Thesis Project Portfolio

Conversion of *Escherichia coli* to Oxidize Methane for Reduction of Bovine Methane Pollution in Agriculture

(Technical Report)

The Effects of Climate Legislation in the United States and Denmark on Communities Living in Poverty

(STS Research Paper)

An Undergraduate Thesis

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Executive Summary

Introduction

The two projects being conducted include: a research project analyzing the effects of climate change policies on poor communities and a technical report aiming to reduce methane emissions of livestock through the insertion of viral vectors. Livestock production is one of the largest sources of methane emissions from human activities. Methane is the primary contributor to the formation of ground-level ozone, which is a hazardous air pollutant and greenhouse gas (EPA, 3). Climate change policies have the power to affect the rate of emissions, but they also have the power to affect the living conditions of those most vulnerable to climate change, communities living in poverty. Through the exploration of the differences between Denmark and the United State's climate change legislation and impacts both countries have on climate change, the connection between policy and treatment of those living below the poverty line can be made. With the completion of the technical project, there will be a decrease in the methane emissions from livestock, which in turn, will mitigate the effects of climate change. By slowing down the effects of climate change, the living conditions of poor communities will improve.

Technical Report

32% of anthropogenic greenhouse gas emissions derive from livestock production for the global food chain. In particular, cattle and dairy cows produce 14.2% of methane emissions through rumination (digestion) and manure (EPA, 1). Our project aims to implement a methane oxidizing pathway in a model *Escherichia coli* strain. To accomplish this goal, the group will use plasmid vectors to integrate three encoding genes for particulate methane monooxygenase (pMMO), a methane-oxidizing enzyme, into an *E. coli* strain. If genetic manipulation is

successful, the *E. coli* strain will oxidize atmospheric methane in a closed environment. Further advancements will implement the modified nonpathogenic *E. coli* strain into cattle gastrointestinal systems to reduce methane emissions from rumination.

STS Research Paper

Key words: Climate change, policies, Technological momentum, social determinants of health

The world is at risk of continuing to promote irreversible effects of climate change due to the lack of action within governments. However, the environment is not the only one being damaged; the quality of life for poor, underserved communities are too. The research question that will be addressed is, How do the differences in climate change policies in the United States compared to Denmark affect poor underserved populations and minorities? Denmark and the United States have taken contrasting approaches to combating climate change regarding their policies. The effects of each countries's policies disproportionately affect their poor communities. Using technological momentum, this research question will be answered, and it is expected to find that the country with the most radical and strict climate change policies is the one with a lower poverty rate and better quality of life for those living below the poverty line. The country with policies created for the integration into society should yield the best results in mitigating the effects of climate change and indirect effects on said communities. This research is significant to the work of STS as it shows not only the connection between climate change policy and society, but it will also show the urgency in action needed for the engineering field to create technology dedicated to a more sustainable future.

Reflection

Conducting both projects simultaneously has allowed me to see the effects methane emissions have on vulnerable groups of people to climate change. If I had conducted the technical report separately, I would have only been able to see the connection between decreased methane emissions to the earth. The driving force behind the choice of genetically editing *E. coli* was to save the environment for future generations. Methane is responsible for more than twenty-five percent of the global warming happening today. The structure of methane traps significantly more heat in the atmosphere per molecule than carbon dioxide, making it eighty times more harmful than carbon dioxide for twenty years after it is released (UN, 2). What I did not release before conducting my STS Research Paper was the effects this would have on poorer communities as well as the amount of control each country's legislation has on the effects of global warming. I have learned that there needs to be great efforts from both the science side of the world as well as the government. Efforts like my technical project need to be made along with consequential change to climate legislation, especially in the United States in order to save the environment from further irreversible damage.

Sources:

Methane emissions are driving climate change. here's how to reduce them. UNEP. (n.d.). Retrieved March 29, 2023, from https://www.unep.org/news-and-stories/story/methane-emissions-are-driving-climate-change-heres-how-reduce-them#:~:text=Methane%20is%20the%20primary%20contributor,at%20warming%20than%20carbon%20dioxide.

Environmental Protection Agency. (n.d.). *Global Methane Initiative* . EPA. Retrieved March 29, 2023, from https://www.epa.gov/gmi/importance-methane#:~:text=The%20largest%20sources%20of%20methane,livestock%20enteric%20fermentation%2C%20and%20landfills.

Environmental Protection Agency. (n.d.). *Sources of Greenhouse Gas Emissions*. EPA. Retrieved March 29, 2023, from https://www.epa.gov/ghgemissions/sources-greenhouse-gas-emissions