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SOMETHING'S SMELLY IN THE STATE OF US AGRICULTURE

By Jacob Fernandes

INTRODUCTION

Every year, a mature lactating Dairy Cow produces about 14.4 tons of manure. Stinky!
Jacob Fernandes, 2022

Cows poop a lot. In fact, according to Utah State University, a 1000-pound lactating dairy cow produces 80 pounds of manure per day. That's nearly 14.4 tons of manure in one year! When left alone, this large amount manure undergoes the anaerobic digestion process. Bacteria degrade the manure into organic acids, producing methane gas and carbon dioxide in the process. Methane gas and carbon dioxide are two of the most damaging **greenhouse gases (GHG)**. These gases, which trap heat above the Earth's surface, can have devastating impacts on both the climate and local communities. As such, managing agricultural output of both methane and carbon dioxide is a very important issue not only for large, industrial farmers, but for small farmers too.

However, cow manure is not the only source of methane gas and other greenhouse gas emissions in agriculture. All of animal agriculture produces these gases, through animal belching, other animal manure sources, and emissions from fuel consumption. Agriculture takes a lot of energy to power its operations: the agriculture sector accounted for 1.9% of the US primary energy consumption in 2016 at 1872 trillion British Thermal Units (USDA Economic Research Service, 2018).

Greenhouse Gas (GHG) *– a gas that contributes to the greenhouse effect by trapping heat in the atmosphere*

Energy consumption in agriculture has been steadily trending upwards since 2015. At the same time, the world population is expected to reach 9 billion by 2050 and agricultural demand is expected to increase by one billion tons in response (Food and Agriculture Organization, 2009). US agriculture is going to need to fix its energy problem if we ever want to create a sustainable industry: an industry that reaches for carbon neutral or carbon negative emissions; that can efficiently feed hundreds of millions;

that supports US industry growth and stimulates the economy; and that can grow as the world grows along with it.

The world population is expected to reach 9 billion by 2050!

EXPLANATION OF THE ISSUE

Historical Development and Background

Cows have pooped ever since the dawn of time. But the industrialization of agriculture and increased reliance on fossil fuels has significantly increased methane production in the modern era. While methane is a naturally produced gas, it is estimated that in the last two centuries, methane concentrations in the atmosphere have more than doubled due to human-related activities (Environmental Protection Agency, 2023). These **anthropogenic** emissions make up 60% of global methane emissions (Iea, 2020).

At the same time, agriculture has grown exponentially in recent years due as technology has made farming more profitable and efficient. The demand for grain alone is expected to rise by nearly a billion metric tons by 2050 and global food production is expected to jump 70% to keep up with rising demand and population growth (Global Agriculture Toward 2050, 2009). All the while, cows are producing more methane than ever and climate change continues to worsen. To address climate change, President Joe Biden pledged in 2021 to limit the US' methane-induced warming, setting a target of a 50% reduction in greenhouse gas emissions from their 2005 levels by 2030 (The White House, 2021)

Methane Gas is a major Greenhouse Gas associated with Animal Agriculture
Jacob Fernandes, 2023

***Anthropogenic** – of a human-activity related origin.*

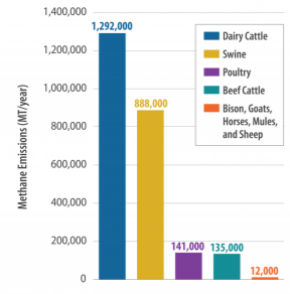
Scope of the Problem

As it has become clear, agriculture is an industry closely connected to the environment and climate change. With high greenhouse gas emissions and energy consumption compared to many other sectors, it is critical to reduce agriculture's energy consumption and move as an industry toward **carbon neutrality**.

***Carbon Neutrality** — a state of net-zero carbon emissions, where we remove as much carbon from the atmosphere as we admit*

A Need to Reduce US Methane Production

While carbon dioxide may be the first greenhouse gas that comes to most people's minds, managing methane is equally important. While the effect of carbon dioxide emissions compound over time, methane is a much more potent gas over the short term. In fact, methane has more than 80 times the heat-trapping power of carbon dioxide during its first 20 years (Hoffman et al., 2022). As such, reducing methane emissions can also quickly reduce the effects of climate change. Yet, despite agriculture being the largest contributor of methane in the US, most federal efforts to curb methane emissions have focused on the gas and oil industry and municipality food waste, all of which produce less methane than agriculture (Ulick, 2023). As



Methane Emissions in livestock. Dairy Cattle make up the largest source, with Swine following closely behind
Environmental Protection Agency, 2022

Slurry *– A type of manure storage where the waste solids are mixed with water to form a semi-liquid mixture.*

Runoff *– The leeching of manure into groundwater*

Lagoon *– an open-air basin used to store liquid manure.*

Anaerobic Digestion *– A way to process liquid or slurry manure, where anaerobic bacteria convert methane into an energy source.*

such, methane production in agriculture may be an area where the US can significantly reduce emissions.

Managing Emissions From Manure

The largest source of methane from livestock is manure. All livestock species produce some form of manure, and it needs to be stored. It is typically stored in one of three states: liquid, **slurry**, and solid. Storage of manure as a solid has several benefits: it process less odor and **runoff**, and has less volume than other manure types (Harrison, 2004). Solid manure must be covered to manage moisture, since if moisture is introduced, it nullifies the benefits that solid storage brings. This type of storage may make the most sense in a more arid area, but in more humid areas, high levels of rainfall can lead to increased runoff. In these areas, a liquid or slurry storage method is more practical. Slurry and liquid storage, however both produce significantly more odors than solid storage and can create a buildup of methane and other combustible gases. However, in warmer climates, **lagoons** to store liquid manure are often considered the better performing method of manure storage (Harrison, 2004). Lagoon storage is also cheaper per animal unit, and can store a much larger amount of manure. Additionally, a lagoon can be made of earthen material, whereas solid manure storage often requires concrete flooring.

Despite its efficiency, liquid manure management leads to the most methane production. Implementing alternative manure management practices — such as solid manure storage — is critical in reducing methane production from animal manure. To reduce methane emissions, many farms have implemented a process called **anaerobic digestion**. Liquid or slurry manure gets collected and processed in a generator, and the methane it produces is collected and converted into a renewable source of energy (Environmental Protection Agency, 2022). Anaerobic Digesters are easily one of the most effective methods of manure management, and the fact that they produce a clean energy source makes them a very attractive option for reducing emissions from manure. Yet, they are very expensive to build, and incur serious upkeep costs and regular maintenance.

But anaerobic digesters are not the only alternative manure management strategy. Pasture-based management, where manure is naturally distributed across the livestock's pasture, reduces the buildup of manure and returns nutrients and carbon directly to the land (Environmental Protection Agency, 2022). However, as with all pasture-based agriculture, this requires a large amount of land. Therefore, this may not practical for large animal operations or in areas where weather does not permit year-round foraging by animals. Such places will need another method of manure management for at least part of the year.

On most farms, liquid manure is stored in an open air storage environment, called a 'Lagoon'

Jacob Fernandes, 2023

Consuming oilseeds like Canola (Seen above) may help reduce enteric emissions!

NPR

Enteric Emissions *– Gasses such as methane produced in the gut and intestines*

Reducing Enteric Emissions

Methane doesn't just come from manure: the next largest source of animal-produced methane is burping! When cattle eat feed, the microbes in their stomachs create a natural fermentation environment, where, devoid of oxygen, bacteria can break down food into organic acids and methane. This methane is then expelled via belching. **Enteric emissions** currently account for 5% of global greenhouse gas emissions (Ulick, 2023). Research into reducing enteric emissions is underway, but there is currently no FDA approved method of reducing enteric emissions in cattle or other livestock species.

However there do exist a large amounts of potential feed additives that have exhibited promise in reducing enteric emissions via belching. For example, the Dutch chemical company DSM has introduced a feed additive called Dovaer which has been shown consistently to reduce enteric emissions of both methane and carbon dioxide by up to 30% in dairy cattle and 45% in beef cattle — the two largest producers of such emissions (Ulick, 2023). Yet the FDA has not approved this additive, despite it being used in more than 40 countries (Ulick, 2023). Alternatively, livestock can be fed oilseeds like canola or grasses that are lower in fiber. However, a switch large enough to make a noticeable impact on methane emissions would be very costly, and could result in lowered productivity (Ulick, 2023).

Natural Gas and Oil and Agriculture

Farms in the US utilize a host of modern equipment, including tractors, trucks, and tilling. Goods need to be transported, often long distances, fertilizers and pesticides need to be manufactured, and electricity needs to be generated for farms to run! All of this requires large amounts of energy and fuel, which generally come from fossil fuels in agriculture. The USDA's Economic Research Service estimated in 2007 that the use of fossil fuels in production of food and beverage in the US account for 13.7% of domestic carbon dioxide emissions, producing 817 million of the 6 million metric tons of Carbon Dioxide in 2007 (Canning et al., 20017).

Fossil fuels are often noted as one of the primary drivers of carbon emissions and climate change. Yet today, the production of fossil fuels remains at an all-time high, having grown by 20% "in energy terms" since 2010 with natural gas rising above coal to become the fossil fuel most in use in the US (Erickson and Lazarus, 2016). This is concerning, as while all fossil fuels contribute to carbon dioxide emissions, methane is the primary component of natural gas and oil. Because of methane's intense warming potential over short-term periods, it is of the utmost importance to reduce reducing agriculture's reliance on natural gas and oil, not just coal (Tabuchi, 2020).

Congressional Action

Little has been done on the federal level to address the issue of agriculture-related methane emissions. In fact, most federal action towards climate change has been pointed towards oil and gas companies. For example, in 2021, Sheldon Whitehouse (D-RI) introduced the Methane Emissions Reduction Act of 2021, which would have required the Department of the Treasury to "estimate annual methane emissions from each oil and natural gas producing basin and levy a fee for such emissions on each company that produces, gathers, processes or transmits oil or natural gas" (S. 645, 2021). The bill was never voted on and died. There have been other congressional efforts to tackle clean energy in agriculture and its other environmental impacts, but to little success.

However, with the passage of the HR 5376, the Inflation Reduction Act of 2022, the federal government took some steps toward methane reduction. This act provided the Rural Energy for America Program (REAP) with $2 billion in grants for the purpose of establishing renewable energy systems for agricultural producers and small business owners. The program's grant size was also increased from $250,000 to $500,000 for energy efficiency projects and from $500,000 to $1 million for renewable energy systems (USDA, 2023). This program scores all potential projects based on various criteria, and prioritizes projects that are located in disadvantaged communities or distressed communities, awarding 15 points to such projects (USDA, 2023)

In 2022, Representative Abigail Spanberger (D-VA-7) introduced the Electric Vehicle Charging Infrastructure for Farmers Act (H.R.6390, 2022), which died in the House and was never voted on. This bill was a bipartisan legislature that would have allowed funding from REAP to be used for installing charging infrastructure for electric vehicles. Spanberger claims that without sufficient infrastructure for charging, the money from these grants is useless: rural America simply lacks the resources to make the implementation of renewable energy systems worthwhile ("Spanberger, Rice Introduce Bipartisan Bill to Improve Ability to Charge Electric Pickups & Farm Equipment in Rural America", 2022).

Other Policy Action

By far one of the most important laws on this issue so far has been California's SB-1383, "Short-lived climate pollutants: methane emissions: dairy and livestock: organic waste: landfills." As the largest milk producing state in the US, California's role in reducing its methane production is critical (Ulick, 2023). This California state law, passed in 2016, required the State Air Resources Board to approve and implement strategies to reduce greenhouse gas

emissions, with the intent of reducing methane emissions by 40% of their 2013 levels by 2030. The bill also required steep reductions in hydrofluorocarbons and black carbon, two other pollutants which are less prominent in agriculture. In addition, the bill set a goal of a 50% reduction in statewide organic waste disposal in 2020 compared to 2014, and a 75% reduction in 2025 (SB-1383, 2016). This was aimed to reduce food waste, and ensure that food that would've been disposed of otherwise, would be recovered and used for human consumption. (Cal Recycle FAQ). The bill did not make emission reductions mandatory, instead relying on voluntary incentives for farmers to reach emission reduction goals (SB-1383, 2016). As you prepare for the conference, consider the design and impact of the California bill and how it could — or could not — be a model for federal legislation.

Not all conservatives and liberals think alike! Be sure to research your role to see what might influence their political views!

The Federal Government has shown interest in reducing methane emissions in similar ways in recent years, with the Biden Administration pledging to reduce Methane Emissions in the US by 30% of the 2020 levels at the 2021 UN Climate Change Conference (Hoffman et al., 2022). The administration has further released the Methane Emissions Reduction Action Plan outlining steps to take toward reducing methane emissions in the US. However, this plan relies mostly on state leadership cooperation and primarily affects the oil and gas industry (Hoffman et al., 2022).

IDEOLOGICAL VIEWPOINTS

Conservative View

No federal system currently exists to fund and subsidize the building of anaerobic digesters on US dairy farms.

In general, conservatives do not readily support measures aiming to combat climate change, especially ones that negatively impact business or involve a high level of government intervention. According to the Pew Research Center (Tyson et al., 2023), 44% of conservatives and conservative-leaning Americans support the shift toward carbon-neutrality by 2050, while 53% oppose it.

Conservatives are more likely to be opposed to any efforts to limit the use of fossil fuels, and 87% of conservatives believe that the US should continue to use a mixture of natural gas, oil, petroleum, along with renewable energy sources (Tyson and Kennedy, 2020). Some conservatives might approve of expanding renewable energy sources, but most will oppose phasing out natural gas and oil.

Liberal View

Liberals in general are much more likely to support measures to reach carbon-neutrality. According to the Pew Research Center, about 90% of liberal Americans support efforts to move toward

carbon neutrality and 50% support phasing out of natural gas and oil (Tyson et al., 2023). Liberals are very likely to support efforts to reduce methane production, and unless they come from a state with strong livestock industry pressure, they may be more willing to apply regulations on agriculture industries. Liberals will likely support researching and developing biofuels and renewable energy sources as well. Some hardline liberals may also support reducing a reliance on animal agriculture entirely, and could favor harsh mandatory restrictions on methane production.

culling *– industry term that refers to killing an animal for meat, hide, or other products.*

AREAS OF DEBATE

There are many possible solutions to the problem of methane emissions in agriculture. Very few pieces of legislation have been passed on a federal level on this situation, so delegates are free to dream big and come up with their own creative solutions to the problems as described above. What follows is a brief description of some commonly proposed solutions by various groups across the nation.

An anaerobic digester (commonly known as a methane digester) consists of manure in controlled oxygenless environment that captures methane. This one is wrapped in plastic!
Jacob Fernandes, 2023

Livestock Manure Management

As we've seen, livestock manure is a major source of methane production. Reducing methane emissions can have a significant and immediate impact on the global climate. Creating management strategies as opposed to simply **culling** animals could create a more sustainable agriculture industry that protects both animal health and US industrial production.

One of the best methods to manage waste involves building anaerobic digester generators. Though expensive, these generators can convert a large quantity of a harmful greenhouse gas, methane, into a clean, reliable source of energy. As of 2021, there were 221 anaerobic digester systems on US dairy farms, reducing 4.29 million metric tons of carbon equivalents per year (Environmental Protection Agency, 2022). The USDA has said there are 2700 dairy farm sites suitable for these digesters, with the potential to reduce 29.9 million metric tons of carbon equivalents per year. This would be essentially equivalent to planting 500 million trees (Environmental Protection Agency, 2022). Though these digesters are typically built on dairy farms, they could be expanded to swine farms, the second largest producer of methane emissions. Delegates can consider distributing grants or tax credits to fund constructing these digesters across the US, or could pursue other incentive structures. Potentially, Congress could create a standard way for farmers to sell the energy they produce through digestion, which could add additional revenue. Though digesters can be costly for farmers, processing food waste and manure together increases

energy production and provides even further revenue (Environmental Protection Agency, 2022).

Proponents of this solution might argue that farmers must reduce their emissions, and that providing incentives such as grants is a non-intrusive way to induce farmers to implement environmentally friendly technologies. Opponents might argue that the government should not be spending large amounts of money to combat climate change or interfering in the private agriculture industry.

Remember that for individual farms, implementing these technologies is very expensive and requires a lot of upkeep. Smaller farms may be more reluctant to implementing these strategies as the costs may literally outnumber the benefits to these farmers. Additionally, an incentive-based system has to provide substantial incentives in order to see a measurable impact on climate change.

This prototype EV Tractor, the T7 Manure Power LNG uses methane from liquid manure as its power source!
Source: CNH Industrial

Political Perspectives on this Solution

Democrats and Republicans alike could support incentives for emission reductions: 78% of Republicans and 90% of Democrats are in favor of implementing a tax credit for businesses which develop carbon capture and storage and 55% of Republicans and 89% of Democrats are in favor of taxing corporations based on carbon emissions according to the Pew Research Center (Tyson and Kennedy, 2020). While these figures refer to carbon emissions rather than methane emissions, they indicate a general positive outlook on incentive-based, business-first solutions to climate change.

However, some might say that reducing emissions from oil and gas companies could be more fruitful than targeting agriculture. They might argue that the consumption of fossil fuels is primary cause of GHG emissions and GHG-related climate change. Agriculture lobbyists are likely to push this view to avoid restrictions and regulations on farmers.

This machine separate manure into solids and liquids to be stored in a nearby anaerobic digester
Jacob Fernandes, 2023

Renewable Energy and Reducing Fossil Fuels

Agriculture has a major energy problem when it comes to fossil fuels. Creating an initiative to reduce agriculture's reliance on unclean energy sources could reduce GHG emissions significantly and help fight climate change. However, this is no easy feat.

One potential solution is to support the development of alternative energy sources. While renewable energy cannot be used in all cases, such powering gas-dependent vehicles and tractors, creating power sources like solar farms, windmills, and installing hydroelectric generators can greatly reduce the reliance of fossil fuels for electricity use on farms. Delegates could consider using grants and subsidies to farmers and business who install large solar farms or other alternative energy generators, including anaerobic digesters (see previous section).

Alternatively, delegates can consider investments into building electric-vehicle-friendly infrastructure, in addition to supporting the research, development, and distribution of industry-capable electric vehicles. While the battery capability required for large, electrically powered tractors is not yet commercially available, technological research into EVs is advancing rapidly. Research into such vehicles has been fruitful, with one EV tractor currently in testing, valued at cost of $58,000 (Hubbard, 2022). However, even with research into such vehicles, the largest obstacle in integrating electric vehicles in rural America has been the lack of infrastructure and charging stations.

Proponents might argue that there are few downsides to the creation of renewable energy, which both creates jobs through infrastructure development and lessens reliance on fossil fuels. However, opponents might argue that pursuing a shift toward renewable energy would have negative consequences for those communities reliant on gas, oil, coal, and petroleum industries.

Political Perspectives on this Solution

Senators from states that rely on fossil fuel industries, such as coal-heavy West Virginia, would be unlikely to support any measure of this type. In addition, Republicans tend not to support measures reducing reliance on natural gas and oil.

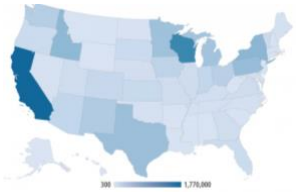
Democrats are much more likely to support such a measure, citing the importance of reversing climate change. However, as always, this may depend on the interests of their constituents and donors.

Funding Research into Alternative Strategies For Reducing Methane

While we've seen the benefits that anaerobic digesters bring, it's also clear that they are a very expensive solution and not every farm is a suitable site for construction. As such, we might want to consider funding research into developing alternative strategies to such a reduction.

One such strategy is the creation and approval of **feed additives** — minerals and vitamins added to animal feed to add nutritional value, and, potentially, reduce enteric emissions. Although there exist some such additives in use in other countries, including the European Union, no such additive is approved in the US by the FDA (Ulick, 2023). Congress could speed up or simplify the process to introduce feed additives like Bovaer, which have been shown to reduce daily methane emissions by 35% (Ulick, 2023). Delegates can consider creating a separate agency responsible for approving such feed additives, creating a unique process for methane-reducing additives, or even shifting responsibilities between departments. The possibilities are limitless!

Feed Additive – *Minerals and vitamins added into feed to add nutritional value.*



US Dairy Population, 2018. California is the state with the largest dairy population
Environmental Protection Agency, 2022

While some feed additives have been proven to reduce emissions, the price of changing feed patterns can be expensive and difficult for farmers. These seeds can be hard to acquire or buy, and farmers may even have to set aside land to grow their own feed! As such, Congress could consider some kind of policy offering subsidies or grants for farmers who might face financial hardships from switching feed patterns.

Some may not support such a legislation, stressing the importance of abiding by tested and official procedures. They might say these processes ensure that feed additives are deemed safe for animal consumption and leave no traces in animal products that could be harmful to humans. Likewise, many may criticize such a plan for its costs to farmers and subsequent potential increase in costs of food to consumers.

Political Perspectives on this Solution

This is not likely to be a solution which is particularly politically charged. Neither Republicans nor Democrats will be especially inclined to support or not support such an action. Republicans will likely not support any mandatory usage of these kinds of feed additives, and might oppose extensive federal spending to promote them.

Reduced Reliance on Animal Agriculture

If managing methane production is not enough to reduce future climate change, many would argue that we should reduce our reliance on animal agriculture altogether. Delegates might consider implementing legislature to establish a maximum allowed number of animals on a farm, or penalizing farmer GHG emissions with fines and regulations. Some countries have taken this strategy by reducing and culling dairy herds. For example, Ireland is currently considering a bill to reduce the number of dairy cows in Irish dairy herds by introducing a voluntary culling program where farmers will be paid up to €600 million at €2,910 per cow culled (O'Sullivan, 2023). Such an effort is expected to reduce methane emissions by 0.45 million tons of carbon equivalents per 100,000 cattle (O'Sullivan, 2023). In 2021, the Netherlands introduced a very unpopular €25 billion plan to reduce methane emissions by reducing livestock numbers, primarily of dairy cattle, by 30% through **farm buyouts** (Levitt, 2021). The plan, although initially voluntary, is expected to become mandatory if climate conditions require it in the future (Levitt, 2021). When unveiled, this plan sparked protests among Dutch farmers who felt unfairly singled out by the plan. In 2023, a modified €1.47 billion plan was approved by the European Commission (Van Campenhout, 2023).

Farm Buyout *– A process where the government seizes or buys farmland and culls all livestock on the farm.*

In addition to regulating animal agriculture, some wish to support vegan or vegetarian lifestyles. These people may advocate for

research into developing alternative meats and milks, including lab-grown meats, which have taken off in recent years. Congress could promote reducing the use of beef and pork — the main sources of methane emissions — in public institutions and schools, or incentivize wider adoption of alternative lab-grown meats.

Political Perspectives on this Solution

Most conservatives are going to be against this type of policy, as it involves stringent government intervention in private markets. Some conservatives from states with large plant agriculture sectors and large animal agriculture sectors may support this type of bill. Liberals are more likely to support this type of policy. Animal rights activists, strong climate activists, and senators from states without a strong animal agricultural presence may support this type of legislature.

In 2022, thousands of Dutch farmers drove their tractors on highways to protest the governments plan to curtail Dutch agriculture
Source: Vincent Jannink

Most senators from states with large agriculture industries would not support this type of legislation, as it could have seriously negative effects on agricultural economies. Senators from states with little animal agriculture presence might be likelier to favor such a proposal. Be sure to see what kind of industries your state has: states like California have huge agriculture industries that would suffer greatly if a policy like this were to be passed.

Agricultural lobbying is a very strong force when it comes to congress, even within states traditionally considered very liberal state, like California and New York. These types of lobbyists are very likely to have a vetted interest in preventing such a legislation.

BUDGETARY CONSIDERATIONS

Creating solutions to massive problems like GHG emissions is not cheap. In fact, when CA SB-1383 was passed, the California Assembly Appropriations committee predicted that the strategies to reduce methane emissions would cost in the tens of millions of dollars (SB-1383, 2016).

Implementing anaerobic digesters can be expensive. Costs vary, with an average digester costing $1.2 million (Environmental Protection Agency, 2012).

CONCLUSION

US Agriculture sits on the cusp of a methane revolution. Currently, methane and greenhouse gas emissions are high in the industry, and not much has been done by the federal government to address it. Not all Americans believe that climate change or

greenhouse are major issues, but for those that do, solving agriculture's smelly problem is of utmost importance.

While we have pledged as a country to lower our emissions, we have largely focused on natural gas and oil industries, and as such, the potential to direct the future of agriculture in the context of climate change is nearly limitless. No one solution can fix or remedy this issue. Delegates should work together to find the best possible solution, which may involve combining solutions described above in various manners, or even by coming up with something entirely original.

GUIDE TO FURTHER RESEARCH

I highly recommend looking into the current system of incentive-based methane reductions in California, which is one of the few systems in existence of this type in the United States. This will be fundamental in any efforts you attempt to regulate methane emissions in the US.

Look into REAP and existing infrastructure for electric vehicles in the US. EV research is great, but without infrastructure, can often be useless.

Research different grants and subsidies and how the US can create incentive-based programs. One of the best ways to handle climate policy is through money, so delegates should be knowledgeable about this process.

Delegates should be keenly aware of their representative's interests: What industries are they close to, what interest groups are large in their state, and what issues do these industries and groups support? All of this will determine how you should act in committee.

GLOSSARY

Anaerobic Digestion – *A way to* process liquid or slurry manure, where anaerobic bacteria convert methane into an energy source.

Carbon Neutrality *— a state of net-zero carbon emissions, where we remove as much carbon from the atmosphere as we admit.*

Culling – Industry term that refers to killing an animal for meat, hide, or other products. Also referred to as "herd thinning."

Enteric Emissions – Gasses like methane, produced in the gut and intestines.

Farm Buyout – A process where the government seizes or buys farmland and culls all livestock on the farm.

Feed Additive – Minerals and vitamins added into feed to add nutritional value.

Greenhouse Gas (GHG) *– a gas that contributes to the greenhouse effect by trapping heat in the atmosphere*.

Lagoon – an open-air basin used to store liquid manure.

Runoff – The leeching of manure and nitrogen into groundwater.

Slurry – A type of manure storage where the waste solids are mixed with water to form a semi-liquid mixture.

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