

The Negative Effects of Agricultural Methane on Public Health: A Policy Solution

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Abstract

Earth is facing a climate crisis, and this climate crisis will change how people live their lives. If action is not taken soon and current trends continue climate change will become irreversible. The negative effects of climate change are everywhere from severe droughts and wildfires to melting ice caps. The changing climate is directly caused by an increase in greenhouse gases in our atmosphere. A main driver of this increase in greenhouse gasses is the agriculture industry. The agriculture industry is the largest emitter of methane in the United States, and their emission levels go unregulated. In order to combat climate change people must change the way they farm globally.

Climate change poses a direct threat to public health around the globe. Severe weather events like droughts, heat waves, floods, hurricanes, and tornadoes are all becoming more common. All these events pose threats to the people living in the areas where they occur. These events can also lead to food shortage due to low yields. The melting ice caps will lead to sea level rise and impact people living in coastal communities. If the government does nothing to combat climate change the health of people will continue to be threatened by climate related events.

Table of Contents

Preface.....	vii
1.0 Introduction.....	1
1.1 Climate Change Overview	1
1.2 Agricultural Overview of the United States	3
1.3 Agriculture's Role in Climate Change.....	3
1.4 Health Impacts of Climate Change.....	5
2.0 Current State Policy Regulations regarding Agriculture's Role in Climate Change	6
3.0 Stakeholder Analysis	8
3.1 Farmers	8
3.2 United States Department of Agriculture (USDA).....	8
3.3 Environmental Protection Agency (EPA)	9
3.4 Consumers.....	9
3.5 Federal Emergency Management Agency (FEMA)	9
4.0 Policy Options.....	11
4.1 Option 1	11
4.2 Option 2	13
4.3 Policy Recommendations	14
Bibliography	16

List of Tables

Table 1. Different effects of Climate Change on regions of the U.S.....	2
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Preface

It is recommended that acknowledgments, nomenclature used, and similar items should be included in the Preface.

The Preface is optional. If you wish to delete the Preface, you need to place the cursor in the Preface title and apply the Normal style to remove the currently applied style. Then delete the Preface content, being careful not to delete the preceding and subsequent sections.

1.0 Introduction

1.1 Climate Change Overview

The climate on Earth is changing (<https://climate.nasa.gov/evidence/>); this change will have negative effects on the health of humans around the globe. Since the mid-20th century, scientist have attributed climate change to the growing concentration of “greenhouse gases” in Earth’s atmosphere causing a “greenhouse” effect. The greenhouse effect is the trapping of heat inside of Earth’s atmosphere. Gases that are responsible for causing the greenhouse effect are carbon dioxide (CO₂), nitrous oxide (N₂O), methane (CH₄), and water vapor (H₂O). The increase in greenhouse gases in the atmosphere has been attributed to human activity (<https://climate.nasa.gov/causes/> 2021).

The effects of climate change have already started to show in the form of loss of sea ice, sea level rise, and extreme heat waves. The Intergovernmental Panel on Climate Change (IPCC) is a panel of over 1,300 scientists around the globe who study climate change. Scientists with the IPCC predict that over the next century average global temperatures will rise 2.5 to 10 degrees Fahrenheit; this rise in temperature will have varying effects on different regions of the world, including the different regions of the United States (Table 1) (<https://climate.nasa.gov/effects/> 2021)

Table 1. Different effects of Climate Change on regions of the U.S.

Region of United States	Effects of Climate Change
Northeast	Heat waves, heavy downpours and sea level rise. Infrastructure, agriculture, fisheries and ecosystems will be increasingly threatened.
Southeast	Sea level rise poses widespread and continuing threats to the region economically and environmentally. Extreme heat will affect health, energy, and agriculture. Decreased water availability due to draughts will have economic and environmental impacts.
Midwest	Extreme heat, heavy downpours and flooding will affect infrastructure, health, agriculture, forestry, transportation, and air and water quality. Climate change will also exacerbate a range of risks to the Great Lakes.
Northwest	Sea level rise, erosion, inundation, risks to infrastructure and increasing ocean acidity pose threats. Increasing wildfire, insect outbreaks and tree diseases are causing widespread tree die-off.
Southwest	Increased heat, drought and insect outbreaks, all linked to climate change, have increased wildfire activity. Declining water supplies, reduced agricultural yields, health impacts in cities due to heat, and flooding and erosion in coastal areas are also concerns.

The effects shown in Table 1 will have negative impacts across all aspects of human life in this country. If these trends continue without intervention humans will continue to see negative impacts on their health, economy, and environment. Researchers believe that “the effects of human-caused global warming are happening now, are irreversible on the timescale of people alive today, and will worsen in the decades to come” (<https://climate.nasa.gov/effects/> 2021). There is hope, however, that if steps are taken now, the negative impacts are still reversible for future generations. Thus, all drivers of climate change must be addressed immediately before the problem becomes irreversible (<https://climate.nasa.gov/effects/> 2021).

1.2 Agricultural Overview of the United States

Farming is a large industry in the United States. In 2020, farming contributed 134.7 billion dollars to the gross domestic product (GDP). In that same year, agriculture and its related industries accounted for 10.3 percent of U.S. employment, or 19.7 million jobs (<https://www.ers.usda.gov/data-products/ag-and-food-statistics-charting-the-essentials/ag-and-food-sectors-and-the-economy/> 2022). Just over half (1.2 billion acres) of the U.S. land base is dedicated to agricultural production. This number has declined since its peak in 1949, when agriculture accounted for 63 percent of the land base (<https://www.ers.usda.gov/data-products/ag-and-food-statistics-charting-the-essentials/land-and-natural-resources/> 2022). Although land use has declined, agricultural production has continued to increase over that same period.

Innovations in technology and agricultural science have given way to the increased production outputs, without adding to the inputs (<https://www.ers.usda.gov/data-products/ag-and-food-statistics-charting-the-essentials/farming-and-farm-income/>). United States Department of Agriculture (USDA) data shows that the agriculture industry has been responsive to innovation and change, and over the last 100 years agricultural trends have shown that the agriculture industry is resilient and adaptive. It is not out of the question to think that the country can farm more sustainably, while not hurting profits and productivity.

1.3 Agriculture's Role in Climate Change

The main focus to reducing climate change has been on cutting carbon emissions by reducing the use of fossil fuels and reducing deforestation across the globe. However, less

attention has been given to another main driver of climate change, the agriculture industry. The agriculture industry contributes to climate change in many ways. A main polluter in the agriculture industry is methane released from livestock. Methane is shorter-lived and less abundant than carbon dioxide in the atmosphere, but it is more effective at trapping heat. The greenhouse gases are important to life on Earth by allowing heat from the sun to penetrate the atmosphere and warm the planet. At normal levels, most of the heat is redirected off of Earth's surface and back into space, and this allows for appropriately warm temperatures. However, when atmospheric greenhouse gas levels are elevated, less heat is able to escape into space, thus warming Earth's surface to potentially harmful levels. Methane is "more than 80 times more potent than carbon dioxide in terms of warming the climate system" (Garthwaite 2021). Studies have shown that cattle and other ruminants have been just as much of a driver of methane increase as the fossil fuel industry. Methane emissions have increased 9 percent (50 million tons) per year since the early 2000's. Agriculture related methane emissions rose to 227 million tons of atmospheric methane in 2017, which is up 11 percent from 2006 (Garthwaite 2020).

Although less of a factor in agriculture driven methane release, food cultivation has also played a role in the increase of atmospheric methane, particularly rice farming. Rice farming requires the fields to be flooded for a period in order for the rice to grow. When the flooding occurs, the fields emit methane (Jordan 2016). The anaerobic conditions created by the flooding creates an optimal environment for methanogenic bacteria to produce methane (Saha et al. 2022). The use of manure as a fertilizer for growing crops is also a major source of methane production. The storing of the manure, as well as the spreading of it release methane into the atmosphere.

1.4 Health Impacts of Climate Change

Climate change poses a major public health threat that requires direct efforts to address. Rising temperatures can cause dangerous weather events such as droughts, floods, and heat waves. From 2000-2019 there were 7,348 major natural disasters globally. This resulted in the death of 1.23 million people. In the previous 20 years (1980-1999) there were just 4,212 natural disasters that claimed 1.19 million lives. The majority of this increase can be attributed to climate-related events. There was an increase of 3,025 climate-related events from 2000-2019 when compared to the previous 20 years. This is nearly double the amount seen from 1980-1999 (Yaghmaei 2020). If these trends continue, lives will increasingly be lost due directly to climate change.

These weather events can have direct impacts on health; however, they can also indirectly impact public health. The indirect impacts come in the form of low crop yield, which will cause food shortages, and economic instability due to the increase of extreme weather events. Different regions of the United States are facing different threats when it comes to climate change, but one common occurrence among them is the predicted loss of agricultural productivity (Table 1). As the United States population continues to increase, food shortages will become a common occurrence if agricultural productivity decreases. The country's population is expected to increase to 404.5 million in 2060, from 332.6 in 2020 (U.S. Census Bureau 2020). One's health is also directly correlated to their economic standing (Wang and Geng 2019). With lost economic productivity, the health of the public will decrease. These negative health effects are not directly caused by the changing climate, but they are just as concerning to public health officials.

2.0 Current State Policy Regulations regarding Agriculture's Role in Climate Change

Unlike with carbon emissions, the United States currently does not have any policy regulations that limit the amount of methane released by the agriculture industry. The United States government has passed laws that allow regulation of the amount of carbon that can be emitted (EPA Clean Air Act sec. 111(b)). Based on scientific findings, it is known that methane emissions are more potent in causing climate change; however, methane is not the greenhouse gas that is being targeted by law.

A White House report from November 2021 outlined a plan to mitigate the rising methane levels from agriculture. The mitigation strategies outlined in this plan do not come in the form of regulations, but rather incentives and partnerships. In response to President Joe Biden's pledge to combat climate change, the Biden Administration proposed the mitigation strategies outlined in the White House report. There are 4 strategies outlined in the plan: (1) adopt alternative manure management systems and other methane-reducing practices; (2) develop a climate-smart agricultural commodities partnership initiative; (3) expand on-farm generation and use of renewable energy; and (4) increase investments in agricultural methane quantification and related innovations (White House 2021).

USDA strategy 1 looks to provide farmers with monetary assistance and incentives if they adopt new manure storage and use practices that are methane capturing. It also encourages farmers to adopt other practices that reduce methane emissions. To support these incentives the USDA introduced a \$10 million Climate Smart Agriculture and Forestry pilot sign-up that specifically targets anaerobic digesters and select rice practices to reduce methane emissions. This program

will be scaled up nationwide for the 2022 fiscal year and they predict that this strategy will be able to reduce methane by 26 million metric tons in 2030 (White House 2021).

Strategy 2 looks to establish new partnerships that seek to increase the market for agricultural commodities that reduce methane emissions. This initiative looks to identify new practices and technology that reduce methane. Strategy 3 looks to create partnerships to promote programs and research on the use of renewable energy on farms. This initiative directly looks at the use of methane as an energy source. Strategy 4 is to increase investments in methane estimation methods, tools, and measurements for tracking gas fluxes associated with agricultural. This will help to accurately monitor the rates of methane being emitted by the agriculture industry. It will monitor the efficacy of methane reduction technologies and improve surveys to better track the adoption of the new practices. These changes will be tracked through the formation of a Climate Change Center of Excellence (White House 2021).

3.0 Stakeholder Analysis

3.1 Farmers

Farmers are the most directly affected by the regulation of methane gas emissions, as such regulation will force farmers to adopt new farming practices. They will need to purchase new technology and learn the new sustainable practices. This is the group that I anticipate providing the most resistance to regulation due to the perceived associated costs and requests to change habits. Specifically, I see farmers of small family farms being the most resistant due to having less resources.

3.2 United States Department of Agriculture (USDA)

The USDA is the federal regulating body that drafts and enforces policies surrounding agriculture. They are also the agency that would have to set aside budget money that would be paid to incentivize farmers for adopting sustainable farming practices, unless Congress were to appropriate the funds. The USDA is the federal agency that looks out for farmers and farming practices, so they have an interest in creating a regulatory environment where farming can thrive going forward. In addition, important research is conducted and funded by the USDA on more efficient and cleaner practices.

3.3 Environmental Protection Agency (EPA)

As the federal agency devoted to environmental protection, the EPA has a vested interest in the health of the environment. Regulations surrounding the reduction of methane gas would be supported by them because ultimately the environment will benefit. The EPA's mission is to protect the environment and climate change poses a direct threat to that goal. They are the federal agency tasked with combating climate change. The EPA also provides funding for research grants for the development of environmentally friendly practices.

3.4 Consumers

Agriculture product consumers are a key stakeholder involved in any regulation surrounding the agriculture industry as they would be impacted if regulations lead to increases in food prices. However, if no regulation occurs and the climate trends continue, food shortages will become a likely scenario. This will also negatively affect the consumer. Both of these scenarios could raise the price of groceries. The average person is sensitive to price increases at the grocery store. It is important to solve climate change for this group, but it must be done correctly.

3.5 Federal Emergency Management Agency (FEMA)

FEMA is the federal agency that helps people "before, during, and after disasters" (FEMA 2021). The agency has a direct interest in any legislation that combats climate change. Globally

trends have shown that with climate change comes extreme weather events. FEMA will have to use more resources and will need more funding if current climate trends continue.

4.0 Policy Options

As discussed above, climate change is a public health emergency and agriculture is a major contributor. The release of methane gas from the agriculture industry is a more potent greenhouse gas than carbon dioxide. In order to optimize the health of the public, policies reducing agricultural methane emissions must be implemented. The main drivers of methane emissions in the agriculture industry are due to livestock-related emissions and rice production. It is important for potential policy initiatives to combat climate change, but also leave room for the farmers to succeed. Below are 2 possible options. One policy is governmental enforced regulation, and the other is based on monetary incentives and attitude changes.

4.1 Option 1

The first policy option is to pass a law requiring all farms in the United States to transition to sustainable farming practices that reduce methane emissions.

1. All farmers, without exception would be required to adopt a method of sustainable manure storage and management systems.
2. If growing rice, farmers must take steps to optimize the conditions of their rice growing, by reducing or interrupting the time in which the fields are flooded.
3. Livestock operations must alter their feed to diets that lessen intestinal processes that create methane.

4. Provide USDA and EPA grant funding to research institutions that research innovative methods to reduce, capture, and use methane emissions.

These steps will be able to drastically reduce the amount of methane emitted into the atmosphere by agriculture. Three of these strategies directly fall on the shoulders of farmers and farming operations. These strategies will be able to drastically reduce the levels of methane that are released into the atmosphere by agriculture. Strategy 1 allows farmers to continue the practice of spreading manure as fertilizer but regulates how they are able to store and use it. This will reduce emissions related to manure pit storage. Strategy 2 targets farmers that cultivate rice. It looks to optimize the growing conditions of the rice because in optimal conditions methanotrophs in the rice paddies will oxidize nearly 80% of methane released (Saha et al. 2022). Strategy 3 targets livestock producers by mandating them to only feed their livestock diets that lessen the methane creating processes in their intestinal tracts. Strategy 4 will provide farmers with the information they need to implement innovative methods to reduce methane emissions.

The transition policy will occur over a period of 10 years which will allow farmers to properly prepare the new standards set forth. Grants and loans will be available to aid farmers in the transition. The aid will come from the USDA funds that are currently set aside as incentives for the optional transition to sustainable farming. Farmers who do not comply will face financial penalties. These financial penalties will be assessed based on the size of the farm. Larger farms that are not in compliance will emit more methane than smaller farms not in compliance. By implementing fines based on size the government will not be placing an unfair burden on a smaller farm that has less income potential.

4.2 Option 2

This option is similar to the USDA initiative laid out in the White House report from November 2021. This option establishes tax breaks and financial incentives to farmers who voluntarily adopt the strategies from option 1. The benefits of the incentive-based policy option that it does not force farmers of small operations to change their practices. Such small farmers are not driving climate change as much as the large farms and they are more likely to not have the resources to alter their practices. Just like the current incentives, financial aid to farmers that switch practices will come from money already set aside by the USDA. Voluntary change sounds better to people who are skeptical of climate change or the government. These farmers may oppose the new regulations simply because they are being forced to do it and feel as though the government is placing a burden on them. Voluntary gives farmers the choice and helps to convince them to change by offering incentives. This policy differs slightly from the White House report by expanding the sustainable practices and by offering tax breaks. The tax breaks offer an incentive that lasts for many years and not just during the transition period. The current policy laid out in the White House report offers initial incentives to switch to climate smart technologies but does not offer long-term incentives like this policy is proposing. The time for combatting climate change is now and extending the period for which incentives can be received will help to encourage more people to make the switch. This policy also differs by expanding on the scope of the White House report, which mainly focuses on manure management strategies and technologies. By altering the feed of cattle, farmers will be able to reduce methane associated with the release of gas and from their manure piles. This policy encourages the feed switch as well as the research of better feed practices.

This policy will also provide funding to create campaigns to alter the diets of humans. If humans can reduce their consumption of meat, then not as many livestock will be needed. With reduced livestock numbers comes reduced methane emissions.

4.3 Policy Recommendations

Policy 1 is strong because it forces all farming operations to take steps to reduce their methane emissions. However, public perception of regulatory policies like this are typically not popular, especially in today's political climate. Thus, it is important to provide farmers with funding to update their equipment and technology. Policy 2 does not force anyone to do anything but offers incentives to encourage positive change. This is where policy 2 is stronger in today's political climate.

Considering the evidence and importance of this public health problem I would recommend policy 1. I recommend this policy because I believe that it has the greatest potential to reduce methane emissions. The United States government regulates emissions of other greenhouse gases that are less of a danger, so why not regulate methane? The world is also at a vital point in the fight against climate change where action is needed. The incentive-based program in policy 2 will not create the change needed.

Both of these options are economically feasible. In the Biden Administration's "Build Back Better" bill, about \$550 billion is set aside for clean energy and climate initiatives. This plan focuses on switching to clean energy and reducing CO₂ (Tollefson 2021). If some of this money was appropriated to clean farming that could help fund the initiatives. The "Build Back Better"

bill could also more generally give funding and tax breaks to companies and individuals that invest in energy efficient and clean technologies. This way all harmful climate practices are included.

The economic feasibility is there to pass these policies; however, the political feasibility is more difficult. In today's political climate it is hard to pass any meaningful legislation unless it is written by your party. The democrats are the party that is pushing for climate change initiatives, and it is difficult to get republicans on board. As a policy maker the important thing to do to pass this policy would be to show republican lawmakers from heavy farming communities how inaction will negatively affect their constituents. If the policy makers can show that cost will not be burdensome on the individual farmers and that the farmers will be negatively affected if current climate trends continue, then it is possible to pass this legislation. It is important to feel as if they are helping farmers for the future and not attacking their way of life.

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