Restoration Through Regeneration:

An Analysis of Agriculture in the United States

A Thesis Presented

By

Rebecca Graham

Presented to

The Department of History and Political Science

In partial fulfillment of the requirements

For the Degree of a Bachelor of Arts in

International Studies

Arcadia University

May 2021

Table of Contents

Introduction.....2

Agriculture and the Environment.....2

What Is Regenerative Agriculture?.....8

Alternative Approaches to Agriculture.....10

Methodology.....20

Farming Reimagined.....22

Impacts of Industrialized Agriculture.....23

Restoration Through Regeneration.....25

Demand and Limitations.....28

Conclusion.....32

Bibliography.....38

Introduction

Agriculture and the Environment

Since the mid-twentieth century, agriculture has developed into an industrialized system that produces food systematically and in great abundance. While the industrialization of agriculture has increased food security globally, current systems of production emit large quantities of pollutants into the air and water, while contributing to deforestation and soil erosion. Agriculture is the world's single largest driver of environmental change globally, with industrialized agriculture emitting the same amount of greenhouse gases as the entire global transportation sector, while draining vital resources at alarming rates (Rockstrom, 2016). Industrialized agriculture's biggest culprit of environmental destruction is intensive animal farming in facilities known as confined animal feeding operations (CAFOs). CAFOs are responsible for the majority of greenhouse gas emissions, deforestation, and fresh water consumption across all agricultural practices (Blattner, 2019). This method of food production is not sustainable long term, as it degrades and pollutes the environment faster than it can naturally heal and regenerate itself. Industrialized animal agriculture threatens the earth's natural ecosystems as it erodes soil quality, emits climate-changing pollutants, and dissolves biodiversity.

The industrialization of agriculture contributes to the environmental degradation and rising global temperatures that are increasingly threatening to ecological stability. This environmental destruction ultimately threatens all agricultural systems, as once arable farmlands are becoming inhospitable to agroecosystems. The industrialized farming of animals is the largest contributor to environmental degradation and climate-changing emissions out of any farming sector (Godfray, 2018). The environmental threat posed by industrialized agriculture raises the question: what alternative ways of production and consumption exist to mitigate agriculturally-induced climate change and environmental

destruction? I explore a variety of approaches to achieving this goal, but ultimately I argue that regenerative agriculture is the best approach to creating a sustainable food system while meeting global food demands. Given that the livestock sector is the largest polluter and resource consumer out of any industrialized agriculture sector, I focus this thesis specifically around industrialized animal farming and its effect on the longevity and sustainability of agriculture as a means of sustaining global food security. Even though regenerative animal agriculture offers a restorative and holistic approach to farming practices, its heavy reliance on expansive pasturelands challenges its ability to meet current rates of consumer demands for resource-intensive animal products. Regenerative animal agriculture offers many environmental benefits when compared to industrialized farming methods but requires a greater amount of land to be used for grazing and farming (Johnson, 2018). While there are many different approaches to mitigation efforts, regenerative agriculture has proven to be the most effective and restorative approach.

Other scholars have demonstrated that policy-based approaches to the mitigation of industrialized agricultural-induced environmental destruction and climate changing emissions offer necessary legal frameworks to base agricultural practices in, while others show developments in food science as a means of achieving a sustainable food system. Some scholars present small-scale community-oriented agriculture as the salvation of agriculture, promoting regenerative farming techniques. My work aligns with and builds on the work of scholars of regenerative agriculture as a means of ecological restoration, where I emphasize the need for a reduction in consumption of meat and dairy products in order to achieve a sustainable food system. I demonstrate that there is an urgent need to abandon industrialized agricultural practices in the livestock sector as a means of agricultural preservation by emphasizing the ecological destruction from industrial farming. I then detail the restorative nature of regenerative agricultural practices, proving the capability of regenerative practices

to achieve agricultural production in a sustainable manner for long term global dependency. In order for agricultural systems to continue providing sustenance to the growing human population, food production must occur in an efficient and sustainable manner.

It is important to note that the content of this data is representative of the agricultural systems in the United States, unless otherwise stated. While much of this data is reflective of agricultural systems in other parts of the world, I focus specifically on the United States and American owned agribusinesses, as industrialized agriculture was invented in the United States in the 1950s. Additionally, the global demand for animal products has more than tripled in the past fifty years, as the meat-heavy American diet has grown in popularity across the world (Ritchie, 2019). With the consumption of meat and dairy seen as an indicator of economic prosperity and social status, people's desire to consume these products have a deeper meaning than just an enjoyable meal. The ability to consume large amounts of meat in developing countries often indicates a person's lift out of poverty. Therefore, I do not critique the consumption of animal products by humans in a global sense, but rather I argue for the use of regenerative agriculture as a means of production in high polluting developed nations, such as the United States. The negative environmental impacts and climate-changing emissions that result from industrialized animal agriculture have a global impact, where the individualized consumption of small amounts of animal products by people in developing nations has a minuscule impact, thus I emphasize the need for a change in food production systems and consumption habits specifically in the United States, where meat is produced and consumed at the highest rates globally (Ritchie, 2019). In order to fully understand the importance of agriculture today, there must be an understanding of the history behind farming practices.

The first known use of agriculture among humans took place twelve thousand years ago in the Fertile Crescent of the Middle East, renowned as the "Cradle of Civilization" due

to the creation of agriculture, irrigation systems, and the wheel (Chatterjee, 2016). With this advent, humans were able to advance their quality of life, as food and water became easily accessible in a controlled environment. The creation of agriculture is a cornerstone of human civilization and remains heavily relied upon today. In the United States, agriculture and related industries, such as food service and grocery stores, contributed $1.109 trillion to the national GDP in 2019, with $136.1 billion of this sum coming directly from American farms (USDA, 2020). With millions of jobs and trillions of dollars stemming from agriculture, farming practices hold a central role in the functioning of the economy. While every American engages with domestically produced food, most do not know where their food originates from or how it is produced. This disconnect between the consumer and their food started in the mid-twentieth century. Prior to this, most food was grown, sold, and consumed within local communities, but in today's industrialized food system, it is estimated that on average, a meal in America travels 1,500 miles before reaching its final destination on consumer's plates (CUESA, 2020). This is due to the drastic decrease in small-scale farms since the mid-twentieth century, with large-scale industrialized farms taking over agricultural production.

The majority of meat and dairy products today come from large-scale confined animal feeding operations (CAFO), also known as factory farms. Factory farms are industrialized buildings that house between several hundred to thousands of livestock such as cows, pigs, and chickens (Sierra Club, 2019). Animals that are raised in factory farms do not have access to natural vegetation, but rather are fed large quantities of corn and food by-product. Livestock are injected with steroids to increase their size and antibiotics to prevent disease. CAFOs are typically windowless facilities built out of sight from passersby, as conditions in these factory farms are poor (Sierra Club, 2019). Fecal waste from CAFOs is dumped into waste pits known as "manure lagoons," where waste is left untreated and spreads easily into

local water sources. Communities where factory farms exist often experience water contamination and air pollution from these facilities. Runoff full of pathogens and chemicals from these facilities leaches into water sources, contaminating drinking water, while emitting over 168 different types of harmful chemicals, such as methane, ammonia, and carbon dioxide (Sierra Club, 2019). Factory farms pose a serious threat to the environment, as they are the highest polluters out of any agricultural sector.

When industrial farming practices began to grow in popularity, farmers were able to expand their production sites, as machinery and monoculture became the new standard of production. This led to the average farm tripling in size, while the number of farms shrunk to a third of what it was prior to industrialized farming (Dimitri, 2005). Across the 20th century, American employment in agriculture went from 41% to a mere 1.9% by the year 2000 (Dimitri, 2005). The consolidation of food production on a limited number of large-scale farms has gravely impacted the quality and variety of food that is produced. Today, farmers produce only 20% of food varieties that were once present prior to the industrialization of agriculture. The lack of variety in food production weakens agricultural systems and food security, as producing a singular strain of a certain crop or livestock species does not offer enough genetic diversity to defend against blights or disease (Dimitri, 2005). While producing food in an industrialized manner has a higher output capacity, the lack of crop diversity and inability to distribute food equitably across the world makes this system of food production a threat to global agricultural stability.

Agricultural practices produce enough food to feed ten billion people annually, on a planet with a population of seven and a half billion (Lal, 2020). Through the industrialization of agriculture, humans have become able to produce more food than there are people to consume it, but with such an overabundance of food production annually, 820 million people experience hunger and two billion people face food insecurity globally (WHO, 2019). This

disparity in access to food points to the inefficiencies and shortcomings of industrialized agriculture. While largescale agribusinesses are able to produce high yields, 30% of this food is never consumed (One Earth, 2021). This is due to the refusal of big agribusinesses to sell their products at lower price points, throwing away food rather than reducing consumer costs. This system of industrialized farming fails to prevent hunger worldwide while threatening the global environment and agricultural systems.

In addition to current systems of industrialized food production failing to feed the global population, sectors such as the factory farming of livestock threaten global agriculture systems as they cause environmental degradation and release climate-changing emissions. Industrialized methods of livestock production are among the most ecologically harmful human activities due to high levels of greenhouse gas emissions, soil degradation, and water contamination (Tabassum-Abbasi, 2016). Current methods of animal agriculture drain water sources, fossil fuels, and top soils at an unsustainable rate, all while emitting greenhouse gases and contaminating vital resources (Horrigan et al., 2002). The environmental destruction of industrialized livestock farming threatens agriculture as a whole, as soil degradation and climate change lead to the infertility of soil and inhospitable environmental conditions for the growth of crops. The destruction caused by current practices of industrialized animal agriculture make the long term utilization and dependency on agriculture unattainable, ultimately leading to food shortages and an increase in global hunger. However, by producing food regeneratively, it is possible to grow crops and raise livestock in a way that protects the environment and promotes global food security.

What Is Regenerative Agriculture?

Regenerative agriculture serves as an alternative to industrialized farming that promotes healthy agroecosystems while having the capacity to feed the world's population. Regenerative agriculture, as defined by the organization Regeneration International, is "farming and grazing practices that, among other benefits, reverse climate change by rebuilding soil organic matter and restoring degraded soil biodiversity -- resulting in both carbon drawdown and improving the water cycle," (Regeneration International, 2017). Regenerative agriculture does this through a holistic approach to land management that utilizes the naturally occurring symbiotic relationship among plants, animals, and microorganisms that exist in the soil, resulting in a closed carbon cycle, soil health, and nutrient density in food (Schroeder, 2019). Healthy soil naturally retains several times the amount of carbon as the atmosphere through plant absorption, but with natural lands being converted into farmlands, the mass production of a single crop and overgrazing of livestock deteriorates the soil's ability to absorb and retain carbon through diverse plant species (Raganathan, 2020). Thus, regenerative agriculture acts in two essential ways: first, it emits fewer pollutants into the air and water than industrialized agriculture, and second, it builds healthy soil that actively absorbs carbon, causing it to not only mitigate climate change, but to play a role in reversing it altogether.

Regenerative farming practices are site-specific, and there is no universal method that suits all farmlands, but there are ways for all farmers to incorporate some combination of regenerative practices into their farms. Depending on existing environmental factors, such as soil composition, plant species and growth, rain and weather patterns, and temperatures, farmers must determine the techniques that are most suitable for what they are farming in their specific environment (Teague, 2017). An emphasis is placed on the natural cycles and systems that exist in nature independently of human interference. While humans play an important role in agriculture, allowing for natural processes and cycles to occur is vital in

successful regenerative farming practices. Farmer Will Harris III found the perfect balance of regenerative practices for his land located in Southern Georgia, which is now a thriving and lively farm.

"There is a lot of symbiosis in nature. What we do here is an imitation of nature. We call it biomimicry. It's an effort to maximize symbiosis and there are many examples of how we try to do that," says Will Harris III, owner of White Oak Pastures (California State University, 2021). For the Harris family, regenerative agriculture has revolutionized their farming practices. Harris, the fifth generation owner of White Oak, decided to incorporate regenerative practices into his farm in 1995 after becoming increasingly disturbed by the wastefulness of his operation. Raising only cattle prior to 1995, Harris decided to return to agricultural practices he calls "radically traditional," emphasizing how monocultural production of food works against nature rather than with it. With this decision in mind, Harris began incorporating a variety of livestock into his farm, including goats, lambs, pigs, chicken, and rabbits.

The livestock at White Oak Pastures no longer consume grain as they once had, but instead graze the pasture lands. Across his 3200 acres of land, he also began to grow crops, now producing over 60 different varieties of organic vegetables. "The cows graze the grass, the sheep and goats prefer the weeds, and the poultry species peck at the roots, bugs and grubs. All species naturally fertilize the land. This way, the pastures are grazed and fertilized in three different ways," Harris describes of his farm (California State University, 2021). Harris also uses regenerative farming techniques such as no-till, composting, and cover crops. Tilling soil destroys root systems and kills microorganisms, weakening the ability of soil to retain water and sequester carbon. Composting food products and waste creates natural fertilizers, allowing Harris to grow organically without any harsh chemicals to promote growth. Planting crops strategically next to each other provides certain crops with more

sunlight and others with less depending on their needs, promoting healthy rates of sunlight and shade according to the needs of specific crops (California State University, 2021). Harris' incorporation of diverse crop and livestock species is an essential part of regenerative agriculture, as these lifeforms work symbiotically together to produce high quality food products without the use of harmful industrialized methods. White Oak Pastures serves as an example of a conventional livestock farm that turned to regenerative practices with the results of a healthy and thriving agroecosystem, a smaller carbon footprint, and higher quality products. Farmers across America can follow the example set by White Oak Pastures by incorporating regenerative farming practices into their farms and reaping the benefits of this way of farming.

Alternative Approaches to Agriculture

Industrialized animal farming is one of the most serious threats to the global environment, as current animal agricultural practices contribute to the rise in deforestation, water scarcity, air and water pollution, loss of biodiversity, and climate change. If this environmental destruction continues, it will inevitably lead to the demise of agriculture, as the degrading environment becomes inhospitable for crops and livestock species. While there are various approaches to mitigating the environmental impact of industrialized animal agriculture, there is no singular fix to this issue that can meet current market demands for meat in a sustainable manner. As environmental degradation worsens and global temperatures continue to rise, scientists urge for a change in the production and consumption of animal products (Horrigan et al. 2002). I argue that policy-based action, community-centered agricultural practices, and innovation in food science can all assist in the mitigation of agriculture-induced climate change and environmental destruction. While these approaches cannot stand alone in their mitigation efforts, they serve as outlets for consumers to push forward sustainable food systems. These approaches can be useful in the shift toward a wide

scale implementation of regenerative agriculture, as they offer a level of quick relief while industrial farms may take years to transform into regenerative spaces. I review literature on policy-based approaches, small-scale, community oriented farming practices, and food science innovations that offer solutions to agriculture-induced climate change and environmental degradation. Policy approaches serve as a strong legal basis to start from when pushing for a national transition to sustainable and environmentally protective farming practices.

It is the responsibility of lawmakers and political leaders to protect those they serve from the harm that comes from the environmental destruction of industrialized agriculture. Policy plays a key role in the reduction of agriculture-induced climate change and environmental degradation. Kristiansen notes the existence of a "livestock policy vacuum," where policy-makers do not direct attention to animal agriculture when making laws about climate change, allowing big animal agribusinesses to emit large quantities of greenhouse gases without consequence (Kristiansen, 2020). Gunderson et al. argue that capitalism is the main driving force behind environmental destruction, as it allows producers to over exhaust natural resources while emitting pollutants and contaminants into the environment in order to turn a higher profit (Gunderson et al., 2020).

Neglection by lawmakers of the role of animal agriculture in global environmental destruction allows big agribusinesses to pollute and contaminate air and water resources without restriction or penalty, resulting in a rise in global temperatures and ecological damage. Laws that were created to protect small-scale farmers have been expanded to protect multi-national, billion dollar agribusinesses (Blattner, 2019). These laws were intended to grant leniency for small farmers that were producing small amounts of pollution and runoff from their farms, but they since have expanded to protect big agribusinesses from lawsuits regarding human rights violations from contaminants and pollution. Rojas-Downing

advocates that farmers be included in policy creation in order to preserve and protect livestock producers, while working towards implementing sustainable production methods within the current food system (Rojas-Downing, 2017), where others believe that the production of livestock needs to be reduced altogether in order to reduce environmental destruction. Policy-based approaches to reduce the production of livestock, and in turn the emission of greenhouse gases, largely center around fiscal intervention on the producer and the consumer.

Government-funded agricultural subsidies continue to fuel the power and destruction from animal agribusinesses by financially incentivising factory farms to produce meat and dairy at unsustainable rates. Henning argues for the removal of livestock subsidies as a means of reducing environmental damage caused by animal agriculture (Henning, 2011). By removing the financial backing of the animal agriculture industry, production will decrease, lessening the output of emissions and contaminants. Like Henning, Sewell also advocates for the removal of subsidies on animal products, noting that market prices will rise to reflect the true cost of production, and in turn, the consumer demand will decline (Sewell, 2020). Both Sewell and Henning believe that the best approach to mitigating climate change and environmental degradation is the removal of government funding of factory farms, while Stanley supports the adoption of an emissions tax.

Stanley offers the idea of an emissions trading scheme as a method to combat animal agriculture-induced climate change (Stanley, 2020). Proven successful across high polluting industries in New Zealand, an emissions trading scheme would effectively put a tax on greenhouse gas emissions for industries with high rates of pollution. In this model, animal agribusinesses would be required to purchase “credits” from carbon-absorbing industries, such as forestry, in order to neutralise carbon emissions. Stanley advocates for this approach, noting it’s two-fold effect, as it’s financial implications both mitigate greenhouse gas

emissions from factory farms while stimulating the economics of sustainable industries. Gunderson, on the other hand, believes the abolishment of capitalism altogether is necessary in order to achieve a sustainable food system, as capitalism demands constant growth and increased production in order to succeed (Gunderson 2011). Regardless of the approach, these policy changes will have a direct impact on the price of animal products for the consumer. While causing the market price to reflect the true cost of production would lead to a meaningful reduction in consumption of animal products, it would make meat and dairy only accessible to those who can afford it. This type of shift in the market price would penalize low-income consumers while still not addressing the root of the problem, which is the environmental destruction caused by big industrialized agribusinesses.

Blatter et al. question if corporate rights overshadow human rights, as big animal agribusinesses receive monetary subsidies as well as leniency on environmental laws, causing direct harm to the planet and those that inhabit it (Blattner et al. 2019). Animal manure contaminates local water sources, and the use of antibiotics in livestock creates antimicrobial resistant bacteria that cannot be killed, leading to human illnesses that cannot be treated (Blattner et al. 2019). Largely, these effects are unknown by the consumer but have a direct impact on the health of both the planet and those that inhabit it. This public ignorance is by design, as large factory farming corporations intentionally keep consumers uninformed about the realities of where their food comes from and the environmental impact that it has. An informed public holds influence over lawmakers to fight for the implementation of the above approaches to climate change mitigation and reduction of environmental degradation caused by animal agriculture.

While policy holds an important role in the reduction of emissions and degradation caused by factory farming, a more holistic approach includes the reworking of farming and marketing practices in order to achieve sustainability within the food system. As defined by

Horrigan, “sustainable agriculture systems are based on relatively small, profitable farms that use fewer off-farm inputs, integrate animal and plant production where appropriate, maintain a higher biotic diversity, emphasize technologies that are appropriate to the scale of production, and make the transition to renewable forms of energy,” (Horrigan, 446, 2002). While some environmentalists, such as Tabassum-Abbasi, advocate for raising “minilivestock” such as insects as a replacement to conventional animal farming practices, most argue that a return to small-scale, localized farming and marketing practices results in a significant reduction in agriculture-induced greenhouse gas emissions and environmental degradation. (Tabassum-Abbasi, 2016). Kremen suggests the diversification of farming practices in order to mitigate the negative environmental impacts of industrialized animal agriculture (Kremen, 2012). She suggests reintroducing old farmland ecosystems, where animals and plants benefit each other's growth and promote soil health. These methods include rotational grazing, the process of rotating when a plot of land is used for growing crops and when it is used for animal grazing. Kremen notes the diversification of animal and crop species promotes sustainable farming practices, as it eliminates monoculture (the mass production of a single crop or livestock), an industrialized farming technique that yields high production, but requires the heavy use of pesticides and emits large amounts of greenhouse gases. Returning to old farmland ecosystems would help mitigate the impacts of climate change and environmental destruction, and this system of farming produces lower levels of greenhouse gas emissions and soil and water contaminants. Sustainable food practices go beyond the farmer, extending to the consumer as marketplaces and consumption habits hold an important role in the food system.

Since the industrialization of agriculture, consumers have become increasingly disconnected from the food that they consume. Prior to the 1950s, people bought and consumed food that was locally, and largely sustainably, sourced (Cudworth, 2011). Today,

the majority of food produced in America comes from a select few large corporate agribusinesses that emit large quantities of pollutants and contaminants (Blattner et al., 2011). Mert-Cakal et al. argue that the marketplace offers a unique space for consumers to connect with the food they eat, as exhibited in Community Supported Agriculture (CSA) programs (Mert-Cakal et al., 2020).

CSAs are a small-scale sustainable food system that can reduce the global dependency on large agribusinesses for food production. In a CSA, the consumer contributes a sum of money to their local farm at the start of the growing season, assisting small-scale farmers with the costly up-front expenses of growing food and raising livestock. CSA members are then able to access fresh foods directly from the farm on a weekly basis for the remainder of the year, bringing the consumer directly to the point of production. Mert-Cakal et al. argue that this promotes a relationship among the farmer, the consumer, and the food, localizing the food system and placing importance on the sustainability of these practices. While purchasing food directly from a local farm as Mert-Cakal et al. suggest will promote sustainable agricultural practices, CSA programs tend to exist only in suburban and rural areas, making it unattainable for those who reside in cities to participate in them. The inaccessibility of CSAs to those who reside in urban areas creates an unequal balance of who has the ability to access sustainable options. Alternative marketplaces, such as food cooperatives, can exist in urban areas and offer consumers locally and sustainably sourced foods and products, but can often be costly.

Food cooperatives (commonly referred to as co-ops) offer the opportunity to localize food systems and connect consumers with their food and those who produce it, as Haedicke argues (Haedicke, 2014). Haedicke suggests the use of food cooperatives as a method of promoting sustainable agriculture. Food co-ops are owned by members and employees rather than corporations, giving the customer a voice in what is sold and where it is sourced from.

Co-ops can operate in urban areas where local farms can be out of reach for many residents, bringing sustainable food options into cities. This is essential in making healthy and sustainable options accessible to all. Haedicke argues that the localization of food systems promotes sustainable agriculture, as it allows small-scale, local farmers to provide food for the population around them, while reducing emissions that come from CAFOs and lessening the dependency on industrialized farming practices (Haedicke, 2014). While co-ops serve as a marketplace for sustainably grown and locally sourced food in cities, prices tend to be higher than an average grocery store, making co-ops financially inaccessible to low-income consumers. The lack of accessibility of CSAs and food cooperatives, both geographically and fiscally, is a drawback to these approaches to sustainable food systems. Additionally, the small-scale nature of CSAs and food co-ops make it difficult to scale these models to meet global food demands. Other approaches, such as food science, can be more easily scaled to meet global food demands.

As consumers in the United States become more aware of the environmental and health implications of consuming animal products, the demand for sustainably produced food has begun to rise (Choudhury et al, 2020). Scientific engineering of food has become commonplace in the American food system since the mid-1990s, when the first genetically modified foods hit the market. Since then, the majority of food consumed by Americans has been genetically modified. While I do not make an argument on the pros or cons of genetic modification, it's widespread presence in agriculture today makes food science an important angle to consider when suggesting a reworking of the food system as a means of climate change prevention and environmental preservation.

Scientific approaches to food production offer solutions to the environmental impacts of industrialized animal agriculture, offering sustainable alternatives to factory farmed animal products. Le advocates for "clean meat" production as an alternative to conventional farming

practices. Clean meat is grown in a lab from a non-invasive biopsy sample from an animal, making it genetically identical to conventional meats (Le, 2018). This technique of meat production offers the same taste, texture, and nutritional profile as livestock meat, but it uses 99% less land, 45% less energy, and produces 96% less greenhouse gases. It can also be engineered to have less unhealthy fats and cholesterol than traditional meat, making it a potentially healthier alternative (Le, 2018). While the cost of production for lab-grown meat is currently too high to compete in the marketplace, Le expects this to not be a barrier for long. While most foods consumed in America already undergo some kind of scientific alteration, be it genetic modification, pesticide and antibiotic use, or lab engineering, Le predicts that some consumers may feel reluctant to consume lab-grown meats, as the technology is new and unfamiliar. For those uninterested in incorporating clean meats into their diet, another healthier and sustainable alternative to factory farmed animal products that has been well-received by the public is plant-based meat alternatives.

Animal-based foods produce more emissions per unit of energy compared to plant-based foods, as animals, particularly ruminant animals, produce high levels of methane. In fact, animal agriculture is the highest producer of methane out of any industry worldwide (Godfray, 2018). A movement led by consumers to reduce meat consumption has led to the creation of plant-based alternatives to animal products such as meat and dairy. Choudhury believes that plant-based alternatives serve as an effective and satisfying imitation of animal-based foods while producing few emissions and preserving ecosystems (Choudhury, 2020). Texturized to look, taste, and feel like meat, plant-based alternatives are commonly made from pea, wheat, and soy proteins. McLeod-Kilmurray argues that plant-based meat alternatives serve as a sustainable alternative to factory farmed foods, as plant products require fewer resources to grow and do not emit high levels of greenhouse gases (McLeod-Kilmurray, 2019). A shift towards plant-based food products aids in the mitigation

of agriculture-induced climate change and environmental degradation, and with the ability of food scientists to replicate and simulate animal products, the consumer does not have to compromise on taste. While current costs of plant-based alternatives still tend to exceed the product they imitate, these prices are still fairly comparable to their animal-based competitors.

In addition to his stance on the removal of livestock subsidies, Henning believes that the most effective method of reducing agriculture-induced climate change and environmental degradation is to reduce the global consumption of meat (Henning, 2011). Henning argues that replacing animal products with plant-based alternatives would reduce agricultural greenhouse gas emissions by 98%, noting that the Earth's limited resources cannot sustain 9 billion humans eating animal protein. A global reduction in the consumption of animal products requires a major societal shift, one that may presently seem unattainable. However, as concerns over climate change and environmental destruction grow across the world, many consumers have begun to embrace plant-based alternatives to animal products, with about a third of consumers identifying as "flexitarians," people who do not follow a strict vegan or vegetarian diet, but consciously choose to reduce their consumption of animal products for the sake of their health and the environment (Choudhury et al., 2020). Plant-based alternatives to animal products can now be found at most grocery stores, restaurants, and cafes due to the high demand by consumers. While these changes cannot happen overnight, they hold the potential to revolutionize the food system. While plant-based products serve as a comparable alternative to meat and dairy, they still do not address the root cause of agricultural-induced climate change and environmental degradation caused by industrialized animal agriculture, as the industrialized production of animal products will continue even with the addition of plant-based alternatives on the market. Thus, I argue that regenerative agriculture is the best approach to mitigating climate change and environmental degradation

caused by industrialized agriculture, as regenerative practices have the power to reverse the effects of climate change and stabilize agricultural practices for future generations. In order to achieve a sustainable food system, consumers must have a greater understanding of where their food comes from and how it is produced.

Tucker and Eshel et al. argue that raising awareness of industrialized agricultural practices among consumers is essential in the move toward a sustainable food system (Tucker, 2018; Eshel et al., 2014). Informing consumers on the role industrialized animal agriculture plays in climate change and environmental degradation gives them the power to take action, whether it be through the advocacy and adoption of policy changes, sustainable agricultural practices, or food science innovations. While these methods cannot stand alone in their mitigation efforts, they offer an outlet for consumers to express their concerns about the impacts of industrialized agriculture, aiding in the efforts to push regenerative agricultural practices to the forefront of food production. Godfray et al. argue that in order to reshape food systems, there must be a reshaping of consumer demands through techniques such as labeling schemes and fiscal intervention (Godfray, 2018). They believe that a change in social norms is essential in moving toward a sustainable food system, and that these changes must arise from an understanding and awareness of the impact of industrialized animal agriculture. Informing and influencing consumer choices can be done through accurate media coverage of the environmental impacts of industrialized animal agriculture, as suggested by Kristiensen (2020). With the environmental impacts of animal agriculture intentionally masked and hidden by big agribusinesses, informing consumers gives them the opportunity to incorporate sustainable choices into their consumption habits.

The mitigation of animal agriculture-induced climate change and environmental degradation through policy-based approaches, sustainable farming techniques, and scientific innovations can be used alongside each other, offering options to the consumer while

reducing the environmental damage that comes from industrialized animal agriculture. Policy approaches to this problem would reduce the amount of environmentally-straining products such as beef that is produced through fiscal repercussions for both the farmer and the consumer. Small-scale, community oriented farming serves as an already existing outlet for consumers to choose sustainable options if their socioeconomic position allows for it. Food scientists are creating new alternatives to conventional meat that offer sustainable options to consumers who have the means and desire to choose these products. The literature I have reviewed points to the range of solutions to move away from industrialized animal agriculture practices, a major contributor to the environmental crisis that exists today. While these mitigation efforts have their own merits, they fall short in creating robust systemic change in the production of food. There is a need for a widespread shift towards regenerative agriculture in order to meet global food needs in a way that is environmentally sustainable and fiscally and geographically accessible to all. Regenerative agriculture is the only solution that can be implemented on a large-scale that actively restores the environment, all while meeting global food requirements and remaining accessible to all consumers. Through regenerative agricultural practices, long term global food demands can be met sustainably while restoring the environment.

Methodology

While many different approaches exist in the efforts to mitigate agricultural-induced climate change and environmental destruction, a widespread implementation of regenerative farming practices would have the greatest positive impact on the environment while meeting global food needs. Other scholars have demonstrated that policy-based approaches to the mitigation of industrialized agricultural-induced environmental destruction and climate changing emissions offer necessary legal frameworks to base agricultural practices in, while others argue for developments in food science as a means of achieving a sustainable food

system. Some scholars present small-scale community-oriented agriculture as the best way to execute agriculture, promoting regenerative farming techniques. While all of these approaches offer environmentally beneficial outcomes, they do not have the ability to fix the root of the problem. Even with the implementation of all of these approaches, the majority of animal products would still come from industrialized factory farms. Policy approaches, small-scale community farms, and food science innovations offer varying levels of environmental benefit, but they do not eradicate the use of industrialized farming practices. Regenerative agriculture has the capacity to fully replace industrialized agriculture, making factory farming a practice of the past.

My work builds on the work of scholars who argue for regenerative agriculture as a means of ecological restoration. I emphasize the need for a reduction in consumption of resource-intensive meat and dairy products in order to create a fully regenerative food system. I demonstrate that there is an urgent need to abandon industrialized agricultural practices in the livestock sector as a means of agricultural preservation by presenting data on the ecological destruction from industrial farming. I present data on the restorative nature of regenerative agricultural practices, proving the capability of regenerative practices to ensure agricultural production in a sustainable manner for long term global dependency. I collected this data through various outlets. First, I pulled data on agricultural practices from the scholarly journals of the literature that I reviewed. Once I had this as a foundation, I looked to private organizations that advocate for farmers and sustainable agriculture.

Through these organizations, I came across the concept of regenerative agriculture as a means of protecting the environment and preserving agriculture as a practice. This data allowed me to confidently make my argument in support of regenerative agriculture as the best alternative to industrialized agriculture, as it can fully replace industrialized agriculture while sustaining global food needs. Though regenerative farming can sustain the global

population, I identified the need to reduce the rate of production of resource-intensive livestock in order to create a fully regenerative food system. I utilized data from the United States Department of Agriculture to look into rates of consumption and methods of production in the United States over the last century. Once I identified that the current high rates of meat consumption is a new phenomena within the last seventy years, I collected data on strategies to create an informed consumer as a means of driving down demand to a sustainable rate for environmentally-straining products such as beef. Through this data, I arrive at the conclusion that regenerative farming practices must be paired with a reduction in the production of resource-intensive foods such as beef in order to achieve a fully regenerative food system.

Farming Reimagined

Agriculture is the world's single largest driver of environmental change globally (Rockstrom, 2016). Methods of food production directly impact the world's ecological balance, with current methods of production proving to be detrimental to the environment. Industrialized animal agriculture is the biggest contributor to environmental destruction out of the entire agriculture sector. In order to protect the environment and preserve agriculture as a practice for future generations, there is an urgent need to change the way food is produced. Through regenerative farming practices, agriculture would not only cease to be destructive, but would actively be restorative to the environment. Regenerative agriculture is the best solution to the destruction caused by industrialized agriculture, as it has the capacity to meet global food needs while restoring the environment. While regenerative agriculture can yield enough food to sustain the global population, the current high rates of demand for resource-intensive livestock products such as beef cannot be met regeneratively. In order to create a fully sustainable food system, there must be a meaningful reduction in the rearing of resource-intensive livestock in conjunction with the use of regenerative farming practices.

As the global demand for livestock products continues to rise, agricultural practices must be able to fulfill nutritional needs for the growing population of the world. I prove this by providing data on the ecological destruction of industrialized farming and how this threatens the long term use of agricultural practices. I then detail the ecological benefits of regenerative agriculture, while noting the capacity limitations of regenerative livestock farms. In response, I provide techniques to lower the consumer demand of these resource-intensive products in order to achieve a sustainable food system. With this data, I arrive at the conclusion that the use of regenerative farming paired with a reduction in the production of resource-intensive livestock is the best approach against the environmental destruction of industrialized agriculture, as regenerative agriculture promotes environmental restoration, meets global food requirements, and secures the use of agriculture for future generations. Through regenerative farming practices, the ecological destruction caused by industrialized agriculture will no longer threaten global food security or the long term use of agriculture for future generations.

Impacts of Industrialized Agriculture

Industrialized animal farming is the biggest contributor to environmental destruction and climate change out of any agricultural sector. Current systems of industrialized food production emit large quantities of pollutants into the air and water, while contributing to deforestation and soil erosion. The livestock sector accounts for 14.5% of all greenhouse gas emissions, equivalent to the entire global transportation sector, with methane making up 44% of these emissions (Food and Agriculture Organization of the United Nations, 2019). Industrialized animal agriculture is responsible for the highest rates of methane emissions globally, a greenhouse gas that is 84 times more potent than carbon dioxide (Godfray, 2018). These emissions come from the flatulence of ruminant animals such as cows and sheep, with cows alone accounting for 65% of all emissions from the livestock sector (Food and

Agriculture Organization of the United Nations, 2019). This poses a serious threat to the Earth's climate, as cattle populations are projected to increase from 1.5 billion to 2.6 billion by 2050 (Thornton, 2010). The overfarming of ruminant animals emits more greenhouse gases into the atmosphere faster than what can be reabsorbed by plant life and soils, contributing to global warming. The rise in global temperatures threatens the stability of agriculture, as it induces extreme weather conditions and temperatures.

The excessive emissions of greenhouse gases from industrialized animal agriculture has worsened the effects of climate change, which in turn harms the stability and longevity of agriculture. The environmental changes that occur from rising global temperatures create adverse weather conditions that farmers struggle to adapt to. In the United States, rainfall patterns have already begun to change, with unpredictable heavy showers and longer periods of dry spells (Climate Change and Agriculture, 2019). This shift in rainfall patterns will result in cycles of flooding and droughts of arable lands, making once fruitful lands barren. Without the ability to produce food on farmlands, global nutritional needs cannot be met. As it stands, humans will run out of the natural resources and fertile lands necessary to sustain current industrialized food production from livestock as early as 2050 (Henning, 2011). Industrialized livestock farming threatens the long term use of agricultural practices for future generations.

In current industrialized animal agriculture systems, livestock eat mostly corn and food by-products. Corn is the most highly produced crop in the United States, occupying 95 million acres of arable lands. In 2013, 48.7 percent of all corn grown in the United States was used to feed livestock (USDA Fact Sheet, 2015). This makes livestock feed the largest market for the United States most highly produced crop. Animal agriculture consumes 70% of global freshwater and accounts for 38% of global land use, straining vital resources and occupying millions of acres of arable land that could otherwise be used to grow foods directly for human

consumption (Blattner, 2019). The high demand for land and water by industrialized animal agribusinesses makes these resources less available to less powerful small-scale growers, jeopardizing the ability of sustainable farmers to produce, even using regenerative farming practices. The overexploitation of Earth's natural resources by industrialized animal agriculture threatens the global farming industry, putting food security at risk. The increasing difficulty for farmers to produce fruitfully on their land threatens the stability of agriculture as a practice, as industrialized agriculture exhausts natural resources that are vital to farming. The inefficiency of this food system contributes to the environmental destruction and warming global temperatures that are increasingly jeopardizing the stability and long term use of agriculture as a means of food production, ultimately threatening global food security. In order to prevent such demise, regenerative practices must replace industrialized animal agriculture.

Restoration Through Regeneration

While there are many different approaches to climate change mitigation and environmental protection as it relates to agriculture, regenerative farming serves as the most effective and sustainable solution. While policy-based approaches, small-scale community oriented farming, and food science innovations offer varying levels of relief, regenerative agriculture is the best approach, as it not only prevents environmental destruction, but actively restores the ecological balance. Regenerative animal agriculture requires the coexistence of plants and trees with livestock as a means of obtaining a healthy soil balance, promoting healthy and thriving agroecosystems (Lal, 2020). Through regenerative agriculture, humans can achieve a sustainable food system that provides enough sustenance to feed the growing global population.

There are many different regenerative farming techniques, and farmers can determine which combination of regenerative practices best suit their specific farm. Mimicking the

centuries old patterns of North American bison on the grasslands, integrated livestock grazing allows livestock animals to graze freely among crops and other livestock, resulting in a reduced need for fertilizers and healthier soil matter. As livestock cattle graze, plant matter and manure becomes stomped into the ground where it enriches the soil with nutrients (Schroeder, 2019). Organic matter, which is comprised of decaying plant and animal matter, is essential for water retention in the ground. Soil retains 20,000 more gallons of water per acre for each additional percentage of organic matter it holds (Payne, 2019). In addition to increased water retention, the incorporation of manure and plant matter into topsoils increases its carbon content. This leads to a higher quality and quantity of plant growth, requiring less artificial fertilizers to be used to promote plant regrowth in the future (Schroeder, 2019). By allowing livestock to consume and defecate freely across farmlands, the natural balance that exists between animal digestive cycles and plant life cycles is restored, resulting in healthier plant life and, in turn, healthier crop production. Integrating livestock production with crop production benefits both the farm animals and the plants, and promotes the long term health and fertility of the soil, creating a stable and thriving agroecosystem (Schroeder, 2019). In addition to integrating livestock into croplands, rotational grazing of livestock in pasturelands boosts the organic matter in the soil, enriching its nutrient content and increasing water retention. This, in turn, requires farmers to use fewer pesticides and less water to maintain healthy pasturelands.

For some farms, more control over livestock grazing is necessary and can be accomplished through rotational grazing practices. Rotational grazing allows livestock to graze in specific areas of pasturelands, allowing unoccupied sections time to regrow stronger and healthier plant matter for future grazing. The use of rotational grazing restores the microbial balance of soil. Rotational grazing as a practice of regenerative animal agriculture stimulates healthy soil, which promotes resilient plant and grass regrowth, which in turn

becomes a nutritious and sustainable food source for livestock (Regeneration International, 2017). Through the use of rotational grazing, farmers do not need to grow corn and other livestock-specific feed crops, as the livestock in a sense become responsible for the growing and consumption of their own food. This allows for arable croplands to become diversified in their production of plant foods for human consumption, creating an increase in food security. Promoting the natural relationship that exists between animal and plant life cycles is essential in achieving a balanced and sustainable food system. For some livestock farmers, this involves the use of adaptive multi-paddock (AMP) grazing management. Adaptive multi-paddock grazing techniques build off of rotational grazing, while adding strategically sectioned zones for livestock to graze within. By concentrating livestock into smaller sections of pasturelands, the animals are forced to graze within the bounds of that zone, allowing plants to grow stronger roots. This promotes resilient and bountiful regrowth of grasses in the unoccupied sections (Teague, 2017). Cattle rotate through these areas, grazing on the healthy grass regrowth while allowing the previously grazed areas time to regenerate. The utilization of AMP grazing management allows farmers to sustain their cattle on naturally growing grasslands, making this regenerative farming technique both cost effective and sustainable. Ultimately, these strategic grazing techniques supply livestock with food while promoting a healthy balance within the agroecosystem.

The use of these grazing techniques creates healthy and bountiful plantlife on livestock farms. Healthy plant life in grazing fields promotes water retention as well as carbon sequestration, decreasing the amount of carbon dioxide in the atmosphere (Teague, 2017). Soil and plants have the ability to store carbon, redirecting it from the atmosphere into the Earth in what is known as a “carbon sink” (Payne, 2019). Currently in the United States, there are 762 million metric tons of greenhouse gases stored in the soil (Delonge, 2016). While this offsets 11% of greenhouse gas emissions, it does not sequester enough carbon to

prevent rising global temperatures (Delonge, 2016). While it is still unknown to scientists exactly how much carbon can be absorbed into the soil, as these tests have only been conducted on small-scale regenerative farms, regenerative agricultural practices lead the way in such discoveries (Delonge, 2016). Carbon sequestration through regenerative farming practices actively reverses the environmental destruction caused by industrialized agriculture. The ability of regenerative agriculture to restore the Earth's natural ecological balance while yielding enough food to sustain the global population proves this approach to be the most effective solution to the negative impacts of industrialized agriculture. While these regenerative methods of livestock production offer environmentally sustainable solutions to the production of animal products, they must also be able to sustain the growing human population and the increasingly large demand for meat. As the global demand for meat and dairy continues to rise, agricultural practices must be able to fulfill nutritional needs for the growing population of the world.

Demand and Limitations

The industrialization of agriculture has enabled humans to produce food in great abundance but at the expense of the environment. Industrialized animal agriculture has an environmental footprint three times larger than that of regenerative animal agriculture (Rowntree, 2020). The overfarming of ruminant animals emits more greenhouse gases into the atmosphere faster than what can be reabsorbed by the plant life and soils of the earth, contributing to global warming. While food production is at an all-time high, alleviating hunger and food insecurity in some regions of the world, the environmental impacts of industrialized agriculture make this method of food production impractical and unsustainable for continued use (Blattner, 2019). While sustainable alternatives to current industrialized agricultural practices exist, they must be expanded to be achievable and accessible on a global scale. Currently, through the use of industrialized agriculture, enough food is produced

to feed 10 million people, with the current global population at 7.5 million people (One Earth, 2021). While there is an overabundance of food produced, a quarter of the world's population is malnourished, an issue that occurs due to the industrialized nature of agriculture and its environmental impacts.

Due to the environmental degradation and climate-changing emissions from industrialized animal agriculture, small scale farmers, particularly in developing nations, are increasingly unable to produce high yielding harvests, as their farmlands become inhospitable to sustaining healthy agroecosystems (Cudworth, 2011). While this is the case, large scale industrialized agribusinesses produce more food than what is necessary to sustain the global population, with about 30% of that food never being consumed (One Earth, 2021). While industrialized agriculture has increased food security for most people in wealthy nations, it worsens food security in countries that rely on small scale farming. Currently, the average american eats 222.2 pounds of meat per year, with domestic meat production exceeding 100 billion pounds per year (Maynard, 2018). As the production of resource-intensive animal products continues to rise with global demands, the environment continues to suffer, and agriculture becomes increasingly at risk.

Regenerative farming practices can offer environmentally sound solutions to industrialized animal agriculture, but limitations occur in production capacity. While animal products can be produced in a sustainable and restorative manner, the capacity of production is less than that of industrialized animal agriculture. Regenerative animal agriculture requires 2.5 times as much land as commercially-produced livestock (Rowntree, 2020). Regenerative farming of animals is land intensive, and while these practices are restorative to pastoral lands, the land required to raise livestock regeneratively while meeting current global meat demands exceeds what is available in current farmlands and would result in further deforestation for the sake of livestock grazing (Rowntree, 2020). There is not enough existing

farmland to rear resource-intensive livestock such as cows through regenerative practices while meeting current rates of demand.

Ultimately, current levels of demand for meat are unsustainable, even when produced through regenerative practices. While regenerative agriculture aids in carbon sequestration and promotes the naturally occurring symbiotic relationship among plants, animals, and microorganisms, current rates of meat and dairy production are unattainable through this practice (Johnson, 2018). In the United States, 99% of all consumed meat comes from factory farms (Anthis, 2019). Therefore, the amount of beef that is currently produced through regenerative farming practices is not substantial enough to make a large impact on mitigating climate change (Gurian-Sherman, 2019). While these regenerative practices exist, they are hardly used by farmers, as consumer demands remain too high to make regenerative animal agriculture an attainable replacement for current rates of demand through industrialized animal agriculture. Given this, consumers must lessen their consumption of resource-intensive animal products in conjunction with a large scale shift towards regenerative agriculture in order to achieve a sustainable food system.

While regeneratively produced animal products exist as a practical and sustainable alternative to that of the conventional variety, this method cannot fulfill the high rates of consumer demands for animal products. Since industrialized animal agriculture is an unsustainable practice, and regenerative agriculture does not have the capacity to meet current rates of production for resource-intensive animal products, a reduction in consumer demands of animal products altogether can aid in achieving a sustainable food system.

Implementing policy that influences market prices of animal products would drive down the demand for these products. Adding a “carbon tax” on environmentally straining products would increase the cost of animal products and result in a reduction of consumer demand (Stanley, 2020). Additionally, removing government funded subsidies on animal

products and implementing fees for overgrazing and overconsumption of freshwater would cause the market price to reflect the true cost of production, again resulting in a reduced demand for these products (Henning, 2011). While these methods would drive down the demand for animal products, it results in an inaccessibility of these products to lower income consumers. Thus, alternative inclusive approaches must be explored.

While there are several fiscal approaches that can limit consumers' consumption of animal products, it is important to maintain the price point of meat and dairy to be accessible to all as to ensure animal products do not become exclusive to the wealthy and elite. One approach that does not influence the market price of animal products is promoting consumer awareness and understanding of sustainable food systems. Consumer awareness about the environmental impact of their food plays an essential role in the reduction of meat production, as people's decisions tend to be influenced by moral guidance (Eshel, 2014). Relaying important information about food sustainability to consumers allows them the opportunity to make informed decisions about what they eat according to their personal preferences and morals. In addition to educating consumers, accurate media coverage on animal agriculture practices can influence demand rates (Kristiansen, 2020). The way in which animal products are advertised influences the rate of demand. Full transparency of farming practices can deter consumers from purchasing industrially produced animal products and influence them to opt for regeneratively raised products instead. While regeneratively produced animal products tend to hold a higher price point than conventionally raised livestock, high polluting private companies can absorb some of these expenses through partnerships with farmers to promote regenerative farming practices through the purchasing of carbon credits from regenerative farmers (Schroeder, 2019). Financial contributions from private companies with large emissions to sustainable agricultural practices assists in making

sustainable agriculture accessible and maintaining a price point that low income consumers can afford.

The most effective way to drive down the demand for animal products is for consumers to reduce their consumption of meat and dairy products overall. Increasing consumption of plant-based foods by consumers would lessen the demand for animal products, allowing farmers to exclusively raise their livestock through regenerative farming practices within the bounds of pastureland limitations (Horrigan, 2002; Lujan Soto, 2021). In order for regenerative animal agriculture to act as both a replacement for industrialized animal agriculture and as a means of rejuvenating agroecosystems, fewer livestock must be raised. Overconsumption of animal products lies at the heart of the environmental destruction from animal agriculture, and while regenerative agriculture can reverse this damage, current rates of demand for animal products exceeds what regenerative agriculture is capable of producing in a sustainable manner.

Conclusion

Humans have long depended on agricultural systems to sustain life and prosper. With the introduction of farming into the Fertile Crescent, people were able to direct their time and energy into the development of sciences, art, and culture, as they no longer had to spend time hunting and gathering their food. The advent of agriculture is still heavily relied upon today, expanding into a global food system. While scientific developments in the agriculture sector have expanded food security and provided opportunity for societal growth and development, it has reached a point of detriment for the planet. Over the course of the past 70 years, agricultural production methods have industrialized, turning farms into factories. I believe that regenerative agriculture is the best approach to maintaining global food security, as current methods of food production over consume and pollute vital resources faster than they can naturally regenerate. With the livestock sector being the largest polluter and resource

consumer out of any industrialized agriculture sector, this thesis specifically focuses on industrialized animal farming and its effect on the longevity and sustainability of agriculture as a means of sustaining global food security.

The environmental destruction caused by industrialized animal agriculture makes current farming practices unsustainable for continued use. The livestock sector is responsible for the majority of agricultural pollution, accounting for 14.5% of greenhouse gas emissions globally, while consuming 70% of global freshwater and occupying 38% of arable lands (Blattner, 2019). The rate of environmental degradation and climate-changing emissions from industrialized animal agriculture threatens agricultural systems as a whole. At current rates of destruction, humans are expected to run out of fertile lands and necessary resources to sustain current methods of food production by 2050 (Henning, 2011). With current practices of agriculture at risk of no longer being a viable means of producing food, there must be an urgent and universal shift towards sustainable agriculture.

Implementing regenerative agricultural practices on a global scale offer a sound solution to the threats of environmental destruction and agricultural demise from current industrialized practices. Regenerative agriculture offers alternative approaches to industrialized farming that restore the naturally occurring symbiotic relationship among plants, animals, and microorganisms in the soil, promoting carbon absorption and water retention, resulting in sequestration of carbon emissions and preventing desertification of arable lands (Regeneration International, 2017). The use of regenerative farming practices has the ability to reverse the effects of climate change and promote healthy agroecosystems. Livestock farmers must incorporate regenerative practices in order to preserve agricultural systems. While regenerative agriculture serves as a sustainable farming practice, there are many approaches that scholars suggest in the efforts to mitigate environmental destruction and climate change caused by industrialized agriculture.

Scholars suggest a variety of mitigation techniques to lessen the environmental destruction caused by industrialized animal agriculture. Some scholars advocate for policy-based approaches, centering around subsidy removal and emission taxes on high polluting big agribusinesses, causing the market price to reflect the true cost of production. While a fiscal penalty would result in a decrease in demand for meat and dairy products, penalizing low-income consumers by driving up the cost of animal products is an unjust approach to environmental preservation. Other scholars believe that small-scale, community oriented farming and marketing of food through community supported agriculture and food cooperatives serves as a sustainable replacement of factory farmed goods. While this is true, these models tend to be inaccessible to the greater population either geographically or fiscally, as cost of food tends to be higher in these marketplaces and can be difficult to scale to meet production needs. Scholars who support developments in food science as a means of replacing industrialized animal agriculture cite lab-grown meats and plant-based alternatives as food products that can replace conventionally farmed animal products. While these replacements have a far smaller carbon footprint and require fewer resources, resistance from consumers remains a barrier. While all of these approaches have their own merits, they cannot stand alone in mitigating the impacts of climate change and environmental degradation caused by industrialized animal agriculture. Regenerative agriculture, in contrast, is able to produce enough food to sustain global needs, while actively reversing the effects of climate change and environmental degradation.

I utilized data on the environmental impacts of livestock farming from both industrialized and regenerative practices. This data proves that the use of regenerative agricultural practices has the potential to reverse the environmental destruction and climate-changing emissions that come from industrialized livestock farming. While regenerative agriculture has the capacity to produce enough food to meet global nutrition

needs and prevent hunger, it does not have the environmental capacity to sustainably achieve current global demands for resource-intensive meat and dairy products. Regenerative animal agriculture requires expansive livestock grazing lands, exceeding what is available in current pasturelands (Johnson, 2018). In order to meet the global demand for animal products through regeneratively produced meat and dairy, forests would have to be cleared to make way for grazing lands, which ultimately would cause more environmental damage than restoration. Regenerative animal agriculture is capable of mitigating climate change and environmental degradation, so long as the demand for animal products exists within the bounds of regeneration, creating an environmentally sustainable food system that is necessary in the continuation of agriculture.

Regenerative agricultural practices revitalize the environment that has been damaged by industrialized agriculture, but global demands for animal products exceed what can be sustainably produced through regenerative agriculture. Thus, an essential component in the success of regenerative agriculture is a reduction in demand for animal products. The growing demand for animal products is unsustainable, even through regenerative agricultural practices, which point to overconsumption of these resource-intensive foods as the root cause of unsustainable food systems. Animal products can continue to be produced and consumed through a shift toward environmentally regenerative production practices, but it must coincide with a meaningful reduction in the consumption of these products. While ultimately the removal of animal products from the human diet can offer great environmental relief, the reality of this notion is likely unattainable anytime soon, as the desire for animal products continues to grow globally.

People do not necessarily have to forfeit animal products for the sake of sustainability and the continuation of agriculture, but a reduction in consumption is necessary in order to achieve sustainability through regenerative agriculture. Reducing global consumption of meat

and dairy products would drastically reduce the environmental destruction and climate-changing emissions that come from industrialized farming of livestock. Informing consumers on the environmental impacts of industrialized animal agriculture gives them the opportunity to change their diet, should their socioeconomic and locational status allow it. Raising public awareness around this issue will push forward the influence of consumers to create change within food systems. The environmental impacts of industrialized agriculture are intentionally hidden from consumers by big agribusinesses, as these corporate farming operations are aware of the power of an informed public. Consumers can be made aware of the environmental impacts of industrialized farming through accurate media coverage and labeling schemes that promote transparency in products. With the support of an informed public, regenerative agriculture can be pushed to the forefront of agricultural practices.

As anthropogenic environmental destruction and rising global temperatures become increasingly threatening to life on Earth, people are beginning to take action. While agriculture is certainly not the only major contributor to this environmental destruction, the global reliance on this practice makes it an important industry to reform. Additionally, the current environmental impacts of industrialized agriculture jeopardizes the continuation of agricultural practices in the future. Soil infertility, unpredictable rainfall, and depleted resources all result from the environmental destruction and climate-changing emissions from sectors such as industrialized agriculture. People are beginning to demand environmental justice, as grave predictions from scientists about the future of humanity creep closer.

In order to preserve global ecosystems and prevent the demise of agriculture, it is essential that production and consumption habits shift intentionally towards sustainability. Through regenerative agriculture, environmental restoration can become the new standard in agricultural practices. While a complete absence of meat and dairy from the human diet is unlikely to occur in the near future, responsible consumption of these products is possible.

People must be willing to alter their diets to consume greater amounts of grains, fruits, and vegetables, and less resource-intensive meat and dairy products. Regenerative agriculture offers the opportunity for humans to restore the natural ecological balance of the Earth while protecting agricultural systems for future generations.

Bibliography

"Animal Feeding Operations | NRCS." 2011. Usda.gov. USDA. 2011. https://www.nrcs.usda.gov/wps/portal/nrcs/main/national/plantsanimals/livestock/afo/.

Anthis, Jacy Reese. 2019. "US Factory Farming Estimates." Sentience Institute. 2019. https://www.sentienceinstitute.org/us-factory-farming-estimates.

Blattner, Charlotte, and Odile Ammann. 2019a. "Agricultural Exceptionalism and Industrial Animal Food Production: Exploring the Human Rights Nexus." *Agricultural Exceptionalism and Industrial Animal Food Production: Exploring the Human Rights Nexus* 15 (2).

California State University. 2021. "White Oak Pastures – Center for Regenerative Agriculture and Resilient Systems – CSU, Chico." Www.csuchico.edu. 2021. https://www.csuchico.edu/regenerativeagriculture/demos/white-oak-pastures.shtml.

Chatterjee, Rhitu. 2016. "Where Did Agriculture Begin? Oh Boy, It's Complicated." NPR.org. July 15, 2016. https://www.npr.org/sections/thesalt/2016/07/15/485722228/where-did-agriculture-begin-oh-boy-its-complicated#:~:text=Sometime%20around%2012%2C000%20years%20ago.

Choudhury, Deepak, Satnam Singh, Jasmine Si Han Seah, David Chen Loong Yeo, and Lay Poh Tan. 2020. "Commercialization of Plant-Based Meat Alternatives." *Trends in Plant Science*, September. https://doi.org/10.1016/j.tplants.2020.08.006.

"Climate Change and Agriculture." 2019. Union of Concerned Scientists. March 20, 2019. https://www.ucsusa.org/resources/climate-change-and-agriculture.

Cook, Seth. 2016. "Fertile Futures: Nurturing the Shoots of China's Sustainable Agriculture." *International Institute for Environment and Development*.

Cudworth, Erika. 2011a. "Climate Change, Industrial Animal Agriculture, and Complex Inequalities." *International Journal of Science in Society* 2 (3). https://doi.org/10.18848/1836-6236/CGP/v02i03/51257.

CUESA. 2018. "How Far Does Your Food Travel to Get to Your Plate?" Cuesa.org. Center for Urban Education about Sustainable Agriculture. February 5, 2018. https://cuesa.org/learn/how-far-does-your-food-travel-get-your-plate.

Dimitri, Carolyn, Anne Effland, and Neilson Conklin. 2005. "The 20th Century Transformation of U.S. Agriculture and Farm Policy Electronic Report." https://www.ers.usda.gov/webdocs/publications/44197/13566_eib3_1_.pdf.

Eshel, G., A. Shepon, T. Makov, and R. Milo. 2014a. “Land, Irrigation Water, Greenhouse Gas, and Reactive Nitrogen Burdens of Meat, Eggs, and Dairy Production in the United States.” *Proceedings of the National Academy of Sciences* 111 (33): 11996–2001. https://doi.org/10.1073/pnas.1402183111.

Fiut, Ignacy, and Marcin Urbaniak. 2016. “Factory Farming versus Environment and Society. The Analysis of Selected Problems.” *Problemy Ekorozwoju* 11 (1).

Food and Agriculture Organization of The United Nations. 2019. “FAO - News Article: Key Facts and Findings.” Fao.org. 2019. http://www.fao.org/news/story/en/item/197623/icode/.

Godfray, H. Charles J., Paul Aveyard, Tara Garnett, Jim W. Hall, Timothy J. Key, Jamie Lorimer, Ray T. Pierrehumbert, Peter Scarborough, Marco Springmann, and Susan A. Jebb. 2018. “Meat Consumption, Health, and the Environment.” *Science* 361 (6399): eaam5324. https://doi.org/10.1126/science.aam5324.

Gunderson, Ryan. 2011. “From Cattle to Capital: Exchange Value, Animal Commodification, and Barbarism.” *Critical Sociology* 39 (2): 259–75. https://doi.org/10.1177/0896920511421031.

Gurian-Sherman, Doug. 2019. “Can Eating Cows Save the Planet?” Food Revolution Network. October 16, 2019. https://foodrevolution.org/blog/regenerative-agriculture/.

Haedicke, Michael A. 2014. “Small Food Co-Ops in a Whole Foods® World.” *Contexts* 13 (3): 32–37. https://doi.org/10.1177/1536504214545757.

Henning, Brian. 2011a. “Standing in Livestock’s ‘“Long Shadow”’: The Ethics of Eating Meat on a Small Planet.” *Ethics and the Environment* 16 (2): 63. https://doi.org/10.2979/ethicsenviro.16.2.63.

Horrigan, Leo, Robert S Lawrence, and Polly Walker. 2002a. “How Sustainable Agriculture Can Address the Environmental and Human Health Harms of Industrial Agriculture.” *Environmental Health Perspectives* 110 (5): 445–56. https://doi.org/10.1289/ehp.02110445.

Johnson, Nathanael. 2018. “Climate-Friendly Burgers: Fact or Fiction?” Grist. April 16, 2018. https://grist.org/article/climate-friendly-burgers-fact-or-fiction/.

Kremen, Claire, Alastair Iles, and Christopher Bacon. 2012a. “Diversified Farming Systems: An Agroecological, Systems-Based Alternative to Modern Industrial Agriculture.” *Ecology and Society* 17 (4). https://doi.org/10.5751/es-05103-170444.

Kristiansen, Silje, James Painter, and Meghan Shea. 2020. “Animal Agriculture and Climate Change in the US and UK Elite Media: Volume, Responsibilities, Causes and

Solutions." *Environmental Communication*, September, 1–20. https://doi.org/10.1080/17524032.2020.1805344.

Lal, Rattan. 2020. "Regenerative Agriculture for Food and Climate." *Journal of Soil and Water Conservation*, August, jswc.2020.0620A. https://doi.org/10.2489/jswc.2020.0620a.

Le, Bianca. 2018a. "Cleaning Our Hands of Dirty Factory Farming: The Future of Meat Production Is Almost Here." *Australian Institute of Policy and Science* 89 (4).

Luján Soto, Raquel, María Martínez-Mena, Mamen Cuéllar Padilla, and Joris de Vente. 2021. "Restoring Soil Quality of Woody Agroecosystems in Mediterranean Drylands through Regenerative Agriculture." *Agriculture, Ecosystems & Environment* 306 (February): 107191. https://doi.org/10.1016/j.agee.2020.107191.

Maynard, Micheline. 2018. "Veggies May Be Healthier, but in 2018, Americans Will Eat a Record Amount of Meat." Forbes. January 2, 2018. https://www.forbes.com/sites/michelinemaynard/2018/01/02/veggies-may-be-healthier-but-in-2018-americans-will-eat-a-record-amount-of-meat/?sh=30a0919019b9.

McLeod-Kilmurray, Heather. 2019a. "Does the Rule of Ecological Law Demand Veganism?: Ecological Law, Interspecies Justice, and the Global Food System." *Vermont Law Review* 43 (3).

Mert-Cakal, Tezcan, and Mara Miele. 2020. "'Workable Utopias' for Social Change through Inclusion and Empowerment? Community Supported Agriculture (CSA) in Wales as Social Innovation." *Agriculture and Human Values*, August. https://doi.org/10.1007/s10460-020-10141-6.

Payne, Emily. 2019. "Regenerative Agriculture Is Getting More Mainstream but How Scalable Is It? - AgFunderNews." AgFunderNews. May 28, 2019. https://agfundernews.com/regenerative-agriculture-is-getting-more-mainstream-but-how-scalable-is-it.html.

Ranganathan, Janet, Richard Waite, Tim Searchinger, and Jessica Zionts. 2020. "Regenerative Agriculture: Good for Soil Health, but Limited Potential to Mitigate Climate Change." World Resources Institute. May 12, 2020. https://www.wri.org/blog/2020/05/regenerative-agriculture-climate-change.

"Regeneration International." 2019. Regeneration International. 2019. https://regenerationinternational.org/.

"Regenerative Agriculture and Food Systems." n.d. One Earth. One Earth. Accessed March 9, 2021. https://www.oneearth.org/regenerative-agriculture-and-food-systems/.

Ritchie, Hannah, and Max Roser. 2017. “Meat and Dairy Production.” Our World in Data. August 2017. https://ourworldindata.org/meat-production.

Rockström, Johan, John Williams, Gretchen Daily, Andrew Noble, Nathanial Matthews, Line Gordon, Hanna Wetterstrand, et al. 2016. “Sustainable Intensification of Agriculture for Human Prosperity and Global Sustainability.” *Ambio* 46 (1): 4–17. https://doi.org/10.1007/s13280-016-0793-6.

Rojas-Downing, M. Melissa, A. Pouyan Nejadhashemi, Timothy Harrigan, and Sean A. Woznicki. 2017. “Climate Change and Livestock: Impacts, Adaptation, and Mitigation.” *Climate Risk Management* 16: 145–63. https://doi.org/10.1016/j.crm.2017.02.001.

Rowntree, Jason E., Paige L. Stanley, Isabella C. F. Maciel, Mariko Thorbecke, Steven T. Rosenzweig, Dennis W. Hancock, Aidee Guzman, and Matt R. Raven. 2020. “Ecosystem Impacts and Productive Capacity of a Multi-Species Pastured Livestock System.” *Frontiers in Sustainable Food Systems* 4 (December). https://doi.org/10.3389/fsufs.2020.544984.

Schroeder, Brianna. 2019. “Regenerative Agriculture and Livestock.” Janzen Ag Law. July 26, 2019. https://www.aglaw.us/schroeder-ag-law-blog/2019/7/26/regenerative-agriculture-and-livestock#:~:text=%E2%80%9CRegenerative%20agriculture%E2%80%9D%20or%20%E2%80%9Ccarbon.

Sewell, Christina. 2020a. “Removing the Meat Subsidy: Our Cognitive Dissonance around Animal Agriculture.” *Journal of International Affairs* 73 (1).

Sierra Club. 2019. “Why Are CAFOs Bad?” Sierra Club. March 18, 2019. https://www.sierraclub.org/michigan/why-are-cafos-bad.

Stanley, Samantha K., John R. Kerr, and Marc S. Wilson. 2020a. “The Influence of Politics and Labelling on New Zealanders’ Attitudes towards Animal Agriculture Emissions Policy.” *Political Science*, August, 1–14. https://doi.org/10.1080/00323187.2020.1800414.

Stuart, Diana, and Ryan Gunderson. 2019. “Human-Animal Relations in the Capitalocene: Environmental Impacts and Alternatives.” *Environmental Sociology* 6 (1): 1–14. https://doi.org/10.1080/23251042.2019.1666784.

Tabassum-Abbasi, Tasneem Abbasi, and S.A. Abbasi. 2016. “Reducing the Global Environmental Impact of Livestock Production: The Minilivestock Option.” *Journal*

of Cleaner Production 112 (2): 1754–66. https://doi.org/10.1016/j.jclepro.2015.02.094.

Teague, Richard, and Matt Barnes. 2017. "Grazing Management That Regenerates Ecosystem Function and Grazingland Livelihoods." *African Journal of Range & Forage Science* 34 (2): 77–86. https://doi.org/10.2989/10220119.2017.1334706.

Thornton, Philip K. 2010. "Livestock Production: Recent Trends, Future Prospects." *Philosophical Transactions of the Royal Society B: Biological Sciences* 365 (1554): 2853–67. https://doi.org/10.1098/rstb.2010.0134.

Tucker, Corrina. 2018a. "Using Environmental Imperatives to Reduce Meat Consumption: Perspectives from New Zealand." *Kōtuitui: New Zealand Journal of Social Sciences Online* 13 (1): 99–110. https://doi.org/10.1080/1177083x.2018.1452763.

"USDA Coexistence Fact Sheets Corn." 2015. https://www.usda.gov/sites/default/files/documents/coexistence-corn-factsheet.pdf.

"USDA ERS - Ag and Food Sectors and the Economy." 2020. Www.ers.usda.gov. December 16, 2020. https://www.ers.usda.gov/data-products/ag-and-food-statistics-charting-the-essentials/ag-and-food-sectors-and-the-economy/#:~:text=What%20is%20agriculture.

WHO. 2019. "World Hunger Is Still Not Going down after Three Years and Obesity Is Still Growing – UN Report." Www.who.int. July 15, 2019. https://www.who.int/news/item/15-07-2019-world-hunger-is-still-not-going-down-after-three-years-and-obesity-is-still-growing-un-report.

Yates-Doerr, Emily. 2012. "Meeting the Demand for Meat?" *Anthropology Today* 28 (1).