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Subsidizing Climate Change: How the Agricultural Business is Harming Our Planet

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Subsidizing Climate Change:
How the Agricultural Business is Harming Our Planet

By Caroline Berejka

Abstract

In exploring the concept of environmental sustainability in the modern age, it is important to look at the practices of the agriculture industry and the role of agricultural production in the multifaceted issue of climate change. The agriculture industry's overwhelming power in the US government and its resistance to moving toward more sustainable practices is an issue that the average American has little awareness of. In order to push the movement of environmental sustainability forward, it is necessary to examine the economic reasons for the slow shift towards sustainable agriculture and possible incentives for industrial farmers to modify their practices. Chapter One uses the EPA's report on Greenhouse Gas Emissions to identify the role of agriculture in climate change. Chapter One examines the growing evidence that agriculture has a large role in climate change and environmental degradation. This chapter details the specific practices and subsets of this industry that are the most detrimental to the environment and focuses on the harms of animal agriculture. Chapter Two outlines the government policies and regulations, which are currently in place, that aim to mitigate the agriculture industries harmful effect on the environment. Chapter Two uses the USDA's National Agriculture Library to identify the major environmental policies and laws that have aimed to regulate or modify current practices used by farmers. This chapter examines the effectiveness of these existing policies. Chapter Three uncovers the lobbying power of large agricultural firms in the United States and the ways that this power has delayed the transitions to more sustainable agricultural practices. Chapter Four showcases the sustainable agricultural practices that are taking place amongst smaller farmers and certain large firms. Chapter Five explores the ways government can shift its

resources from subsidizing detrimental agriculture programs (i.e animal agriculture) and fund more sustainable alternatives.

Keywords: agriculture, sustainable agriculture, environmental policy, environmental economics, animal agriculture, subsidies, lobby, government

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Introduction: Agriculture: The Victim or Villain of Climate Change

Over the past few decades scientists have amassed growing evidence that our climate is growing warmer and human activities are degrading our planet. Many people think of the technological and industrial revolutions as detrimental turning points in our relationship with Earth because these movements brought forth mass production, exploitation of resources, and introduced large quantities of harmful pollutants into our atmosphere. While the industrial and technological revolutions certainly altered and damaged the Earth, humans relationship with Earth and use of its resources was first significantly altered during the agricultural revolution.

The agricultural revolution was the first great turning point in the relationship between man and Earth, as it was the first time in which humans manipulated Earth's natural processes and services to benefit the human species on a large scale. Although most think of agriculture as a natural and environmentally-friendly process, overuse of land and certain agricultural practices can diminish productivity, deplete Earth's resources, and ultimately be harmful to ecosystems and the earth as a whole. Nevertheless, agricultural production is critical to the perpetuation of human life on Earth and man has had to learn the careful planning and balance it takes to maintain crops or farmland. Due to the delicate nature of agricultural production, many have grown concerned about the future of agriculture in the face of climate change. Scientists claim that climate change will bring forth unpredictable and extreme weather patterns, soil erosion, and overall temperature increases. Such sudden changes to our planet will undoubtedly affect crop yields and some argue that they already have. Droughts, floods, hurricanes, unseasonal and odd temperatures have created immense problems for farmers across the world, and many have rightly accused human-induced climate change for causing these problems.

However, it would be a gross misconception to label the agricultural industry as mere victims of the climate change phenomenon. While the agricultural industry is certainly suffering from the effects of climate change, in many ways they have brought forth their own demise. The agriculture industry has been labeled by many as one of the leading sources of carbon dioxide emissions and is responsible for many environmentally destructive practices. The unsustainable practices of the agriculture industry have contributed to climate change significantly and have caused or worsened the issues farmers now face as a result of global warming.

Additionally, much of the agricultural industry cannot claim ignorance to their contributions to environmental destruction. As agriculture has grown into a massive industry, which relies on technology and mass production in order to create particular commodities, they have developed unsustainable practices in order to help them continuously produce their goods. Technological advancements have allowed the agricultural industry to defy ecological limitations and bypass the many issues farmers have already faced caused by climate change. However, these technological solutions have their own limitations and potential harms, and in many cases can exacerbate the existing problems. In the USA, the agriculture industry has a significant amount of money and lobbying power which has allowed them to continue their unsustainable practices while prioritizing cheap mass production over long-term sustainability. This paper will first outline the specific environmental threats posed by agriculture in the U.S., then analyze the policies and regulations in place which aim to mitigate environmental risks. Next, this paper will aim to understand the agriculture industry's role in the U.S economy and their influence on policy. Then, this paper will explore alternative policies and sustainable practices that could be

adopted by agriculture and finally look at the ways that government can push sustainable agriculture forward.

Chapter 1. The Agricultural Industries' Contributions to Climate Change

The agriculture industry's role in environmental degradation and climate change is well documented. There are numerous practices of agricultural firms which directly contribute to global warming and even certain crops or commodities which have been shown to be more destructive than others. The primary environmental issues which agricultural businesses contribute to can be divided into the categories of greenhouse gas emissions, land use, water use, and pollutants. Furthermore, in identifying these primary issues, the animal agriculture industry can be recognized as one of the major contributors to climate change within the agriculture industry overall.

Greenhouse Gas Emissions. Greenhouse gases are gases that trap heat in the atmosphere and warm the overall climate. While greenhouse gases are often produced from natural functions of the Earth, increased human activity has resulted in high concentrations of greenhouse gases in the Earth's atmosphere. The primary human induced greenhouse gases are Carbon Dioxide, Methane, Nitrous Oxide, Ozone, Chlorofluorocarbons (CFCs), and Hydrofluorocarbons or HFCs. The increased concentration of these greenhouse gases in the atmosphere is detrimental to the environment because greenhouse gases have been linked to rapid temperature increases and overall climate change. These rapid temperature increases are shown to have had increasingly negative effects on the planet as a whole and are said to disrupt functioning ecosystems and biological processes. As noted in the UN's "Millennium Ecosystem Assessment", functioning ecosystems and ecosystem services are extremely beneficial to human life and critical to

environmental well-being. However, the globalization and industrialization that has occurred over the past century has brought on an increase of greenhouse gas emissions in the atmosphere, thus leading to the current concerns surrounding climate change. According to the EPA “Carbon dioxide concentrations have increased substantially since the beginning of the industrial era, rising from an annual average of 280 ppm in the late 1700s to 401 ppm...a 43 percent increase”. These numbers are widely accepted by the scientific community and the majority of scientists agree that this significant increase in the concentration of carbon dioxide is a result of human activity. Furthermore, the EPA also claims that “The concentration of methane in the atmosphere has more than doubled since preindustrial times, reaching approximately 1,800 ppb in recent years”. Some believe that the transportation and energy industry are solely responsible for such environmental damages, as a result of burning high concentrations of fossil fuels. However, the agriculture industry has also proven to be responsible for a considerable amount of greenhouse gas emissions in comparison to all other industries. In the annual study entitled “Inventory of U.S. Greenhouse Gas Emissions and Sinks”, the EPA divides sources of greenhouse gas emissions in the US amongst the “economic sectors” of transportation, industry, electricity, agriculture, and commercial & residential. According to the EPA, the agriculture industry alone was responsible for about 9% of greenhouse gases in comparison to these other sectors in the United States, in 2015(EPA 2017). While this number is small in comparison to other sectors, this number could be greatly reduced and the effects of climate change could be significantly mitigated if the agriculture industry made further commitments to eliminate environmentally detrimental agricultural practices and increase the use of sustainable agricultural methods. Due to certain practices of the agriculture industry, the agriculture sector is mostly

responsible for emitting carbon dioxide, methane, and nitrous oxide. Furthermore, the EPA is not the only organization that has recognized the agriculture industry for its harmful contributions to climate change, the Food and Agriculture Organization divides the categories amongst industries somewhat differently and attributes 21% of greenhouse gas emissions worldwide to “Agriculture, forestry, and other land use”, with agriculture accounting for the largest share of emissions within this subcategory (FAO 2016). Furthermore, the exponentially increasing population requires a greater demand for food, which presupposes that these numbers will only continue to increase. In their evaluations of agricultural practices, the EPA has recognized management of agricultural soils, livestock, livestock manure management, and rice cultivation as some of the greatest sources of greenhouse gas emissions within the agriculture industry. Additionally, the Food and Agriculture Organization notes that a significant amount greenhouse gases emissions can be attributed to pre- and post production food processing, which is often factored into emissions released by “Industry”, rather than agriculture. While it may not appear that agriculture plays a large role in release of greenhouse gas emissions in comparison to other economic sectors in the US, the many facets of the agricultural industry must be taken into account. Ultimately, changes in technique and accounting for all GHGs released during agricultural production reveal the critical impact agriculture has on worldwide greenhouse gas emissions.

Land Use. The Agriculture sector requires vast amounts of land to produce their goods, and accounts for around 51% of land use in the US (EPA 2017). Land use for agriculture can lead to deforestation, habitat loss, soil erosion, and environmental degradation of existing croplands. Issues of deforestation for conversion to cropland is a larger issue in developing

countries that continue to expand their cropland as their populations and economies grow. The United States Department of Agriculture has stated that “the amount of land used for U.S. crop production has remained relatively stable for the last 100 years.” and therefore cropland conversion is less of an environmental concern in the United States (UDSA 2017). However, the small-scale deforestation that does occur to create cropland in the US continues to damage and reduce habitats which provide essential ecosystem services and are homes to keystone species. Furthermore, deforestation for croplands can lead to an overall reduction in the forest areas in the United States and therefore reduce the capacity for biological carbon sequestration. Biological carbon sequestration is the ability of plants and trees to capture and store carbon dioxide from the atmosphere. Due to the high amounts of carbon dioxide the agriculture industry emits, the losses in forest land and thus, a loss in capacity for carbon sequestration, continues to exacerbate climate change. Additionally, some farmers have been known to convert wetlands into cropland as well. Wetlands are also essential ecosystems which are home to unique animal and plant life and provide ecosystem services which help regulate floodwaters and protect water quality. While there are laws and regulations in place which have reduced the occurrence of wetland conversion, this agricultural practice is extremely harmful when attempted.

However, there are many other concerns surrounding the potential damages of overused croplands across the United States. One of the main environmental concerns surrounding agricultural land use in the US is soil quality. Soil quality can be compromised by overuse and leads to soil degradation and soil erosion. According to the USDA “Soil erosion involves the breakdown, detachment, transport, and redistribution of soil particles by forces of water, wind, or gravity”. This occurs when farmers plow their fields and leave soil exposed to the elements.

Eventually, wind and rain sweep soil into rivers and lakes. According to Anson Bertrand of the US Department of Agriculture “The economic pressure-- to generate export earnings, to strengthen the balance of payments and thus the dollar-- has been transmitted more or less directly to our natural resource base. As a result soil erosion today can be described as epidemic in proportion” (Brown and Wolf, 5) Here, Bertrand explains that the ever-growing demand for food is greatly harming soils worldwide as it has led to overuse of lands and farming techniques that aim increase production, yet harm soils in the process. Meanwhile, the FAO reports that soil degradation is considered to be “ a change in the soil health status resulting in a diminished capacity of the ecosystem to provide goods and services for its beneficiaries.” This is different from soil erosion, and refers to the reduced productivity of the soils that remain after erosion takes place. Consequently, “According to a 2006 study published in Science, the loss of soil and water from US cropland decreases productivity by about \$37.6 billion per year”. Additionally, Crosson (Journal of Environmental Economics, 2007) estimated the loss in farm income in the US per year at \$100 million US dollars as a result of soil erosion.” Overall, agriculture’s use of land is not only extensive but harmful in practice. Crop conversion and soil degradation are harmful to essential ecosystems, to perpetuation of climate change, and the future of agricultural productivity.

Water Use. One of the largest environmental concerns surrounding industrial agriculture is water use. According to United States Geological Survey (USGS 2017) water use data, agricultural irrigation accounts for approximately one-third of all water withdrawn in the U.S. on a daily basis. The amount of water that the agriculture industry uses is a major concern because water supply has continued to become scarce in the face of climate change and water quality has

been affected as well. The scarcity is a result of higher population growth, higher prevalence of wasteful and unsustainable uses of water, warmer temperatures melting ice caps, and greater levels of water contamination.

The Food and Agricultural Organization, which divides worldwide water withdrawal into the categories agricultural, industrial, and municipal withdrawal claims that the agricultural sector accounts for 42% of total water withdrawn in the United States (FAO 2017). Agricultural water comes from a variety of sources such as surface water, groundwater from wells, and rainwaters. In addition, agriculture sometimes uses municipal water systems such as city and rural water. However, agriculture water use is not only considered to be the water that plants take in for growth. Farmers use irrigation system to direct water from its source to their farm for a variety of uses. Agricultural irrigation includes water used before, during, and after growing seasons to suppress dust, prepare fields, apply chemicals, control weeds, remove salt from root zones, and protect crops from frost and heat, as well as other activities needed for harvesting. Additionally, the process of irrigation and many of the uses of water on farms pollutes water and greatly reduces water quality, thus further limiting the supply of freshwater available. While some might suggest that the agriculture industry become less reliant on irrigation and convert to rainfed cropland, it has been shown that irrigated land is more than twice as productive as rainfed cropland, and thus is not a viable option for countries with a booming population.

While water is absolutely necessary for productive agriculture, it is a finite resource that is essential for human life, and overuse or misuse of water is a growing concern. Overuse within a watershed can lead to unintended consequences, such as water shortages, the need for additional treatment, and higher costs from storage and distribution. Water withdrawal in

agriculture has steadily increased over the last century. In 2005, total irrigation withdrawals were 9 % less than just five years later in 2010. Furthermore, “about 62,400 thousand acres were irrigated in 2010, an increase of about 950 thousand acres (1.5 percent) from 2005”. While this makes sense due to the ever-increasing worldwide population, it is important that agriculture find ways to reduce water use maintain water quality in order to preserve this finite resource and ensure food security for future generations. In analyzing water use within the agriculture industry it is also important to look at the most water intensive crops and goods produced. Crops have specific water requirements, and these vary depending on local climatic conditions. Whereas an indicative figure for producing one kilogram of wheat is about 1000 litres of water that is returned to the atmosphere, paddy rice may require twice this amount. The production of meat requires between six and twenty times more water than for cereals, depending on the feed/meat conversion factor (USDA 2017). Analyzing which crops are more water intensive is one of the keys to pushing forward sustainable agriculture in the future, as countries must prioritize crops that do not drastically infringe on their water supplies.

Pollutants. As the world population has dramatically increased, farmers have looked for ways to push ecological limits and drastically increase their crop yields. This issue caused the widespread use of pesticides and fertilizers in everyday farming. Pesticides are primarily used in order to kill or detract “pests” from feeding on agricultural crops. While pesticide use has drastically increased food production, pesticide use is also considered to be controversial by many for their effects on animals, the environment, and to human health. Nevertheless, pesticide use in the US has continuously increased over the past few decades. In a report document by the Union of Concerned Scientists, it was revealed that 383 million additional pounds of herbicides

have been used on genetically engineered crops since 1996. These results in comparison to what would have been used if genetically engineered crops had been replaced by conventional, non-GE varieties. Furthermore, according to the EPA, U.S. pesticide expenditures at the producer level totalled nearly \$9 billion in 2012 . Meanwhile, between 2008 and 2012, U.S. expenditures accounted for 18-16% of total world pesticide expenditures. “When differentiating amongst types of pesticides, in 2012, U.S. expenditures accounted for 21% of world expenditures on herbicides , 14% of world expenditures on insecticides, 10% of world expenditures on fungicides, and 23% of world expenditures on fumigants” (EPA 2017).

Although these pesticides have been extremely beneficial in increasing crop yields, and are perhaps necessary to maintaining and increasing yields in traditional agriculture, the ecological effects have shown to be harmful. The pesticides used in agriculture do not only affect the predators of crops but can harm animals or insects that may be beneficial to the surrounding ecosystems and the crops themselves. Through the process of bioaccumulation and biomagnification pollutants can move through the food chain and become more concentrated, harming and potentially killing entire ecosystems. This process was first detailed in Rachel Carson’s famous book, *Silent Spring*, the book reveals how far-reaching and unpredictable the consequences of pesticide can be.

Furthermore, pesticides can reach surface water through runoff from treated plants and soil. Contamination of water by pesticides is widespread and is harmful to animals that come in contact with it. The results of a comprehensive set of studies done by the U.S. Geological Survey (USGS 2017) on major river basins across the country in the early to mid- 90s yielded startling results. More than 90% of water and fish samples from all streams contained one, or more often,

several pesticides (Aktar 2009). However, not only does contaminated water affect animals and marine life, it can also further reduce humans supply of freshwater in the environment, as noted in the previous section. Furthermore, pesticides can contaminate groundwater, and eliminate use many potential sources of water before they are uncovered. Pesticides can also contaminate soil and air, thus reducing soil fertility and increasing the likelihood of asthma, lung problems, and certain illnesses in particular areas. While the negative effects of pesticides have done a great deal of damage to animals, the environment, and human health it is important to remember that there are some significant benefit to using certain pesticides. Pesticides can also reduce the spread of infectious diseases by disease carrying animals such as mosquitoes, rats, and ticks. Furthermore, they can reduce the likelihood of microbial contamination and avian flu. These pesticides are particularly beneficial to us, and therefore it is necessary to acknowledge that not all pesticides are bad. Ultimately, it is necessary to continue to place stringent regulations on pesticide use and continue to do extensive research on the effects of pesticides in order to create a sustainable future.

Monocultures. Large industrial farms are frequently dedicated to producing monoculture crops, or a single crop in a given area. While this is more efficient for farmers, it is also detrimental to the land. Only producing one crop on a piece of land depletes the soils of the nutrients that are essential to that plant and attracts pests that feed of such plants. Eventually, after producing only one crop in a certain the soil becomes highly damaged and it alters the food supply chain in those ecosystems as there is an abundance of only one type of plant for animals or pests to feed off of. Given the number of large monoculture farms that exist throughout the US, it is clear that monocultures can greatly impact the earth in negative ways.

Animal Agriculture. While there are many environmental issues surrounding the agricultural business, data has suggested that animal agriculture is the most environmentally damaging sector of the industry and least sustainable. As the population grows and living standards increase, the demand for livestock production continues to increase. This is because people have grown to associate meat consumption with a higher standard of living. Countries like the US and Australia have some of the highest levels of meat consumption in the world, whereas lesser developed countries have significantly lower levels of meat consumption. However, as more countries move out of poverty, the demand for meat grows as well. This poses problems for both global health and the environment. Emissions from farm animal processing total several tens of millions of metric tons per year. The amount of fossil fuels burned varies depending on the species and type of animal product. For example, processing 1 kg of beef requires 4.37 megajoules (MJ), or 1.21 kilowatt-hours, and processing 1 dozen eggs requires greater than 6 MJ, or 1.66 kilowatt-hours. However, approximately 0.8 million metric tons of carbon dioxide are emitted annually from the transportation of feed and animal products to the places where they will be consumed and even more fossil fuels are emitted due to the heavy farm machinery that is frequently used on industrial farms (Koneswaran). The animal agriculture industry also produces a significant amount of methane, a greenhouse gas that plays a large role in climate change. This methane is largely a result of gas released by cows and it is said that an average cow releases about 70 to 120 kg of methane per year. The FAO estimates that livestock production alone produces about 35% of the world's methane emissions (FAO 2017). Livestock production has also been shown to be the most land-intensive and water-intensive type of agriculture. Reportedly, livestock use about 30% of the earth's land surface and "During 2010,

withdrawals for livestock use were an estimated 2,000 Mgal/d, or 2,240 thousand acre-ft/yr. Livestock withdrawals were about 1 percent of total freshwater withdrawals” (USGS). It is important to acknowledge that along with land-use and water-use come habitat destruction, deforestation, and water contamination. Furthermore, this land-use estimate does not account for the land that is used solely to grow crops like corn, wheat, and soybeans that are converted into animal feed.

Overall, agriculture contributes to climate change and environmental degradation in numerous ways. In the next chapter this paper will analyze the regulations that aim to reduce the agriculture industry environmental impact and further measures that must be enacted.

Chapter 2. Government Policy & the Agricultural Industry

The proven links between agriculture and climate change have pushed the United States government to implement agricultural programs focused on minimizing environmental risks and to place environmental regulations on the agriculture sector. While many of these programs are voluntary for farmers, the United States attempts to shift towards sustainable agricultural practices are evident in the United States Farm Bill and the regulations set forth by the EPA. In analyzing the environmental programs and regulations within the U.S. Farm Bill and those set forth by the EPA, the agriculture sector's strengths and shortcomings concerning environmental sustainability can be better evaluated.

The United States Farm Bill. The United States Farm Bill is a comprehensive bill that addresses regulations, laws, and programs surrounding agriculture in the U.S. and is amended about every five years. This piece of legislation was first brought about in 1933 and made way for the US government's large role in the agriculture industry that is present today . The bill initially

sought to increase farmers incomes after the financial crisis of 1929 and the Dust Bowl crisis of the 1930s brought farmers incomes down to only one third of the average American income. The bill provided incentives for farmers to produce less, in order to restore the health of the nations croplands after the Dust Bowl crisis. The changes to this bill that are made every five years continue to have major implications for the environment. The Farm Bill has created numerous programs that provide incentives for farmers to use sustainable techniques, which have had impressive results thus far.

Energy Use and Livestock Production in the US Farm Bill. The US Farm Bill has sought to address the issues of energy use and livestock production within the agriculture sector, which have significant impacts on climate change and environmental degradation.

There are a some programs in place that attempt to address fuel usage and farm equipment on farms across the United States. As agriculture has grown into a massive industry and technologies have increased, the equipment required to maintain industrial farms have become more fuel intensive. The Mobile Source Program regulates farm vehicles, engines, equipment and fuels while other regulations address oil storage and oil spills. Meanwhile, the Rural Energy Program for America (REAP) provides agricultural produces with loans and grants that encourage the use of renewable energy and more energy efficient technology for farm machinery.

Furthermore, in 2008, the US decided to subsidize biofuel production in attempts to reduce carbon emissions released from cars that use traditional gasoline fuel and promote more sustainable fuel alternatives. There are a number of programs in place that encourage use and production of biofuel within the US Farm Bill. Biofuels are defined as “fuel composed of or

produced from biological raw materials” (Merriam Webster Dictionary). According to the EPA “First generation biofuels are made from sugar crops (sugarcane, sugarbeet), starch crops (corn, sorghum), oilseed crops (soybean, canola), and animal fats.”. Meanwhile “Second generation biofuels, or cellulosic biofuels, are made from cellulose, which is available from non-food crops and waste biomass such as corn stover, corn cobs, straw, wood, and wood byproducts.”.

Proponents of increased biofuel production cite it’s renewability and abundant national availability as the fuels’ major advantages. However, while the subsidization of such biofuels may sound as if it would be beneficial for reversing climate change there has been a great deal of controversy surrounding the promotion of biofuels as a more “sustainable” alternative to gasoline fuel. Critics claim that production of biofuel typically releases as much or more carbon dioxide into the atmosphere than the production and use of petroleum based fuels. (Gore) This is because it takes a greater quantity of biofuel to produce the same amount of energy as petroleum based fuels and because the machinery necessary to produce the crops for fuel also release a significant amount of carbon dioxide.

Voluntary and Incentive-based Conservation Programs. Many of the early programs carried out by the United States government, that pushed for agricultural sustainability, were focused on land conservation and were voluntary in nature. The most well-known programs and regulations begun to be implemented in the 1980s. The Conservation Reserve Program is one of the better-known land conservation programs that was signed into law by President Ronald Reagan in 1985, and pays farmers to withdraw environmentally sensitive farmlands from agricultural production. The goal is to restore these farmlands to their natural state for a typical length of about ten or fifteen years. This program is carried out by the Farm Service Agency

(FSA) and is considered to be the largest private lands conservation program in the United States. According to the USDA, the goal of the program is to reduce soil erosion, improve water quality, and reduce loss of wildlife habitat. Furthermore, this program has taken on more specific goals through implementing various initiatives which aim to restore the habitats of particular species or protect specific ecosystems. For example, under the CRP program the “Upland Bird Initiative”, “Floodplain Wetland Initiative”, and the “Longleaf Pine Initiative” have all sought to encourage farmers to protect certain species or ecosystems that exist upon their land. The program provides financial incentives for those farmers who wish to participate, and thus is completely voluntary.

Similarly, in 1996, EQIP or the Environmental Quality Incentives Program was put in place, and “provides cost-share payments and technical assistance to farmers for adopting conservation practices on active agricultural land” (Reimer). Through this program the National Resources Conservation Services “co-invests” in the conservation practices that farmers wish to implement on their farms, thus reducing costs of conservation practices for farmers. Some of the most popular conservation practices implemented are prescribed grazing quotas, improving irrigation management, and the introduction of cover crops. This program also has specific goals and initiatives that encourage farmers to prioritize certain sustainable practices such as the “on-farm energy initiative” and the “organic initiative”. Furthermore, there are a number of similar voluntary conservation programs which have been implemented through the US Farm Bill in recent years, such as the Conservation Stewardship Program (CSP), Healthy Forests Reserve Program (HFRP), Wildlife Habitat Incentives Program (WHIP), and the Agricultural Conservation Easement Program (ACEP). These voluntary programs are available for farmers to

increase their sustainable practices at a lower cost and to ensure that agricultural production does not destroy the lands that are essential to future food supplies. However, there are a number of compliance measures which require farmers to meet certain standards in order to receive such farm subsidies from the United States government. With the passage of the 1985 Farm Bill, these compliance measures stated that farmers must have an approved conservation plan that attempts to prevent excess erosion and also stated that producers who continue to farm on natural wetlands or native grasslands converted after 1985 would be ineligible for subsidy payments (USDA 2017). These compliance measures could also be considered voluntary, considering that farmers are not required to participate in farm subsidy programs.

Regulatory Policies. While voluntary programs and compliance measures have been beneficial in the push towards sustainable agriculture, the EPA has also introduced substantial involuntary regulations that influence agricultural practices throughout the country. In order to address the harmful effects of pesticide use in agriculture, the US established the Federal Insecticide, Fungicide and Rodenticide Act (1996). This policy requires all pesticides sold or distributed in the United States to be registered by the EPA. Registration requires farmers to prove that their use "will not generally cause unreasonable adverse effects on the environment." (EPA 2017). Furthermore, this policy requires label directions that control how products are used, allows the EPA to suspend or cancel a product's registration, and require training for workers in pesticide-treated areas.

In order to address water pollution the EPA has established the National Pollution Discharge Elimination System (NPDES) in addition to the Clean Water Act. The Clean Water Act of 1972 prohibits all people from discharging of pollutants through a point source into US

water. The NPDES is a permit program which places limits on what can be discharged and contains monitoring and reporting requirements. NPDES permits have provisions in place which ensure that amounts and types of discharge released do not hurt water quality or the health of people. The NPDES primarily affects the animal agriculture sector of agricultural operations, which often use Animal Feeding Operations (AFOs). AFOs are defined as facilities in which animals are confined and fed for 45 days or more and crops or vegetation are not sustained. According to the EPA “Manure and wastewater from AFOs have the potential to contribute pollutants such as nitrogen and phosphorus, organic matter, sediments, pathogens, hormones, and antibiotics to the environment.” (EPA 2017).

Greenhouse gas emissions and air pollutants released by the agriculture industry have also been addressed through government policies. The Clean Air Act of 1970 applies to agricultural operations and aims to protect public health through the regulation of emissions of air pollutants. Air pollutants in the agriculture sector are largely released by certain agricultural technologies, pesticide application, and livestock production. Livestock production facilities are major contributors to air pollution and are responsible for the release of nitrous oxides and volatile organic compounds due to animal waste. Farms are also required to participate in Greenhouse Gas Reporting when they emit equal to or greater than 25,000 metric tons of CO₂ per year (EPA 2017). Again, livestock producers are the biggest perpetrators within the agriculture industry and the EPA’s evaluation of the agriculture industries’ emissions levels estimates that 100- 110 of the largest livestock facilities would be required to report their emissions (Leher 2010).

The Endangered Species Act also significantly impacts the actions of agricultural firms. Under this act agencies are required to ensure that all actions that they perform or fund will not put the continued existence of any species listed as endangered in jeopardy. Also, their actions must not cause the destruction or permanent damage of a critical habitat for such species. The law also prohibits any action that causes a "taking" of any listed species of endangered fish or wildlife. Therefore, farmers may not take any endangered species and may not destroy critical habitats of species listed to create cropland or carry out farm activities.

In addition to these programs and regulations set forth by the federal government, the USDA claims that education is an important aspect of their policy instruments. The USDA claims that the aims of these programs and regulations are not only to minimize environmental damages, but to help farmers become more aware of environmentally destructive practices and push forth sustainable agriculture. While these policies have helped begin to address the environmental concerns surrounding the agricultural business, there are many more measures that need to be taken.

Meanwhile, in spite of the large role of livestock production within the agriculture industry, regulations or programs directly concerning livestock production are a relatively small part of the US Farm Bill. Such regulations concerning livestock typically fall under Title XII, which is labeled the miscellaneous section. Such regulations as Animal Health Protection Act (AHPA) and the Feral Swine Eradication Program are mostly about ensuring the hygiene of livestock production facilities and the animals themselves.

Participation and Communication. While there are a number of programs and regulations in place that aim to move agriculture in a sustainable direction, it is important to analyze

effectiveness of the measures taken thus far. In a study entitled “Farmer Participation in US Farm Bill Conservation Programs”, the researchers found that there are various motivations and barriers to participation in many of the voluntary programs that have been established in the US Farm Bill. One major issue preventing participation in such programs is a lack of awareness about available programs. In this study researchers found that most farmers only had knowledge of a few more well known conservation programs such as Conservation Reserve Program, while many had little or no knowledge about programs such as EQUIP. Furthermore, even those farmers who expressed awareness of such programs were unclear about the specific goals of the programs and the benefits that could be provided to them. Complex and lengthy program applications as well as fear about burdensome requirements were also noted as significant barriers that prevent farmers from enrolling in voluntary conservation programs. Many farmers in this study also found a lack of communication between the conservation agencies and farmers created a negative experience for them and discouraged them from re-enrolling in conservation programs. Meanwhile, farmers in this study also noted that the incentives and benefits provided by such programs were not enough to encourage participation. Although, there are numerous barriers that prevent farmers from participating in voluntary conservation programs many farmers cited the environmental benefits as a key motivation for participating in the programs. Therefore, it is clear that lack of participation in conservation programs is not necessarily due to apathy about the environment on behalf of farmers but is more likely due to the structure of the programs themselves and issues with the organizations that implement them.

Ultimately, the number of regulations and programs that are intended to promote sustainability within the agriculture industry are impressive. However, it is important to

continually evaluate the effectiveness of the measures that have been taken and modify them in order to increase their successes.

Chapter 3. The Economic Power of Agriculture

While the United States government has taken many measures to regulate the agriculture industry and mitigate its environmental threats, the economic power held by this industry has often hindered regulation and exacerbated environmental harms. This chapter analyzes the agriculture industry from an economic standpoint and examines the ways in which economic policy can affect food production.

Lobbying. In the United States the practice of lobbying has significantly increased in the last few decades and greatly influences policy making decisions. “Organizations increased the annual amounts they spent to lobby Congress between 1983 and 2010 by a factor of thirty-five, and registered lobbyists have multiplied tenfold since 1976” (Simon, 23) The job of a lobbyist is to influence legislation and government officials to make decisions that benefit corporations or businesses. Lobbyists largely work on behalf of large businesses with substantial funds because disenfranchised groups such as the poor, minorities, or environmental groups often do not have the capital to hire lobbyists and push legislation in their favor (Godwin 2013). Many agricultural firms have significant lobbying power and typically influence legislation in ways that hinder regulations and increase questionable subsidies. Agricultural firms immense lobbying power has transformed the way Americans eat and has allowed the agriculture industry to produce at levels that are detrimental to consumers and the environment. In Simon's book “Meatonomics” the author states that the “the animal food industry spends more than \$100 million yearly paying lobbyists and making strategic donations.”. Significant amounts of money are also spent by

lobbying groups of other agricultural sectors and commodity crops, such as corn, soy, and wheat. It has been reported that in 2017 agribusinesses spent about \$131,186,241 in total on lobbying efforts, yet the highest amount ever recorded occurred in 2013 when the agriculture industry spent about \$154 million on lobbying. These funds came from a total number of 445 clients or businesses. However, money is often used to influence legislation in the form of campaign contributions as well. In the past twenty years, the agriculture industry has reportedly spent 624.5 million to political candidates. (opensecret.org) In return for their strategic lobbying efforts and significant campaign contributions, agricultural firms have pushed legislators to continuously provide substantial subsidies for farmers and also ease regulation set forth by the EPA. Agricultural firms argue that pesticide and emissions regulations set forth by the EPA are too costly and hinder business. Lobbyists also tend to appeal to the more idyllic of American farm life, and are thus able to convince both legislators and the American public into giving copious amounts of money to agricultural firms which further allows them to push for reduced regulations. While agriculture is one of the most highly regulated businesses in the nation and farmers' arguments about regulations should be heard, the big voices and wallets found amongst agricultural lobbyists often drown out concerns put forth by the EPA and

Subsidies. In order to gain a better understanding of the economic power held by agricultural firms and how this influences legislation, it is necessary to address the issue of agricultural subsidies. Subsidies are paid directly to farmers or agricultural firms and typically provide crop insurance and price control measures. According to the US Government Accountability Office, about 20 billion dollars a year are transferred from the hands of taxpayers to farmers in the form of subsidies (USGAO 2017). Lobbyists, farmers, and many legislators

argue that these subsidies are not only necessary, but beneficial to both consumers and farmers. They argue that price controls serve to keep prices low for consumers, help keep farming profitable, allow farmers to keep up with innovative farming practices, and bolster food security. However, the benefits and necessity of these subsidies have often been called into question.

The distribution of agriculture subsidies has been greatly criticized and has become highly secretive. In 2014 amendments to the Farm Bill made it so that recipients of farm subsidies, in the form of crop insurance, are now kept secret. This provision was first introduced by Representative Larry Combest, who is now an agricultural lobbyist, in 2000 and ensures that the public cannot know which firms receive farm subsidies and for how much. This law was likely an attempt by agricultural lobbyists and legislators to keep criticism and accusations of misallocation at bay. However, there has consistently been debate and controversy over the distribution of subsidies within the agriculture business for the last few decades. While many might think that these massive subsidies are going to small farms that need assistance to simply maintain their farms, it has been shown that a large proportion of subsidies go to some of the biggest agricultural firms in the nation. This alleged misallocation occurs because subsidies are primarily given to farmers who produce specific crops. Although the United States produces about 400 domestic agricultural products, over 90% of farm subsidies are provided to farms that produce five of these crops (heritage.org). Furthermore, agricultural subsidies are increased when these farms produce more of their crop. This means that two-thirds of agricultural subsidies go to ten percent of the nations, which typically earn over \$250,000 a year. Meanwhile, in spite of the significant amount money dedicated to farm subsidies, about 60% of the nation's farmers are excluded from the farm subsidy program.

The disproportionate allocation of farm subsidies is not only confusing and seemingly unjust, but it has significant effects on environmental degradation. Subsidizing major crops like corn, wheat, and soy promotes the development of large farms and does not enable the many small farmers the financial resources to compete with large agriculture businesses. Such large farms require significant machinery, pesticides, and fertilizers to continuously produce their crops on the same land. Furthermore, large farms also require much more land and thus are more disruptive to surrounding ecosystems, taking a greater toll on the soil. While some might argue that large agribusinesses are more educated on sustainable agricultural practices and therefore may be more sustainable, the very nature of most large farms is quite unsustainable because they are often dedicated to cultivating monocultures. As previously discussed, the creation of such monocultures limits biodiversity and weakens the ecosystems. Mass producing one strain of one crop does not allow for other species to survive, depletes the soil of a variety of nutrients, and ultimately requires more water and chemicals to be used. Ultimately, as the government continues to subsidize such large farms and increases their funds as they produce more crops, the adverse effects of industrial agriculture continue to accumulate.

Additionally, a great deal of these agricultural subsidies have been shown to primarily benefit those in the animal agriculture business. “Nearly two-thirds of government farming support goes to the animal foods that the government suggests we limit, while less than 2 percent goes to the fruits and vegetables it recommends we eat more of.” (Simon, 79) These benefits are provided directly to animal producers and indirectly in the form of subsidies for corn and soybean producers. Cheap corn and soybean prices help keep the prices of animal food production low, as the majority of farmers rely on corn and soy as feed for cows, chickens, pigs

and other farm animals. Furthermore, animal food production accounts for nearly a third of US consumption of corn and soy. While animal products are a staple in the diets of many in developed nations, the disproportionate subsidization of these products encourage citizens to consume more than is beneficial to their health and to the environment. As mentioned earlier, animal agriculture has been shown to be one of the largest contributors to environmental degradation within the agricultural business. These immense subsidies encourage farmers to produce more product and consumers to consume more at incredibly low prices, thus exacerbating the environmental effects of animal agriculture through sustaining these subsidies.

As further evidence of the disproportionate subsidization and promotion of animal agriculture in the US, there is an entire section of Title I of the US Farm Bill that is dedicated to programs which promote and aid the dairy industry. Some of the programs include the Dairy Product Protection Program, Dairy Promotion and Research Program, the Dairy Indemnity Program, and the Dairy Forward Pricing Program. Each of these programs are aimed at expanding and promoting the dairy industry. Two of these programs were established in the 2014 Farm Bill, shortly after the dairy industry spent its highest recorded amount of about 8 million dollars on lobbying efforts in 2013 (opensecrets.org). These programs keep dairy prices artificially low, promote research on the nutritional benefits of dairy, and require the USDA to buy dairy products for food banks, amongst other things (thefarmbill.com). While dairy is a major component of many American diets, its health effects and environmental effects do not suggest that such extensive government support of the dairy industry is necessary or beneficial to the the average American. Many studies show that dairy has almost no beneficial effects on bone health, as many Americans believe, and can contribute to cardiovascular disease due to its high

content of saturated fat. Furthermore, many Americans have a dairy or lactose intolerance which makes them sick shortly after consuming dairy products (pcrm.org). These adverse health effects combined with the dairy industry's significant contributions to pollution and atmospheric CO₂ suggest that the promotion of this industry is doing Americans more harm than good.

However, these subsidies do not only go to producers of crops and animal agriculture. Companies like John Deere, Monsanto seed company, and the Dow chemical company all receive massive subsidies due to their significant inputs to agriculture. The business of these companies have significant environmental effects and the subsidies allocated give little incentive for these companies to address issues of environmental harms and sustainability. While many argue that farmers are often required to meet certain environmental regulations to qualify for these subsidies, the disproportionate allocation of these subsidies makes these qualifications a moot point. Furthermore, some of these subsidies allow or encourage farmers to bypass regulations that are already in place. In California, subsidies exist that allow farmers to use about one-fifth of the state's water and pay a drastically lower price than typical California residents (Simon). This encourages irresponsible water use, which is already a problem for California and the agricultural community as a whole.

External Costs. Agricultural firms have gained immense capital and increased their economic power through these subsidies. They manage to hold onto this power in part because they are not held responsible for the many external costs caused by agricultural production. External costs occur when producing or consuming a good imposes a cost that is not accounted for in the actual price of such a product. While many claim that subsidies help farmers to keep up with the most innovative techniques, most farmers still rely on the most efficient and cost

minimizing techniques, which rarely take environmental harms into account. These adverse effects of environmentally harmful agricultural production techniques are inflicted on consumers and society, are not accounted for in the original price, and are known as negative externalities. The extensive pollution caused by pesticide and fertilizer use is one example of the agriculture industries' negative externalities. These chemicals may adversely affect the health of animals, can create dead zones in fisheries, and potentially cause harm to humans as well. This disrupts the fishing industry, creates health costs for Americans, and prevents society from receiving the many ecosystem services that can be obtained from healthy ecosystems. Furthermore, animal food production has some of the most exorbitant external costs to consumers within the agriculture industry. When it comes to animal agriculture it is estimated that society pays about \$414 billion in external costs, making the "true cost of a \$5 carton of organic eggs is roughly \$13. A \$10 steak actually costs about \$27." (Simon, 76). The external costs that society must pay for include the antibiotics fed to animals that pollute our waters, pesticides that runoff and pollute waters or damage ecosystems, greenhouse gas emissions, and waste collection runoff that pollutes waters. Additionally, the low costs of animal products in stores encourage consumers to purchase more animal products, which continues to further increase the external costs as production continues to increase. Although it may seem difficult to account for the prices of pollution, greenhouse gas emissions, or waste collection when selling agricultural products, the current system for distributing subsidies only exacerbates these issues by providing extensive support to firms who likely do the most environmental harm. These industries may play a large role in the US economy and provide a substantial amount of the country's food, but allowing

select firms to have such a large economic influence is detrimental to economic competition and is preventing sustainable alternatives from fully establishing themselves.

Ultimately, while the idea of price controls, subsidies, and interest groups sound like they could be beneficial for both consumers and businesses, they all give an inordinate amount of leverage to agricultural firms. These mechanisms serve to alter the markets and give great economic power to agricultural firms, which can be detrimental to society as a whole.

Chapter 4. Alternative Agricultural Practices

Although there are many agricultural practices that are extremely harmful to the environment, modern research and technology has uncovered numerous techniques that will allow for a more sustainable agricultural future. Some of these techniques require conservation and modifications of traditional agricultural production while others may not be considered agriculture, in the traditional sense, at all.

Sustainable Agriculture. The primary concerns of sustainable agricultural producers are water use and quality, energy use, air quality, and soil erosion. One of the major facets of sustainable agriculture is the use of alternate sources of energy. Switching to the use of solar, hydro-power or wind-farms is one of the most environmentally-friendly decisions agricultural producers can make. Farmers can use solar panels to store solar energy and use it for electrical fencing or running of pumps and heaters. Additionally, river water can be used as hydroelectric power and can be used to run farm machinery. Farmers might also use geothermal heat pumps to dig beneath the earth and can take advantage of earth's heat. Another major source of concern in sustainable agriculture is use of pesticides. Integrated pest management is a more environmentally sensitive pest control technique which focuses on pest prevention and uses

pesticides only as needed (Aktar 2009) This is a combination of techniques that aims to identify, monitor, and prevent pests. This method acknowledges that not all pests are harmful and that it is more cost efficient to let these pests co-exist with crops rather than spend money on eliminating them. Targeted spraying is often used as an IPM measure and can aid in reducing water and air pollution and does less harm to wildlife. Sustainable farmers can also attempt to use natural pest eliminators such as bats, birds, and insects to reduce need for pesticides. Crop rotation is an old farming technique but one that is vital for sustainable agriculture. Crop rotation requires that the crops are picked in a pattern so that the crops planted during one season will replenish the nutrients and salts from the soil that were absorbed by the previous crop cycle (USDA 2017). Reducing tilling is also another important factor in reducing soil erosion and maintaining healthy soils. Crop diversity is also key to maintaining healthy soils, yet this practice is not implemented much in the industrial monoculture farms that are rampant today. Animal agriculture producers should also periodically shift the grazing lands for cattle in order to maintain healthy soils and prevent soil erosion. Water management is one of the biggest factors in sustainable agriculture and the selection of crops that are adaptable to the weather conditions of the region is key to managing water use. Furthermore, irrigation systems must be carefully designed in order to prevent river depletion, dry land, and soil degradation. Environmentally conscious farmers can also build rainwater harvesting systems to store rainwater and use as a water source.

Hydroponics & Aeroponics. Hydroponics is a method of growing plants or crops without soil, where cultivation takes place in a water-based environment. While it might seem counterintuitive to grow plants without soil, plants can actually grow extremely well in hydroponic systems. In order to grow and reach maturity plants need water and nutrients, which

are traditionally absorbed from the soil they are grown in. However, hydroponic systems use a nutrient-rich solution that is applied directly to a plant's root zone which allows them to thrive without any soil. While many may have only heard of hydroponic growing taking place in homes and on small scale farms, there is great potential to use hydroponic systems for large scale farming. In many cases hydroponic farms outperform traditional farms in production because they don't have some of the major disadvantages that come with soil-based farming. While some might think that hydroponic systems dependence on water would make it more water intensive than traditional farming, it is estimated that hydroponic farms use about one-twentieth of the amount of water used in traditional gardening and farming. Hydroponic systems often use a closed loop system in which water recycled and reused which limits the overall amount of water that is needed. Hydroponic farms can also be used for the purpose of remediating gray water, in which plants are able to filter wastewater from sinks, baths, and washing machines through the process of transpiration and make it available for use again. Furthermore, since a concoction of nutrients is designed for each crop to grow there is no need for chemical fertilizers and thus these systems do not produce the agricultural runoff that often contaminates water supplies and destroys fisheries. Hydroponic systems typically do not require pesticides because hydroponic plants are grown in controlled environments and therefore are not liable to diseases, pests, or fungi. Additionally, as extreme weather conditions become more frequent due to the threat of climate change, traditional farms struggle with crop loss, which is not an issue faced by indoor hydroponic systems. Hydroponic farms also alleviate the burdens of land-use and transportation which are large issues in traditional agriculture. Since hydroponic growing takes place indoors,

more crops can be grown without using as much land. Less fossil fuels are used due to the shorter distance between the grow site and consumers.

Hydroponic growing has gained some popularity recently as consumers attempt to be more aware of the origins of their food and attempt to be more environmentally conscious. In the US there are currently about 2,808 hydroponic farming businesses and the industry has had an annual growth rate of about 3.4% since 2012. (ibisworld.com) The industry is expected to grow even more in the near future due to consumer demand for healthy and organic foods. More frequent crop failures, due to extreme weather events, are also expected to help the industry grow in the near future.

Aeroponic farming is another similar option that should be seriously considered when discussing the future of agriculture. Aeroponic farming is very similar to hydroponic farming except aeroponic systems only use water to spray a specified amount of nutrients, water, and oxygen onto the crops in order to maximize growth. Meanwhile, hydroponic systems allow crops to bathe in the water and nutrient solution. Therefore, aeroponic systems use even less water than hydroponic farming but have similar benefits to hydroponic farming in terms of pest management, land use, transportation, and weather control. In Dr. Dickson Despommiers' book "The Vertical Farm", this Columbia biology professor lays out his unique ideas about the future of farming and suggests that urban farms with indoor hydroponic or aeroponic systems will be the next frontier of agriculture. He states that the benefits of a "Vertical Farm" will go beyond the environment and have many positive social impacts as well. Despommier states that the "vertical farm" will provide new employment opportunities, have the ability to address problems such as food deserts, and potentially provide stability in regions in which there is a

great deal of political turmoil as a result of scarce water and food resources. Despommier also suggests that as the farming industry moves from traditional agriculture to the “vertical farm”, farmers be given credits for carbon sequestration in order to incentivize them to return their farmland back to its natural restoration. This idea would take many years to come to fruition and would likely cause major disruption and uproar in the traditional agriculture industry. However, the benefits that hydroponic and aeroponic farming systems provide suggest that these technologies should no longer be kept on the backburner, but instead promoted as some of the most sustainable options for the future of agriculture.

Biotechnology. Creating cultured meat is another technological advancement that could overhaul the current industrial agriculture system. Meat can be created through biotechnology which requires adding a collagen matrix, taken from either living or deceased animals, to adult muscle stem cells from a live animal, which together create strips of skeletal muscle grown in a lab. However, to create the flavor of normal meat and to mimic the texture and tenderness, fat cells need to be co-cultured. The technique of generating meat in vitro has been possible for more than 100 years, yet it has only recently garnered attention. Recently, in 2013, Mark Post from Maastricht University in the Netherlands created the first burger made from bovine stem cells, which took five years of research. Cultured meat is important for the future of sustainable agriculture because it could vastly reduce both greenhouse gas emissions created through meat production and deforestation of grazing land as well as minimize the animal agriculture industries other harmful effects. “Researchers comparing the production of cultured and conventional meat found that producing 1,000 kilograms of cultured meat involves approximately 7% to 45% lower energy use, 78% to 96% lower greenhouse gas emissions, 99%

lower land use and 82% to 96 % lower water use.” (Galusky 2014). The reduction in greenhouse gas emissions is largely because there won't be as many cows that release methane into the atmosphere. The reduction in land use from the production of cultured meat does not only stem from the land directly used for animal agriculture, but also the reduction in land used for crops such as corn, wheat, and soy which are overwhelmingly produced in order to be used as animal feed.

While the potential benefits of cultured meat sound amazing there are still many issues that the biotechnology field must overcome. One of the biggest problems with creating widespread, commercially available cultured meat is the price. The first cultivated burger cost more than \$300,000 to make, however those in the business of producing cultured meat claim that the price is steadily on the decline. The issue is that the technology is not yet at a level which will allow for commercially priced cultured meats, yet there is unbounding optimism amongst those in the field that the technology being developed will soon allow prices to drop significantly. There hope has proven to be just, as in 2016 a company in the United States produced the first cultured meatball which cost just \$1,200 and the company that produced the first cultured burger reports that is now producing cultured meat at a significantly lower price than before. While \$1,200 may still seem like a hefty price, it shows that prices have already begun to decline and that there is promise for cultured meat to become commercially available at reasonable prices.

Currently there are a number of scientists and entrepreneurs who are working towards a future where cultured meat is commercially available. These companies are not only producing meat from real animal cells, but using algae, bacteria, and yeast to create animal products as

well. While there are only a few cultured meat startups that exist today, prominent businessmen like Bill Gates, Richard Branson, and Jack Welch have begun to invest in such technology and view it as one of the next technological and agricultural frontiers. In regards to cultured meat Branson has said “I believe that in 30 years or so we will no longer need to kill any animals and that all meat will either be clean or plant-based, taste the same, and also be much healthier for everyone. One day we will look back and think how archaic our grandparents were in killing animals for food”(Shapiro). Meanwhile, many other savvy investors have begun to pour millions of dollars into the development of the biotechnology industry in recent years. The enthusiasm displayed by such prominent figures and their willingness to invest large sums of money into making the idea of commercially available cultured meat a reality suggests that “clean meat” will certainly be an option for consumers in the future.

However, one other major problem facing the development of this industry is public perception of cultured meat. Some studies have found that many people view “cultured meat with disgust, deeming it unnatural, and believing that it carried risks similar to other novel food technologies such as genetic modification and animal cloning” (Slade) These perceptions show that the enthusiasm for cultured meat amongst consumers does not match the enthusiasm shown by investors, environmentalists, and animal welfare activists. In order for cultured meat to become the sustainable alternative to animal agriculture that many envision public perceptions will have to change. Growing concern about the environment, increasing awareness of the harmfulness of animal agriculture, and the support of prominent figures could likely influence consumers to think more positively of cultured meat in the future.

Furthermore, one potential problem that has not yet been faced is the possibility of government regulation. As Paul Shapiro, the author of “Clean Meat” states, governments and regulating bodies might be skeptical of meat grown in a lab. Even if cultured meat is proven to be safe for consumption, the lobbying power of the traditional animal agriculture industry will likely fight for cultured meat products to face harsh regulations. The animal agriculture industry has already fought against the many meat, egg, and dairy alternatives that are on the rise in the US. In February 2018 the US Cattlemen's Association filed a petition with the USDA complaining that plant-based and lab-grown meats should not be able to use the words ‘meat’ or ‘beef’ on their labels. The dairy industry has also fought against companies that produce plant-based milks such as almond milk, coconut milk, cashew milk, etc., stating that they should not be allowed to call their products “milk”. Meanwhile, it has been reported the American Egg Board lobbied for an attack on Hampton Creek, a startup creating egg-free mayo. The AEB filed a false advertising lawsuit against the startup and attempted to get Whole Foods to remove Hampton Creek products from stores (theguardian.com). The backlash faced by companies producing plant-based alternatives to animal products has been swift and shows that the animal agriculture feels extremely threatened by the rise of plant-based alternatives. If producing lab-grown meats becomes more common and readily available, it is easy to imagine that the animal agriculture industry will do everything in their power to dissuade the public from accepting lab-grown meat as a viable alternative to traditional animal products.

Consumer Sustainability Efforts. Cultured Meat, hydroponics, aeroponics, and sustainable agriculture methods are some of the most important methods for ensuring the sustainability of agriculture. However, while these efforts are underway many consumers have

taken it upon themselves to ensure that the things they consume are as sustainable as possible. As people become more aware of the environmental effects of animal agriculture, many have chosen to abstain from meat and animal products. It has been reported that 6% of consumers claimed they were vegan in 2016, while only 1% claimed they were vegan in 2014. Meanwhile, the “Locavore” movement has also gained traction in recent years. This is a movement in which consumers attempt to purchase most of their food and produce from local sources. Consumers go to local farmers markets and “Farm-to-table” restaurants in order to reduce the fossil fuels associated with the transportation of agriculture. Consumers who are apart of this movement also tend to choose organic produce in order to limit the amount of pesticides and fertilizers that go into their environment. These efforts are commendable and reveal the growing demand for more sustainable agricultural products. However, the agriculture industry cannot afford to regard these movements as temporary trends and instead they must see this as a signal that major changes need to take place within the industry as a whole.

Evidently, sustainable agriculture techniques and technologies are constantly evolving. These technologies are evidence that in spite of policy decisions that attempt to maintain the current state of industrial agriculture, there is real possibility to drastically alter our farming systems while bettering the environment.

Chapter 5. Conclusion: Funding Sustainable Agriculture

With the rise of these new technologies and growing demand for sustainability by consumers, the current state of agriculture is bound to falter. While traditional agriculture will remain an important part of every human culture, the unsustainable practices used by the industrial agricultural systems of the modern age will need to be scaled down in order to

minimize environmental damages. However, a more sustainable future can be built in the US if the government chooses to shift economic power away from traditional agricultural practices and encourage investments in new agricultural technologies and policies.

Increasing Incentive Based Programs. Currently, the government has a number of regulatory mandates and some incentive-based programs that have been implemented in order to shift the US towards sustainable agriculture. However, these incentive based programs mostly focus on the issue of “land-use”. These programs encourage farmers to avoid soil erosion and to restore farmlands to their original uses, but fail to address issues such as greenhouse gases, water use, and pollution. The US government has chosen to address the latter issues through regulatory mandates and while they have had some success with such mandates, further action must be taken. Regulations such as The Clean Air Act, The Federal Insecticide, Fungicide and Rodenticide Act (1996), and The Clean Water Act all enforce regulations on the agriculture industry. Yet, the guidelines for these regulations merely encourage businesses to do less harm to the environment. These mandates fail to inspire businesses to innovate in new ways or push the boundaries of sustainability goals. Furthermore, while these regulations set important standards for industries to meet, these standards were set prior to the turn of the century. As farm machinery and farms themselves grow bigger, it is necessary to reassess the impacts agriculture has on climate and set new goals for the industry. Therefore, incentive based programming could prove to be a key feature in pushing the agriculture industry forward. Incentive-based programs, that aim to address the issues of greenhouse gases, water-use, and pollution, could provide subsidies to farmers based on new sustainability goals. If the US government emphasizes

the importance of these concerns, businesses will likely be more encouraged to implement alternative practices that would further limit their impacts on the environment.

Increasing Participation and Communication. There must also be increased participation in the voluntary programs that currently exist. To increase participation in such programs conservation agencies must ensure there is better communication between themselves and farmers. Better communication requires that farmers be more aware of the various programs that are available to them and what benefits can be provided to them. Furthermore, there should be clearer communication about requirements for participation in such programs and assistance in helping farmers fill out the necessary paperwork that is required for enrollment. Additionally, the benefits and incentives provided for each program should be continuously assessed. Programs with low participation rates should be considering increasing or altering the benefits offered for enrollment. The best way to increase both communication and participation will likely be to increase the number of people employed at conservation agencies. The lack of communication and information available to farmers is likely as result of overworked employees. If more people were available to communicate with farmers about their options and what benefits enrolling such programs could provide them, then there would likely be an increase in participation rates.

Less Government Intervention. The economic power of the agriculture industry has proven to have a powerful effect on legislation. The industries large subsidies allows them the finances to create powerful lobbying groups that push legislation in their favor. These subsidies distort market prices and are pushing forth a select group of agricultural crops and commodities that are not always healthy for the American people or for the environment. In 2016 the dairy industry asked the US Government to bail them out for \$150 million dollars of excess cheese that

was produced. While the US government only provided them with \$20 million, this large sum of taxpayer money could certainly be better spent elsewhere. Furthermore, such taxpayer money should not be spent on an industry that has shown to be environmentally destructive and whose products are in lesser demand than ever before. The American consumers have shown that they no longer desire the same abundance of dairy products and therefore the government should not distort the market in attempts to revive a fading industry. Although the dairy industry and other industrial agriculture businesses will likely always be apart of the American economy, these businesses should be able to stand on their own and succeed without excessive government intervention. Ultimately, reducing government involvement in traditional agricultural businesses will allow for more sustainable alternatives to thrive.

Investing in Hydroponics and Biotechnology. In addition to encouraging alternative practices within the existing industrial agriculture business, it is necessary for the US to look towards additional options for sustainable agriculture. Therefore, the government should aim to shift the massive subsidies that disproportionately support the animal agriculture industry towards hydroponics, aeroponics, and biotechnology. The US government should begin to give serious consideration to the ways that hydroponics and biotechnology could improve our food system, however there are a number of issues that stand in the way of implementing these new technologies.

One issue facing widespread implementation of commercial hydroponic farming is that is not often seen as a viable alternative to large industrial farms. Hydroponic farming is often viewed as a mere hobby that is practiced by agricultural and environmental enthusiasts on a small scale. However there are a growing number of large hydroponic farms that provide ample

amounts of food to their surrounding regions. According to the EPA, total US crop production is worth \$143 billion, while US hydroponic revenue has been estimated by IBIS to reach \$607 million. However, statistics have shown that “the US hydroponic industry has grown at an annual rate of 3.6% in the last five years, faster than the growth the US GDP had experience in the same period”, revealing that hydroponics is increasingly becoming an integral part of our food system.

Many private investors have begun to recognize the promising future of hydroponic farming and have helped this industry to grow. However, this industry could become a more common feature of food production in the US through government aid. India, one of the most densely populated countries on the planet, and home of the original “green revolution” has recently decided to subsidize hydroponic farming. The Goa State of India’s Agriculture Department has begun to offer a 100% subsidy for the setup of a hydroponic farm and 50% for the cost of cultivation. This is in an effort to increase yields in the face of massive droughts, and to avoid further environmental damages through over cultivation of land and increased use of pesticides. While the US has a dramatically different environmental landscape than India, their efforts to encourage hydroponic farming could serve as a beneficial example to the United States.

Ultimately, as the US government continues to provide massive subsidies to farmers across the nation, the regulations and programs that aim to alleviate the environmental damages that are intrinsic to agricultural production can be called inadequate at best. Due to high investment costs, the current political and economic forces of the agricultural industry have resisted change as much as possible. Yet ample evidence has shown that traditional agricultural

methods will not be able to meet the food demands of the ever-growing population. Many claim that agriculture will need yet another “green revolution” in order to meet the demands of a population that continues to grow at an exponential rate. Thus, the US should aim to set new sustainability goals for agriculture and provide support for new agricultural developments through shifting economic power away from traditional agricultural practices, in the form of subsidies, whilst providing a foundation for sustainable agriculture to grow.

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