWS AND POLICIES

Before delving into the creation of new policies and regulations, I will focus on the use of existing tools. There is substantial room for improvement within current policy. The policy foundation upon which animal agriculture rests is “already marked with broad brush strokes resulting from ignorance, neglect, [and] conjecture”, however, “this should not give rise to despair, rather it should inspire hope that relatively minor changes, in a sector that has often been considered environmentally unimportant, could have a major impact” (“Livestock’s Long Shadow”). The recommended changes and suggestions provided in this section could be considered low-hanging fruit options for policymakers and government agencies to control the meat industry.

\(^2\) Recall that the lifecycle for food typically includes agricultural production, processing and packaging, transportation, retail, use, and waste disposal (“Scientific Report”).
Several small improvements can be made within the Bureau of Land Management that would have a relatively large impact. For one, the definition of the term “range” should be rewritten so as to include more than just land for cattle. Recall from Chapter Two that the Taylor Grazing Act defined the word range as “land dedicated to domestic stock”. The term should be reworked to include all of the components that actually comprise a range. This would include the ecosystems it contains that hosts all the native populations like elk, antelope, trout, and wildfowl. The term range should also include the intrinsic value that the range beholds as a monument of the American West, as well as land use for public recreation. Currently 68% of all BLM rangeland is described as poor or fair (fair is defined as land supporting less than half of its historical carrying capacity). Factoring in these other uses of public rangeland would improve the health of the ecosystem and reduce the near-monopoly of an industry that destroys the very ground it depends on.

The BLM should also shift its focus on land health and sound land management, as well as eliminate unregulated grazing of domestic cattle on the public range (Wilkinson). The book Crossing the Next Meridian outlines a system in which the BLM can “bring an end to the rancher’s code” to create the drastic change needed:

The agency should make the first, critical land management decision by deciding which acres can properly be used for grazing and which cannot, either permanently or for a few years. For those areas where domestic grazing will be allowed, federal officials should then insist that sound management plans be adopted within a realistic time frame, no more than one or two years: among other things, cattle should be excluded from all
riparian zones for most of each year, and stock should be rotated through upland pastures. Ranchers should be encouraged to adopt goal setting and integrated planning and management. These approaches usually lead to an acceptable plan from the standpoint of federal law. When a rancher refuses to move with deliberate speed, the agencies can and should exercise the power they have under existing law: to revoke the permit of any rancher who refuses to propose a plan or to comply with an approved plan.

(Wilkinson)

Strengthening the authority and increasing enforcement efforts of the BLM is vital to protect the health of the public rangelands. Charles Wilkinson, author of Crossing the Next Meridian, goes so far as to suggest that Congress ought to “terminate BLM advisory boards, which are dominated by hard-line ranchers and wield far too much power” (Wilkinson). These minor changes within the BLM will incorporate the importance of the surrounding ecosystem to rangeland health, while cracking down on the long-held powers that many cattle grazers have wielded for years.

Another low-hanging fruit option is to lower the amount of animals required to define an operation as a CAFO. The definition is significant, because operations that qualify as CAFOs face far more stringent regulations than those that do not. Therefore, companies can avoid regulation by purposefully disqualifying themselves as CAFOs with narrow alterations. The disparity lies in the varying definitions of what constitutes a CAFO. The definitions vary from state to state, and even county to county. For example, Nez Perce County, Idaho, will only regulate facilities that confine at least 1000 animal units for a minimum of 90 consecutive days (Kapplan). Therefore, an operation that
contained more than 1000 animals for only 80 days would evade local regulation. To include more operations under regulation, more broad definitions should be adopted. Replacing language like “confined for X consecutive days” for more general wording like “maintained for a total of X days” qualifies more operations to be considered CAFOs, therefore subjecting them to regulation (Kapplan). If a national definition becomes standard, the federal government can require that states and counties either adhere to their minimum definition, or create a stricter one, as is common with most other environmental standards. That way the proposed regulations and policies will be applied to more operations, greatly reducing widespread environmental degradation.

Simple definition changes within the BLM and beyond can have widespread implications that will reduce the adverse effects of industrial animal agriculture.

SECTION E. SUBSIDIES, TAXES, AND FEES: UTILIZING PRICING MECHANISMS

One major policy flaw that sustains the scale and harm of this industry, therefore driving environmental degradation, is inaccurate pricing and obsolete subsidies. A top policy priority should be to make prices and fees reflect the full economic and environmental costs of producing meat, including most or all externalities (“Livestock’s Long Shadow”). Monetary incentives play a critical role in altering economic behavior, with economic instruments such as subsidies to encourage positive behavior, and negative instruments like taxes and fees to discourage or punish negative outcomes. Industrial animal agriculture shelters a wide variety of distorted prices that sustains its destructive behavior: “many of the inefficient, degrading, wasteful or otherwise damaging aspects of livestock production result from distorted price signals that discourage efficient resource use and foster misallocation and uncontrolled degradation
of resources” (“Livestock’s Long Shadow”). This section will delve into the use of pricing mechanisms as a policy tool to reduce the environmental degradation and control the meat industry beginning with subsidies, then shifting to water pricing, and ending with taxes and other fees.

SECTION E1. SUBSIDIES

Livestock production is highly dependent on subsidized resources, and these often perverse subsidies tend to encourage environmentally harmful practices. Animal agriculture is dependent upon natural resources such as land, water, energy, and soil nutrients. Yet the prices that producers pay to utilize these goods and services are “almost universally underpriced because of policy distortions” (“Livestock’s Long Shadow”). Distortion in allocation of resources occurs from unequal support across commodities, which causes farmers to concentrate on the most subsidized commodities, leading to “reduced cropping flexibility and increased specialization” (“Livestock’s Long Shadow”). This is what fuels monoculture, which as seen in Chapter Three is highly detrimental to the surrounding ecosystem and species. Many of the current subsidies fund the growth of crops which are not foods for direct human consumption, meaning policy makers must “reevaluate whether subsidizing fossil-fuel-intensive industrialized agriculture is serving the best interests of our nation” (Angelo).

In order to reevaluate the current subsidies in place, a criteria for subsidies must be established that incorporates ecological values and eradicates pricing mechanisms that support environmentally damaging behavior. One fundamental flaw that needs to be eradicated is that many subsidies that currently support the industry are products of 1930s legislation in response to the Great Depression and the Dust Bowl (Angelo). Subsidy
criteria should include questions such as “are the goals of the legislation passed in the 1930s in response to the Great Depression and the Dust Bowl the goals that are most salient today? If not, what other goals must be considered? Even if our goals remain largely the same, is the currently labyrinthine agricultural subsidy system really meeting the stated goals?” (Angelo). If the United States is to have an economically and ecologically sustainable food supply, it must stop subsidizing high-yield monoculture and industrial commodity production and instead promote less energy and water intensive, more ecologically inclusive, and diverse forms of agriculture.

A shift from this intensified commodity-crop program to a sustainable, diverse, conservation-based agricultural production system is essential for the United States. In order to include ecological principles into farming practices, farmers should be rewarded to protect and conserve natural resources and ecosystem services. Recognizing ecosystem services seeks to protect and restore the multitude of services that ecosystems provide such as purifying air and water, detoxifying and decomposing waste, renewing soil fertility, regulating climate, mitigating droughts and floods, controlling pests, and pollinating plants (Angelo). Incentivizing farmers to partake in sustainable agriculture that enhances natural resources and ecosystems is a win-win situation, as this model still encourages necessary food production while ensuring a robust and diverse environment, that in turn promotes crop growth in a positive feedback loop (Angelo). The British government is currently considering implementing this subsidy, debating plans to “pay farmers who manage their lands in a way that helps prevent flooding in towns and cities” (Harrabin). Promoting this ecosystem service would include treating river catchments that benefit wildlife, slowing the flow of water, and improving water quality (Harrabin).
British environmentalists are pushing the issue even further, demanding that “all farmers should be obliged to catch water on their land if they want to receive EU farm funds” (Harrabin). This type of requirement falls directly in line with the regulatory framework of Title IX jurisdiction, and the United States could follow a similar path by requiring all farms that receive federal subsidies or funding to adopt ecosystem management to promote these beneficial ecosystem services, therefore holding farms up to higher standards and reducing pollution.

In order to integrate ecosystem services payments into federal farm policy, Congress ought to begin by funding research “to determine how to calibrate farm practices with ecosystem service delivery at local sales” (Angelo). Next, they should develop national standards for “quantifying ecosystem service values associated with agricultural lands, including the development of proxies that can inexpensively be measured to estimate delivery service potential” (Angelo). Congress should also give preferential treatment to those farms whose ecosystem services are of measurable value to local and regional populations (Angelo). The final step to begin to incorporate ecosystem services into national farming practices is to fund pilot demand-based state and local farm multifunctionality programs (Angelo). If this type of system is deemed functional, an overhaul of the current monoculture-incentive program will be necessary in order to effect the change necessary to return lands back to biological health.

Subsidizing ecosystem services and the protection of natural resources is not only completely sensible, it is entirely justified. Compensation for sustainable practices promotes vital ecological health, and also adheres to the Paris agreement. Recall from Chapter Seven that the COP21 text calls for “safeguarding food security and ending
hunger, and the particular vulnerabilities of food production systems to the adverse impacts of climate change”. Healthy and diverse ecosystems are less vulnerable to climate change, and will work to ensure robust crop production. The agreement also states that parties must work to ensure “the integrity of all ecosystems, including oceans, and the protection of biodiversity” (“Paris Agreement”). Shifting the current commodity crop system to one that rewards sustainability and ecosystem protection and restoration is essential for returning the nation’s land to biological health.

SECTION E2. WATER PRICING

Another major market failure in pricing of natural resources regards water prices for American agriculture. Recall that 80-90% of water consumption in the United States is attributed to agriculture, and over 60% of that water goes directly to livestock (“How Much Water”) (Riebel and Jacobsen). Almost all of this water is heavily subsidized and extremely underpriced\(^{23}\). In fact, farmers pay as little as 1-5 cents per cubic meter of water, while households pay 30-80 cents for the same amount (“Livestock’s Long Shadow”). Therefore the use of this scarce natural resource is typically wasteful, highly inefficient, and statistically unsustainable in the livestock industry. The government should reevaluate its current subsidies and create policy to bring water prices to a more accurate amount to ensure conservation and efficient use.

To have agricultural water prices reflect their true cost, the full cost of water must be evaluated and applied. The following components must be considered:

- Full supply cost (including operation, maintenance, and capital investment)

\(^{23}\) Revisit section B of Chapter Eight for an outline of current subsidies.
- Full economic cost (including full supply cost plus opportunity costs and economic externalities)
- Full costs (full economic cost plus environmental externalities)

Once these factors are calculated, the prices should signal and reflect the true scarcities of water, as well as the cost of providing the service (“Livestock’s Long Shadow”). This will encourage more efficient water use and would likely incentivize farmers to shift to producing crops directly for human consumption rather than for livestock feed. Recall that growing an equivalent amount of plant protein as compared to beef requires 15 times less water, and other vegetables requiring up to 50 times less water. This dramatic shift to plant-based crop cultivation is exactly what regulations should aim to achieve.

SECTION E3. OTHER TAXES AND FEES

Beyond ridding the system of obsolete subsidies, creating new ones to incorporate ecosystem services, and reworking water prices to reflect true economic cost, there are several other outlets for pricing mechanisms to control the adverse effects of industrial animal agriculture. Taxes and fees should be imposed on other resources and externalities to curb their detrimental effects.

Carbon Tax

One major outlet for curbing livestock-related emissions is to impose a national, economy-wide carbon tax. A carbon tax is widely regarded as the most critical and effective means of mandating greenhouse gas reductions. The root cause of climate change is that the atmosphere is a global commons and it is currently free for polluters to dump greenhouse gases into the air (Dessler).
While a carbon tax would likely only initially control point sources of greenhouse gas emissions, terrestrial carbon release must also be considered. There is widespread destruction of these vital carbon sinks, whose protection are vital in the combat against climate change. Recall from Chapter Five that soils are the largest carbon reservoir in the terrestrial carbon cycle, so any mere disturbance will release the trapped CO2. Then remember from Chapter Three that animal agriculture is the number one anthropogenic land user and the primary cause of desertification, and therefore is the main culprit in releasing carbon dioxide from vulnerable land sinks. In the meantime, point source regulation should target manure lagoons and other waste handling sites, then follow up with nonpoint source pollution from the cows themselves (similar to automobile tailpipe emissions).

Including animal agriculture in a national carbon tax would require harmful methane emissions to be captured and controlled. The technology already exists to capture and reduce methane emission from this sector, but it must be either required or incentivized through use of a carbon tax. Energy and transportation sectors would also be targets of a carbon tax. Seeing as meat production is heavily dependent on fossil fuels at all stages of its lifecycle, the production costs would increase as well. Regulating emissions from transport and energy sectors will reduce meat’s carbon footprint and may incentivize producers to switch to renewable energy sources. This would make the costs of final meat products rise, disincentivizing consumer purchase. With the Paris Agreement signed into power and attempts to keep warming below 1.5 degrees Celsius, carbon tax legislation will almost inevitably make its way to Capitol Hill in the coming future.
Other

Specifically regarding livestock, there are several fees and taxes that should be used as control mechanisms. Many of the natural resources that the sector depends upon are free or underpriced, “which leads to overexploitation and pollution” (“Livestock’s Long Shadow”). Below is a list of suggested fees and taxes to curb and control environmental degradation pertaining to natural resource use:

- Impose market-based grazing fees to halt overgrazing and land degradation
- Establish a progressive grazing tax, charging higher fees for larger herds
- Secure tradable rights to water, land, and use of common land and waste sinks
- Charge land taxes to encourage more productive use
- Employ zoning regulations to discourage large concentrations of intensive livestock production that is far and decoupled from cropland where nutrients could be recycled (“Livestock’s Long Shadow”)

Shifting the economic burden away from the producer, a final pricing mechanism that would yield widespread environmental benefits is a Pigovian tax on meat and dairy products. A Pigovian tax “is a tax levied on any market activity that generates negative externalities (costs not internalized in the market price). The tax is intended to correct an inefficient market outcome, and does so by being set equal to the social cost of the negative externalities. In the presence of negative externalities, the social cost of a market activity is not covered by the private cost of the activity. In such a case, the market outcome is not efficient and may lead to overconsumption of the product (“Pigovian
Tax”). This is the exact circumstance plaguing the case for the meat industry. Increasing consumer prices to reflect the marginal damage costs would result in animal products rising in price to carry their associated social costs (Sall). This sin tax would “provide incentives to reduce environmentally damaging practices in animal food production, and at the same time promot[e] the dietary changes needed” (Sall). Chapter Three highlighted the gaping inefficiencies of a carnivorous diet as compared to a plant-based diet, with beef boasting the largest amounts of land, water, and greenhouse gasses. Beef also benefits the most from price distortions in the form of subsidies, so imposing a meat tax would pass the economic burden to consumers to internalize the detrimental externalities of their dietary preferences.

Evidence shows that this method is an effective means of reducing consumption. Recently, Sweden imposed a Pigovian tax on meat and dairy products to combat the rising demand and the associated greenhouse gases, and found that the products are elastic, or are sensitive to price change. The researchers imposed a tax level for each meat product that was “derived from the environmental damage caused by GHG, nitrogen, ammonia and phosphorus at the production stage of that meat and dairy product” (Sall). Depending on product and environmental impact, taxes ranged from 1.7% - 32% of price, and led to an average of 12.1% reductions in consumption of livestock products (Sall).

The United States already taxes cigarettes, alcohol, and gasoline to help pay for their associated health and environmental costs, and meat consumption and production has similar adverse health and environmental effects. This tax could reduce demand for meat products, in turn reducing “skyrocketing annual healthcare costs” associated with
eating a carnivorous diet, environmental degradation, and greenhouse gases (“Tax Meat”).

SECTION F: ROOM FOR REGULATION

Regulations are the most important tool in the policy toolkit for controlling environmental damage. They are often applied to sources of air, water, and soil pollution, as well as resource use (“Livestock’s Long Shadow”). Regulations typically require specific technologies or universal emission limits, and are the “policy instrument of choice at the early stages of addressing environmental objectives” (“Livestock’s Long Shadow”). This section will provide regulatory mechanisms for waste pollution, greenhouse gases, and water pollution.

SECTION F1: CONTROLLING WASTE POLLUTION

Animal waste is a tremendous environmental hazard, not just because of its effects, but also because of the sheer quantity of it. American livestock produce 3.3 trillion pounds of manure annually, which is 13 times the amount of yearly waste produced by humans (Riebel and Jacobsen). Left untreated it produces greenhouse gases, emits nitrous oxide, leaches toxins into soil, and eutrophies water. Approximately 82% of American rivers and streams and 77% of lakes that fail to meet water quality standards are impaired because of agricultural runoff (Percival). Despite their being 13 times less of it, human waste within cities and municipalities is highly regulated, with stringent laws mandating vital infrastructure to collect and treat waste properly. Since animals in this country create 13 times the amount of waste that humans do, government agencies need
to impose stricter regulations on controlling livestock waste to prevent pollution and include strong enforcement mechanisms to ensure compliance.

To begin, water quality monitoring efforts need to be expanded to comprehensively identify quality-impaired rivers and lakes. The EPA should then set very stringent total maximum daily loads, or TMDLs, for clean and impaired waters with ecosystems in mind, and identify point and nonpoint sources responsible for impairment. Controlling nonpoint sources of pollution is vital to reducing water pollution from agriculture. The EPA should “impose stormwater treatment requirements on agricultural discharges that are currently not subject to CWA regulation because they are not defined as point sources” (Angelo). Agricultural nonpoint sources are a major source of pollution, and though the same technological fixes that are applied to point source discharges may not be feasible for nonpoint pollution, appropriate technology-based standards should be identified and imposed as necessary (Angelo). Finally, discharge permits and best management plans should be implemented with close monitoring and strict enforcement (Percival). States should aid in enforcement in case of insufficient EPA oversight and increase investigations into potentially damaging or noncompliant facilities.

Codes of conduct requiring certain management practices and emissions limits should be included in regulatory framework and can be imposed utilizing legislative framework similar to Title IX. Fencing and buffer zones should be required in order to prevent cattle from polluting delicate water sources or other ecologically sensitive areas. Fencing should be used to exclude livestock from badly degraded or sensitive sites, and any riparian zones to prevent direct deposition of manure into water ("Livestock’s Long
Shadow”). These fences should be designed and constructed as to not impair habits of wildlife in the surrounding area (“Livestock’s Long Shadow”).

Conservation buffers, or “strips of land along freshwater courses under permanent, relatively undisturbed vegetation” should also be required (“Livestock’s Long Shadow”). These buffer zones provide several ecosystem services (as described in the Subsidies section), including slowing water runoff, removing pollutants, improving filtration, and stabilization of riparian areas (“Livestock’s Long Shadow”).

Beyond controlling waste runoff, fencing can help return ecosystems back to biological health. One of the most extensive studies conducted analyzing the return of degraded rangeland took place in Camp Creek, Oregon (Wilkinson). Camp Creek, “where the soils, water, and wildlife have been so thoroughly worked over since the 1880s” became an experimental ground for the BLM and Oregon Fish and Wildlife Service (Wilkinson). They fenced a square mile of Camp Creek to keep cattle out and studied it for decades. About 20 years later, the ecosystem was almost completely revived. The vegetation returned, there was about 6 inches of new soil, the fish reinhabited the stream, mule deer tracks were sighted, and native birds were abundant (Wilkinson). As the BLM wildlife biologist who conducted this project stated, “nature is ten times the stabilizer that our engineers are. We don’t tell the stream where it needs help. We let the stream tell us” (Wilkinson). Camp Creek is a powerful example of what ecosystem management and best management practices can do to restore and protect damaged lands.

24 For example, the top wire on both riparian pastures and riparian enclosures should not be barbed because riparian areas provide big-game habitat and water for surrounding uplands.
Fencing and buffer zones are extremely simple, cheap, and effective ways of restoring ecosystem health and reducing pollution. Codes of conduct requiring certain fencing mechanisms, management practices, and emissions limits should be included in regulatory framework and can be imposed utilizing the federal spending clause utilized in Title IX. Fencing and buffer zones should be required in order to prevent cattle from polluting delicate water sources or other ecologically sensitive areas. Fencing should be used to exclude livestock from badly degraded or sensitive sites, and any riparian zones to prevent direct deposition of manure into water (“Livestock’s Long Shadow”). These fences should be designed and constructed as to not impair habits of wildlife in the surrounding area\(^{25}\) (“Livestock’s Long Shadow”).

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There are several options to manage sewage at various stages that reduce nutrient loads and their environmental impacts including manure separation and storage, lining of effluent ponds, optimizing land application of manure, reduction of metal, antibiotic, and hormone additives in feeds, and biogas capture and generation (“Livestock’s Long Shadow”). The technology exists to control waste; it just needs to be used.

Creating stricter waste regulations and regulating nonpoint sources like stormwater and runoff from agriculture will reduce adverse like eutrophication and ocean

\(^{25}\) For example, the top wire on both riparian pastures and riparian enclosures should not be barbed because riparian areas provide big-game habitat and water for surrounding uplands.
deadzones. The EPA should issue more stringent total maximum daily load (TMDL)\textsuperscript{26} amounts, and must increase their monitoring and enforcement efforts with the aid of state agencies. It can also require ecosystem management framework, best management practices that incorporate proper fencing mechanisms, and buffer zones to protect sensitive or damaged areas and promote ecosystem health.

SECTION F2: REGULATING WATER POLLUTION

Farms and feedlots are the United States’ largest source of water pollution (Riebel and Jacobsen). The EPA, FAO, and Worldwatch have declared animal agriculture as the leading cause of global species extinction, ocean deadzones, water pollution, and habitat destruction (“What Is a Dead Zone?”). In the United States, livestock are responsible for 55\% of erosion, 37\% of pesticide use, 50\% of antibiotic use, and 33\% of nitrogen and phosphorous pollution into freshwater resources (“Livestock’s Long Shadow”). To control this water pollution, water quality standards must be established and defined locally with ecosystem health as a top priority. The waste control options described in the previous section will greatly aid in reducing water pollution and contamination. These further suggestions to control water pollution and should be coupled with the previously mentioned policy options to ensure optimal water quality. To comply with such standards, different mechanisms can be employed including:

\textsuperscript{26} According to the EPA, a TMDL is a pollution budget and includes a calculation of the maximum amount of a pollutant that can occur in a waterbody and allocates the necessary reductions to one or more pollutant sources. A TMDL serves as a planning tool and potential starting point for restoration or protection activities with the ultimate goal of attaining or maintaining water quality standards. Under section 303(d) of the Clean Water Act, states, territories and authorized tribes are required to submit lists of impaired waters. These are waters that are too polluted or otherwise degraded to meet water quality standards. The law requires that the states establish priority rankings for waters on the lists and develop Total Maximum Daily Loads (TMDL) for these waters (Springmann)
- Setting stringent minimum standard definitions to reduce emissions and effluents to acceptable levels
- Requiring specific technology and equipment to meet said standards
- Creating of a tradable permit system in which units of pollution can be traded on a market
- Specifying maximum industrial activity in sensitive or highly populated areas ("Livestock’s Long Shadow")

These measures should be built into authorization codes that regulate water rights and authorize water access ("Livestock’s Long Shadow"). Monitoring water quality is crucial to ensuring compliance, and violators must be held accountable with established penalties.

An analysis of livestock regulation in the United States showed that “areas with more stringent environmental regulations suffered declines in livestock numbers to counties and states with less stringent regulation (called “pollution havens”) ("Livestock’s Long Shadow"). Imposing waste and other environmental regulations is vital to reducing livestock numbers and transferring our food system away from one dominated by animal agriculture.

SECTION F3: GREENHOUSE GAS REGULATION

Of all the regulations and controls to be imposed, greenhouse gases are the most important. Animal agriculture accounts for about 18-51% of global greenhouse gas emissions, at least 9% of total US emissions, and 36% of US methane emissions.\(^\text{27}\)

\(^{27}\) See Chapter 4 for the various sources of greenhouse gases attributed to the livestock sector, and why 9% is such a conservative estimate.
Yet the United States continues to only focus on reducing greenhouse gas emissions from energy and transportation sectors. The path dependencies of this country run deep as the economy and infrastructure are largely dependent on fossil fuels. The conversion of the entire energy and transportation system from fossil fuels to renewables would cost “trillions of dollars, require political will and consensus that does not appear close to hand… and are expected to take more than a decade to implement fully, by which time the tipping point may long since have passed for irreversible climate disruption” (Goodland and Anhang). As explained in previous chapters, reductions in short-life greenhouse gases lead to quicker warming reductions, and methane is a perfect target. Animal agriculture is responsible for 36% of United States methane emissions, 7% more than natural gas and petroleum operations (Tilman and Clark). Yet in the US’s INDC, policymakers chose to focus on reducing methane from landfills and the oil and gas sector. While regulating those sources is highly essential, there are also great strides to be made by including the livestock industry in emissions reductions efforts.

The Clean Air Act is the primary policy vehicle for regulating US greenhouse gas emissions. Established in 1970, the CAA allows the EPA to classify specific pollutants and then regulate their release into the atmosphere (Verheu). Greenhouse gases are classified as pollutants because they “endanger public health and welfare”, and the effects of climate change on public health include “sickness and death” (Percival). Until now, there have only been federally sponsored voluntary methane reduction programs for the

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28 See Chapter Seven for the complete list of climate actions the United States committed to in their 2015 INDC.
agricultural sector, which garners very little participation\textsuperscript{29}. It is evident that the EPA has the authority to regulate methane emissions from a wide variety of sources, and now it must bring down the regulatory hammer on animal agriculture.

If the Parties of the COP21 agreement are to genuinely pursue a 1.5 degree Celsius target (Article 2.1a), emissions from agriculture will absolutely have to be included in emissions reductions efforts\textsuperscript{30}. Article 4.1 calls for parties to undertake rapid emissions reductions in accordance to the best available science. The best available science shows that animal agriculture contributes more methane than the two sectors the US chose to regulate. The government should adhere to their commitment and follow the best available science and include the largest methane emitter in their INDC for quick reductions. Since this INDC has already been submitted, the next INDC must include agriculture in accordance to articles 4.3 and 4.4, which require all successive INDCs to be more progressive than the current and reflect the country’s highest possible ambition, as well as mandating that emission reduction targets are being made economy-wide. The EPA not only has the authority to regulate emissions from this sector, but it is essentially obliged to as it poses such a large threat to human health. There are several existing methods for capturing and reducing emissions from livestock (anaerobic digesters, improved manure management, conservation tactics etc.), and stringent regulations will lead to much-needed technology forcing.

\textsuperscript{29} So little, in fact, that the EPA has since removed information from their website about the Voluntary Program since this initial research was conducted.

\textsuperscript{30} See Chapter Seven for a case study on what it would take for the US to help achieve a 1.5 degree Celsius target.
SECTION G: PUT THE BURGER DOWN: REDUCING MEAT CONSUMPTION

Ask any vegan or vegetarian and they will tell you just how difficult it is to attempt to convert their friends and family to a plant-based diet. There is a tremendous amount of education, awareness, and personal responsibility that goes into converting to a meatless diet when our whole lives we have been conditioned to believe that meat and animal-products are an essential part of our diet. Modern society is constantly surrounded by advertising and media projecting this social-norm that burgers, pizzas, and bacon are not only staples to American diet, but to American culture. This is why this thesis presents top-down solutions to the environmental crisis as it relates to animal agriculture, as opposed to bottom-up. Though necessary, bottom-up voluntary action would require a radical social shift fostered by widespread education and awareness programs, all dependent on the mere hope that the American public finds this cause worthy enough to sacrifice their daily cheeseburger indulgence. This shift in consumer demand and personal responsibility will be beneficial in driving current animal agriculture out of practice, but because of the massive scale and lethality of the problems, top down control is imperative. Instead of solely relying on the public to make the personal choice to switch to plant-based diets, there are outlets for top-down action to reduce national meat consumption.

Recall the vast inefficiencies of producing meat as discussed in Chapter Three. Growing the same calories of plant-based food compared to beef requires up to 160 times less land, 8-50 times less water, and 11 times less greenhouse gases. Meanwhile the federal government spends millions of dollars subsidizing large-scale water projects and commodity crops that foster this inefficient food system (Eshel et al.). Livestock and their
feed crops consume half of the nation’s fresh water. As this precious resource grows ever scarce, it must be allocated more efficiently. The federal government can directly reduce national meat consumption and facilitate the necessary shift towards plant-based diets by altering national dietary guidelines, which dictate and guide what millions of Americans eat each year.

In 2015 the Dietary Guidelines Advisory Committee (DGAC) decided to incorporate sustainability into their Federal Nutrition Recommendations. This incorporation was based on the reasoning that it is important to have “alignment and consistency in dietary guidance that promotes both health and sustainability”, and recognizes “the significant impact of food and beverages on environmental outcomes, from farm to plate to waste disposal, and therefore, the need for dietary guidance to include the wider issue of sustainability” (“Scientific Report”). The guidelines state that “addressing this complex challenge [sustainability] is essential to ensure a healthy food supply will be available for future generations. The availability and acceptability of healthy and sustainable food choices will be necessary to attain food security for the US population over time” (“Scientific Report”). The report cited figures similar to those previously alluded to in this thesis31, including that “global production of food is responsible for 80 percent of deforestation, more than 70 percent of fresh water use, and up to 30 percent of human-generated greenhouse gas emissions. It also is the largest cause of species biodiversity loss” (“Scientific Report”). When seeking to construct a sustainable diet, the DGAC sought to “determine dietary patterns that are nutritionally adequate and promote health, while at the same time are more protective of natural

31 See Chapter One and Chapter Three for statistics on the environmental harm caused by animal agriculture.
resources” (“Scientific Report”). The report states “consistent evidence indicates that, in general, a dietary pattern that is higher in plant-based foods, such as vegetables, fruits, whole grains, legumes, nuts, and seeds, and lower in animal-based foods is more health promoting and is associated with lesser environmental impact (GHG emissions and energy, land, and water use) than is the current average US diet” (“Scientific Report”).

Naturally, when the meat industry found out about this potential incorporation, there was uproar. Having federal nutrition guidelines suggest Americans eat less meat would take a massive toll on their industry, so they wielded their long held political power to stop it. The North American Meat Institute declared the DGAC was going “well beyond its scope and expertise” in incorporating sustainability in US dietary guidelines (Watson). Representative Robert Aderholt (R-Alabama), who serves as chairman of a subcommittee of the House Appropriations Committee that handles agriculture, stated that he and the committee expected the final report “to only include nutrient and dietary recommendations and will not include environmental opinions” (Aubrey). The meat industry lobbied against this inclusion for an extensive amount of time, and eventually caused enough disruption and protest that the addition of sustainability in the 2015 nutrition recommendations was fully removed.

Incorporating sustainability in the national nutrition guidelines is not only well within the scope and expertise of the DGAC, it fits directly into their role. In a legal analysis conducted by public health attorney Michele Simon, she noted that the dietary guidelines also include issues such as physical activity and food safety, “which are arguably outside the realm of nutritional and dietary information”. She added “our analysis of the law, including Congressional intent, clearly shows that USDA and HHS
would be well within its mandate to incorporate sustainability in the Dietary Guidelines for Americans” (Watson).

These nutrition guidelines set the standard for most federally funded food programs, including school and prison meals. The guidelines are taught in school health programs, are used in doctor’s offices nationwide, and are plastered everywhere and in between. Therefore, “they have a vast and perhaps immeasurable influence” (Watson). Including sustainability within the guidelines would drastically reduce national meat consumption and help facilitate the shift to the sustainable agriculture system necessary.

Incorporating sustainability will not only address several articles of the Paris Agreement, but it will also increase food security. By fostering sustainability and incorporating ecosystem services, biodiversity is encouraged and makes crops far more resilient to climate change than monoculture. The next national nutrition recommendations will be created and issued in 2020, and policymakers must not succumb to the powerful beef industry and include sustainability in the standards in order to reduce greenhouse gas emissions, reduce resource consumption, and dramatically shift the American agricultural system to directly incorporate sustainability into its core values.
CHAPTER TEN: RESTATEMENT OF RECOMMENDATIONS CORRELATED TO THE PARIS AGREEMENT AND CONCLUSION

“A new ethic is required -- a new attitude towards discharging our responsibility for caring for ourselves and for the earth. We must recognize the earth's limited capacity to provide for us. We must recognize its fragility. We must no longer allow it to be ravaged. This ethic must motivate a great movement, convincing reluctant leaders and reluctant governments and reluctant peoples themselves to effect the needed changes.”

(“1992 World Scientists’ Warning”)

The planet is in perilous condition, and unless swift and drastic change is enacted on both political and personal levels, the future looks bleak. One of the simplest and most effective methods of improving the earth’s condition is to change dietary preferences and methods of food production. The United States, which accounts for only 5% of the world’s population but 25% of the world’s CO2 emissions, is especially obliged to reduce its carbon footprint (Fox). But it owes the planet more than that, because below the atmosphere, into the coral reefs, the prairies of the midwest, all the way down into the microbes in the soil, there is widespread damage being caused by an unnecessary and destructive food production system. Animal agriculture has enjoyed widespread subsidies, regulatory exemptions, and long-held political powers for decades. Now with international policy demanding accountability for the widespread terrestrial, oceanic, and atmospheric degradation, the meat industry will have to be controlled for their widespread externalities and damages.

The Paris Agreement serves as a fantastic guideline for influencing the US policy making process regarding animal agriculture. This concluding chapter will revisit articles of significance that commit the United States to controlling the environmental impacts from the meat industry.
Annex line 10:
The United States recognizes “the fundamental priority of safeguarding food security and ending hunger, and the particular vulnerabilities of food production systems to the adverse impacts of climate change”

Ending hunger: Recognizing that ending hunger is a fundamental priority, the United States must reconsider its dietary preferences. As stated in the introduction, one study found that the earth could feed 10 billion people on a primarily vegetarian diet, but only 2.5 billion on a highly carnivorous, typical American diet (Riebel and Jacobsen). Another study actually found that the amount of cereal and grain consumed by the animals Americans raise for food could feed 3 billion people on a mostly vegetarian diet (Riebel and Jacobsen). As the human population is projected to increase dramatically and millions of people are already starving or malnourished, the US must no longer systematically encourage this inefficient and wasteful food production system.

Safeguarding against adverse impacts of climate change: The third priority listed in this clause of safeguarding food production systems to the adverse impacts of climate change should signal the need to eradicate monoculture and increase resiliency through ecosystem restoration and preservation. In order to achieve this, commodity-crop and Depression-era subsidies\(^{32}\) need to be reevaluated to meet the criteria discussed in Chapter Nine, and ecosystem services should be rewarded to promote sustainable production.

\(^{32}\) See Chapter Two for the historical development of these subsidies.
Annex Line 14:

The United States notes “the importance of ensuring the integrity of all ecosystems, including oceans, and the protection of biodiversity”

Ecosystems: The EPA, FAO, and Worldwatch have declared animal agriculture as the leading cause of species extinction and habitat destruction, and agriculture is listed as the principal habitat threat affecting endangered species in the US (“What Is a Dead Zone?”) (Primack). Nearly 98% of American tallgrass prairie has been converted to farmland, and over half of the contiguous US is devoted to the livestock sector (Primack) (Glaser et al.). Thus, incorporation of ecosystem management must be central to federal policy initiatives, with market-based incentives as a potential tool for rewarding the protection of ecosystem services and conservation of natural resources. Other market-based fees for overgrazing and land degradation must be imposed, and taxes can be created to control herd sizes and land use.

Oceans: Agricultural runoff from even the most landlocked of states causes detrimental ocean dead zones, and approximately 82% of American rivers and streams that fail to meet water quality standards are impaired because of agricultural runoff (Percival). Agencies must require fencing and buffer zones in accordance to Best Management Practices, require similar management and treatment techniques as required of human waste management, close loopholes within the Clean Water Act, impose restrictions on non-point sources for agriculture, issue more stringent total maximum daily loads, increase enforcement mechanisms, and craft all of these policies with ecosystem health as the main priority.

33 See introduction of Chapter Nine for the definition of ecosystem management.
**Biodiversity:** Globally, 37% of terrestrial ecosystems reported livestock as one of their current threats, 66% of global biodiversity hotspots are negatively affected by livestock, and the IUCN shows that the majority of Red List threatened species are suffering habitat loss due to livestock\(^{34}\) (“Livestock’s Long Shadow”). Nationally, agriculture is the number one threat to endangered species, with livestock grazing ranking fifth (Primack). Again, policy needs to be targeting the incorporation of ecosystem health and viability\(^{35}\) in order to protect the remaining habitat and species still in existence.

**Annex Line 17:**

The United States recognizes “*that sustainable lifestyles and sustainable patterns of consumption and production, with developed country Parties taking the lead, play an important role in addressing climate change*”

**Sustainable Consumption:** According to the DGAC, sustainable diets are “a pattern of eating that promotes health and well-being and provides food security for the present population while sustaining human and natural resources for future generations” (“Scientific Report”). Instead of growing food for animals (that are raised to be eaten as food), the vast amount of grains and crops could instead be fed to people. Recall that plant-foods have a far smaller environmental impact than meat, averaging 160 times less land, 8-50 times less water, and 11 times less greenhouse gases (Eshel et al.). An organically grown vegan diet is shown to have the lowest estimated impact on resources and ecosystem quality, whereas the diet with the highest environmental impact foods

\(^{34}\) Refer back to Chapter Three, Sections C and D for more information about habitat destruction and species extinction.

\(^{35}\) This can be achieved by requiring that farms adopt ecosystem management, as described in Chapter Nine.
included beef, cheese, milk, and seafood (“Scientific Report”). Policy should work to shift national food consumption habits towards plant-based diets, utilizing mechanisms like Pigovian taxes and factoring sustainability considerations into official dietary guidelines.

**Sustainable production:** Livestock production is by far the single largest anthropogenic land user, covering about 45% of earth’s total terrestrial surface (Primack) (Thornton et al.). In the United States, half of the contiguous country is devoted to animal agriculture, and about 2 billion tons of soil are lost annually as erosion due to agriculture (Thornton et al.) (Riebel and Jacobsen). Producing just the feed for livestock requires 17 trillion gallons of water annually, and the amount of water a single cow consumes during its stay in a CAFO is enough to float a destroyer (Jacobson) (Rifkin). Animal agriculture production is almost entirely fossil-fuel dependent, requiring nearly 1600 calories of fossil fuels to produce 100 calories of grain fed beef (as opposed to just 50 calories of fossil fuels to produce an equivalent 100 calories of plant-based food) (Jacobson). To facilitate a shift towards sustainable food production, as called for in the Paris Agreement, the United States should work to limit the land area used for livestock production, stop subsidizing high-yield monoculture, subsidize less resource intensive and diverse forms of agriculture, remove harmful price-distorting subsidies that favor animal production, and charge the full costs of water to ensure efficient use. A national carbon tax will also aid in reducing the harmful effects of industrial agriculture as farm energy use will either be reduced or shifted to renewable energy, and transportation costs will increase (adding costs to meat production).
Article 4.1

The United States agrees to “aim to reach global peaking of greenhouse gas emissions as soon as possible... and to undertake rapid reductions thereafter in accordance with the best available science”

Rapid reductions: Compared to carbon dioxide, methane has a very short atmospheric life. A molecule of methane resides in the atmosphere for about a decade, whereas a molecule of carbon dioxide can reside in the atmosphere for centuries or even millenia (Dessler). Because of its potency, “if we stopped emitting methane today, within a few decades all of the human-emitted methane would be gone, and the atmosphere abundance would be back down to pre-industrial amounts” (Dessler). Therefore, emphasis should be placed on immediate actions to aggressively reduce methane and other short-lived greenhouse gases like nitrous oxide, for which animal agriculture is responsible for 84% (Smith et al.). The United States acknowledges this, and decided to target methane reductions from natural gas operations. However, because the majority of the nation’s methane emissions come from livestock, the meat industry must be incorporated in emissions reduction efforts.

Article 4.3

The United States’ “successive nationally determined contribution will represent a progression beyond the Party’s then current nationally determined contribution and reflect its highest possible ambition”

Highest possible ambition: The United States acknowledges that animal agriculture is a major source of greenhouse gases, but has only created voluntary
programs in attempts to make reductions. The regulatory and physical tools exist to control and reduce the greenhouse gas emissions from the meat industry, and the successive INDC must include them to reflect the nation’s true highest possible ambition.

Article 4.4
The United States shall continue taking the lead by undertaking economy-wide absolute emission targets.”

Economy-wide targets: Despite receiving billions of dollars in federal subsidies, accounting for 5% of the United States economy, and generating at minimum 9% of total greenhouse gas emissions and 36% of methane emissions, the US has no determined emissions targets for agriculture (“Ag and Food Sectors”). The 2015 INDC includes targets and methods for energy extraction, energy production, and transportation. While these will regulations will impact the meat industry (fossil-fuel dependent from farm machinery to final transport), there are no targets for agriculture itself. Since agriculture is a major economic sector and receives billions in federal subsidies, the EPA has the authority to regulate emissions from this economic sector, and it must be included in the successive INDC.
Article 2.1a

The United States agrees to “Holding the increase in the global average temperature to well below 2 degrees C above pre-industrial levels and to pursue efforts to limit the temperature increase to 1.5 degrees C above pre-industrial levels”

1.5 - 2 degrees Celsius: Livestock are responsible for 18-51% of global greenhouse gas emissions (Goodland and Anhang). They are the most significant contributors of anthropogenic methane emissions (20 times more powerful than CO2), and are responsible for 84% of global nitrous oxide emissions (296 times more powerful than CO2) (Smith et al.) (“Livestock’s Long Shadow”). American livestock are responsible for at least 9% of total US greenhouse gas emissions, but represent the majority of national methane emissions (36%). Similar to the rest of the world, the United States chose to focus on emissions reductions from energy production and transportation sectors for their first INDC. However, if the United States are serious about pursuing efforts to keep warming under 1.5 degrees Celsius, regulating animal agriculture will absolutely be essential. Utilizing the aforementioned policy recommendations will help achieve these temperature goals.

CONCLUDING REMARKS

To keep global warming under catastrophic levels, to conserve strikingly scarce natural resources, to keep alive dwindling species and the ecosystems they comprise, and to feed a growing human population, the world and this country need to control the industry that poses threat to all of the aforementioned factors. The United States has not only moral and ethical obligations to shift to a more sustainable food production system, it is obliged to under international agreement. It will take decades for the United States
and the rest of the globe to undo decades of infrastructure and lifestyles dependent on fossil fuels. While this shift to renewables is essential in combatting long-term climate change, the cheapest and easiest answer to immediately combating climate change boils down to what is being served on a plate three times a day.

This thesis has shown that there are plethora of policy tools and option to control the meat industry and its harmful effects in order to facilitate a shift to a sustainable and ecologically sound food production system. The federal government has been shaping American agriculture for centuries, and it must reevaluate its current policies to confront the environmental crisis faced today. When policy makers convene to create the successive 2020 INDC under the Paris agreement, I encourage them to ditch the beef and reach for the low-hanging fruit (and vegetables).
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