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What's at Steak? The Political Discourse of Emissions Intensity and Implications of Animal Agriculture

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Abstract

This thesis analyzes the international discourse of greenhouse gas emissions in relation to livestock production. Specific government ministries, research institutes, and multilateral organizations are framing a new strategy to mitigate emissions by using emissions intensity metrics. Emissions intensity is a ratio comparing emissions produced per unit of animal product as oppose to measuring absolute emissions. This research is acknowledged as a win-win scenario which allows for a reduction of greenhouse gas emissions while continuing production more efficiently. This thesis outlines the emergence of this metric in international discourse and the implications this shift has on the livestock sector globally. Ultimately, I argue that a focus on reducing emissions intensity in isolation from reduction in absolute emissions allows for the continued mass industrial production of livestock through a business-as-usual process. Improving efficiency produces cheap meat and drives up consumption overall increasing the overall production of livestock. The narrow scope of emissions intensity developed as an economic stance with political ambition, but branded as a mechanism to address climate change.

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Chapter I: Introduction

The Earth's climate is changing drastically. The concentration of greenhouse gas (GHG) is altering the natural equilibrium of the planet. It is critical that anthropocentric emissions are controlled in order to mitigate the catastrophic ramification of climate change. This is a global challenge and in turn will require a global response (Hytten 2013). Due to this, international discourse on the environment is entering a new era. A main focus in this new era, is addressing emissions from livestock production. The livestock sector is responsible for emitted the most greenhouse gas emission into the atmosphere than any human activity. International discourse is shifting to create strategies to combat the contribution of livestock to climate change. The main strategy I will be focusing on is emissions intensity. Emissions intensity is a metric and intervention used to understand the contribution of a particular sector or activity to greenhouse gas emissions.

This thesis will answer the question, what led to the global convergence of emissions intensity and what are the implications this shift has on livestock production? This will be answered through a discourse analysis of emissions intensity in relation to international research on livestock production. I will outline the current literature on climate change discourse, the actors involved, and the significance these political changes have on overall global climate change mitigation strategies.

This introduction is divided into two subcategories. The first section is a conceptual review of the main themes and ideas throughout the thesis. The second section outlines the necessary background information on climate change, livestock, and emissions intensity.

My main argument is that the emergence of emissions intensity allows for a complete shift in how the world thinks about and approaches livestock related emissions. This is imperative because emissions intensity facilities a business as usual approach of increased efficiency and production that is projected to increase rather than reduce emissions related to livestock. This point will be further expanded upon in the introduction and throughout the entirety of the thesis.

Conceptual Framework

This research takes a discourse analysis approach to understand and explain the emergence of a new way of understanding livestock emissions. The term emissions intensity initially referred to productivity and efficiency in the energy sector and more recently surfaced in the livestock sector. This is important because the same logic is assumed to work in both sectors, however there are several nuances which prove there are some major shortcomings in the application of emissions intensity between the energy and livestock sectors.

Emissions intensity is a ratio comparing emissions per unit of output, and in regards to this research, emissions per unit of animal product (meat, milk, protein, etc.). Emissions intensity emphasizes improvements in efficiency and productivity while reducing certain aspects of greenhouse emissions. This is the overarching storyline established by the main research institutes, government ministries, and multilateral organizations. This research has generated a great deal of attention and support in recent years by numerous credited and influential sources. These include the Intergovernmental Panel on Climate Change (IPCC), United Nations Framework Convention on Climate Change (UNFCCC), prominent government ministries from New Zealand, the United

States, the Netherlands, and Australia, as well as multilateral organizations such as the Global Research Alliance (GRA) and the Consultative Group on International Agricultural Research (CGIAR). These actors strategically fund and support efforts to make emissions intensity measurements the mainstream method for tackling emissions related to livestock.

The actors briefly mentioned above are the main entities highlighted in this thesis analysis as the ones responsible for changing the discourse of livestock and climate change mitigation. Broadly, those mentions are the greatest beneficiaries of emissions intensity research because it serves as a justification for the mass industrial production of animals as a global commodity. The government ministries and organizations in developed countries funding this research are heavily invested in continuing the global surge of animal production. The top countries consuming and exporting livestock are the same ones investing and promoting emissions intensity research. On one hand, emissions intensity research is beneficial because it gets countries around the world talking about ways to mitigate livestock-related emissions. However, on the other hand, it does not necessarily mitigate absolute emissions which is the actual cause of climate change. A narrow focus on emissions intensity without government intervention and policies that reduce absolute emissions, even the largest reductions in intensity will not abet climate change. Also, as production becomes more efficient, the cost of animal products will be cheaper and increase the demand for livestock.

Climate Change Background

Climate change is interchangeably referred to as the greenhouse gas effect. The greenhouse gas effect is the heating of Earth's surface due to the sheer presence of

greenhouse gases (Hopwood 2008). The main gases that contribute to this effect are carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) which are all present in livestock production (IPCC 2014). Naturally, sunlight passes through the atmosphere to warm Earth's surface, however most of the heat is then supposed to be reflected back into space (NASA 2017). Greenhouse gases molecules instead absorb the solar radiation and reemit the heat downward which causes the lower atmosphere closest to Earth's surface to warm (Hopwood 2008).

The Intergovernmental Panel on Climate Change (IPCC) records that humanity is on track to increase temperature by 4 degrees Celsius by the end of the century (AR5 2014). However, the IPCC assessment strongly urges no more than 2 degrees increase from pre-industrial levels before major environmental damages occur (Clark 2017). The smallest incremental increases in temperature correspond with enormous changes in the environment. The warming of the planet introduces a great deal of consequences. The global temperature increases, droughts and floods are become more server, sea levels are rise and become more acidic, and natural disasters are more frequent and intense.

Carbon Dioxide, Methane, and Nitrous Oxide

This section provides a brief description for each of the three key GHGs. Carbon dioxide is the most abundant and longest living GHG in the Earth's atmosphere. In regards to livestock, CO_2 accounts for 27 percent of the total emissions for the sector (Gerber 2013). CO_2 is inherently released as humans and animals exhale as well as through the burning of fossil fuels, deforestation of plants, waste, and certain chemical reactions (United States Protection Agency 2017).

The next GHG is nitrous oxide which accounts for 29 percent of gas emitted from the livestock sector and it the most potent. Industrialized agricultural processes are responsible for the drastic increasing concentration of N_2O in the atmosphere; crop and livestock production are responsible for 70 percent of total N_2O emissions (Steinfeld 2006). Nitrous oxide is emitted through soil cultivation practices, disposing of waste, usage of synthetic fertilizers, fossil fuel combustion, and biomass burning (NASA 2017). The emissions for nitrous oxide are 296 times more effective at trapping radiation than carbon dioxide and have an average lifespan of 114 years in the atmosphere (Steinfeld 2006; Overview of Greenhouse Gases 2017).

The last of these GHGs is methane and accounts for 44 percent of the livestock sectors total emissions (Gerber 2013). Methane is emitted during the production and transportation of fossil fuels, landfills, rice cultivation, and most glaringly in the production of livestock. Methane molecules remain in the atmosphere for the least amount of time for approximately 12 years. (Overview of Greenhouse Gases 2017). However, methane is 21 times more efficient in trapping solar radiation than carbon dioxide (Steinfeld 2008). CH_4 the most critical greenhouse gas mentioned in this research on livestock and climate change.

Due to the increasing quantities of CO_2, N_2O, and CH_4, "each of the past three decades has been successively warmer at the Earth's surface than any the previous decades in the instrumental record, and the decade of the 2000's has been the warmest" (IPCC 2013). It is important to recognize that greenhouse gas emissions are not inherently harmful to the environment since the GHGs emitted and removed through

natural cycles. Human activity is inadvertently altering this ecological balance and rapidly changing the global climate.

Livestock and Climate Change

Livestock plays a significant role in climate change and substantially impacts many aspects of the environment (Steinfeld 2008). Directly and indirectly, the livestock sector alone occupies 30 percent of earth's surface and is responsible for an estimated 18 percent of total anthropocentric GHG emissions (Gerber 2013; Caro 2014). The entire system of livestock production emits each of the three of the greenhouse gases significant quantities. These emissions are released from four main pathways as illustrated in the Table 1.

Table 1. Main Emissions Pathways from Livestock

1. Methane from enteric fermentation.
2. Methane and nitrous oxide from manure management.
3. Carbon dioxide and nitrous oxide from feed production, processing, and transport.
4. Carbon dioxide emissions from energy consumption.

(Gerber 2013)

Every stage in the production system of livestock emits greenhouse gas emissions. This starts with the production of animal feed whereby livestock consume more than one third of the world's cereal grains including 40 percent of the feed going to ruminant animals (cattle, buffalo, sheep, and goats) and pigs (Eisler 2014). Feed crops account for 8 percent of total human water use, increase pesticide and fertilizer use, land degradation and deforestation (Steinfeld 2008; FAO 2009). N_2O emissions are produced mainly from

the production of feed and the nitrification and denitrification of the organic nitrogen in the manure and urine of livestock (Caro 2014). On the other hand, methane is a by-product of the digestive process, respiratory system, and the manure management of livestock (FAO 2009; Caro 2014).

Emissions intensity research emphasizes mitigation that improves feed and nutrition, animal health and husbandry, genetics and breeding toward greater efficiency (FAO & New Zealand Agricultural Greenhouse Gas Research 2017). Some of the interventions established to create more efficient production of livestock are outlined in Table 2.

Table 2. Interventions of an emissions intensity approach

Feed and nutrition:	· Feed supplements
	· Precision feeding
	· Dietary improvements
Genetics and Breeding:	· Finding new traits for GHG emissions
	· Selecting for low-methane producing ruminants
	· Improved performance on low-quality feed
Rumen modification:	· Transferring the microbiome of low-methane producing ruminants
	· Vaccines to reduce methane production in the rumen
	· Inhibitors
Animal health:	· Increase disease resistance
	· Increasing productive lifetime of animals
	· Prevention, control, and eradication of diseases
Manure management:	· Storage coverage
	· Manure deposition and application
	· Capturing biogas from anaerobic processes
	· Temperature and aeration of manure
Grassland management:	· Carbon sequestration
	· Grazing practices
(Andeweg 2013).	· Pasture Management

These are the main interventions from those who support emissions intensity research. The focus is changing certain elements of livestock production rather than addressing the larger structural, political, and economic side of the livestock sector. These interventions have different implications on developed and developing countries which will be explored in further detail.

Conclusion

We are facing a serious problem. Livestock production accounts for a large portion of greenhouse gas more than any other human activity. By 2050, the demand for animal products will double as population grows, income increases, and production becomes more efficient (Steinfeld 2008). The shift toward emissions intensity aligns with a world view that justifies the escalated production of livestock through a business as usual lens. This view allows for continuation of meat and dairy production in developed countries and an exacerbates the vulnerability for those in developing countries.

Chapter II: Literature Review

This study engages the literature that conceptualizes a methodological approach known as discourse analysis. The term discourse in common vernacular is often synonymous with discussion or the most basic mode of communication. However, in the social sciences, a discourse has a more specific meaning; it is collective means of understanding and articulating certain facets of the world (Jørgensen 2002). Michel Foucault is noted for coining discourse analysis as a method to understand the trends and patterns within political systems, and is the basis for a suite of approaches that use discourse as an object of analysis. Foucault defines discourse as "a group of statements in so far as they belong to some discursive formation… It is made up of a limited number of statements for which a group of conditions of existence can be defined" (Lindseth 2006; Foucault 1972). Foucault's analysis emphasizes that discourse is a convergence of power relations that inevitability results in legitimizing a specific form of knowledge production; in this production of knowledge certain positions are empowered while others are excluded (Feindt and Oeis 2005; Hovden and Lindseth 2004). Discourse illuminates power relations in all social interactions as it becomes the focal point for both hindering and enabling action (Lindseth 2006).

Many scholars build on Foucault's formulation of discourses and discourse analysis. Wetherell et al. (2001) refers to discourse as the "language-in-use" similar to Dryzek (2013) who defines it as a "shared way of apprehending the world" that is embedded in language, which forms common sense and legitimate knowledge (2001; 2005). In a rudimentary sense, a discourse analysis is the study of language in action and its capacity to make policy (Hajer and Versteeg 2005; Wetherell et al. 2001; Hytten

2013). Maarteen Hajer is often cited as a pioneer for his extensive work on expanding the use of discourse as a way to study environmental issues and making the results of those studies relevant to contemporary politics. In his work, "discourse is defined as an ensemble of ideas, concepts and categories through which meaning is given to social and physical phenomena, and which is produced and reproduced through an identifiable set of practices" (Hajer and Versteeg 2005). Hajer built on earlier work by focusing on the role and power of individuals to shape concrete shifts in policy.

Hajer's work is instrumental in showing how discourse analysis can be usefully employed to gain a deeper understanding of environmental politics. Hajer's work is instrumental in this regard. Hajer operationalized his theory on discourse analysis for environmental politics based on the concept of storylines. Unlike prior authors such as Harré (1990) or Billing (1997) who cite storylines as subtle mechanism for creating and sustaining discursive order, Hajer takes a more direct stance on the importance of storylines. Storylines are "a generative sort of narrative that allows actors to draw upon various discursive categories to give meaning to *a specific physical or social phenomena*" (Hajer 1995; Billig 1990). Storylines focus on the notion of framing issues as they play the role of positioning subjects and structure (Hajer 1995; Smith 2009; Scrase 2009; Szarka 2004; Hovden and Lindseth 2004). Storylines are devices actors use to pursue a particular agenda and influence policy-making (Lindseth 2006). Actors gather in what is referred to as "policy networks", or coalitions around similar storylines.

The first dimensions in policy making stems from the structure and creation of policy networks. Policy networks are very complex configurations that are difficult to disentangle. However, most broadly, policy networks are social structures that are

comprised of major political and administrative actors who negotiate with one another to ensure desired policy outcomes (Bulkeley 2000; Ingold 2011; Kenis 1919). These networks are frequently used to describe actors who are joined together in political, social, and economic life (Peterson 2003). This is further explainedt:

> Networks involve the institutionalization of beliefs, values, cultures and particular forms of behavior. They are organizations that shape attitudes and behavior. Networks result from repeated behavior and, consequently, they relieve decision makers of taking difficult decisions; they help routinize behavior. They simplify the policy process by limiting actions, problems as solutions. Networks define roles and responses. In doing so they are not neutral, but, like other political institutions and processes, they both reflect past power distributions and conflicts and shape present political outcomes (Marsh 2000).

Discourse and Advocacy Coalitions

Scholars forward two main theoretical concepts that underpin this debate. The two approaches to policy networks are categorized by advocacy coalitions framework and discourse coalitions as briefly mentioned above. These two models help conceptualize the complex and often confusing process of policy making and policy changes. The advocacy coalition framework was first developed in 1987 by Paul Sabatier. Advocacy coalitions are recognized as groups of actors who share the same core beliefs and work in concert to create and revise policy objectives (Sabatier 1988; Bulkeley 2000; Weible 2011). Sabatier created the conceptual framework of an advocacy coalition in a three-layered tier: core beliefs or deep beliefs, policy core beliefs, and secondary beliefs (Sabatier 1998). These coalitions are made up by scientists, policy-makers, politicians,

journalist, and researchers who are bound together by the stout sharing of specific beliefs. In this regard, the political process is seen as a dispute between coalitions that must be mediated by the intervention of a third party known as a policy broker.

On the other side, Hajer defines discourse coalitions as a socio-cognitive process outlining the relation between storylines and actors. Coalitions assemble around "the ensemble of a set story line, the actors that utter these storylines, and the practices that conform to these story lines, all organized around a discourse" (Szarka 2004; Hajer 1995). A key element in this framework is the emphasis on discourse and the language used to establish and formulate policy. Hajer's approach of discourse coalitions illustrates the interactions between agents in a broader structure who try to secure support for their definitions of their prescribed realities (Hajer 1995). Hajer terms the process as a discursive hegemonic game determined by credibility, acceptability, and trust (Hajer 1995).

A key difference between the two frameworks is the glue that binds the actors from both coalitions together (Lovell 2008; Lovell 2009). In the advocacy coalition, actors are bound together based on shared values and beliefs whereas discourse coalitions focus on storylines toward mutually beneficial goals (Szarka 2004). One main critic of advocacy coalitions is the inability to disentangle those in the coalition that share the same beliefs as oppose to those who participate on a professional basis (Hajer 1995). With this, some authors align with the framework of discourse coalitions when analyzing the environmental policy process (Scrase 2010; Hajer 1995; Lovell 2009; Dryzek 2005; Hajer 2006; Rydin 1999).

The study of discourse analysis and coalitions have the capacity to answer 'how' questions. Hajer (2006) alludes to the fact that "the analysis of discourse can help to illuminate why certain definitions do or do not catch on at a particular place and time and to explain the mechanisms by which a policy does or does not come about." In this context, storylines set the overall terms and limits by which physical and social realities are given meaning. Policy change is stimulated by the reordering of the meaning, authorizing new definitions of environmental problems (Lovell 2009).

Discourse Coalitions and Climate Change Politics

This same method has more recently been extended to encompass general story lines discussing climate change. The important focus of this literature is on the specific rhetoric used to create and alter story lines. The association of given words or phrases can alter the enter storyline by allowing for flexible interpretation. The redefining and restructuring of story lines by actors in the discourse coalition framework are key mechanisms to explain policy changes (Hajer 1995; Bulkeley 2000; Rydin 1999; Scrase 2010). Many scholars simultaneously acknowledge the difficulty in establishing new and modifying current story lines. Dismantling previous story lines is problematic because they have been embedded in institutions and ultimately confront former discourse coalitions who successfully achieved prominence for their viewpoints and claims (Rydin 1999; Scrase 2010).

The process of disentangling policy is challenging, but not impossible or uncommon. This is demonstrated in the new era of global environmental political changes. The study of discourse coalitions is a method being used to discuss climate change policy and metrics. However, it is necessary to take a step back and engage the

literature on the discourse of climate change. Climate change deals with the issue of framing. The manner in which this particular issue is framed in research alters policy structures how it is addressed and understood. Hovden and Lindseth (2004) "argue that even more than many environmental issues, climate change cannot be directly experienced and understood. It is not possible to see of feel climate change occurring in the way one might see deforestation taking place or feel photochemical smog irritating one's eyes and lungs." It was not until more recently that impact and long term ramifications of climate change could be experiences around the world (Hytten 2013). In this realization, it is more crucial to scrutinize the communicative process and information available in the study of responses to climate change (Lindseth 2006). The stakes of climate change discourse transcend mere semantics. A study of climate change discourse is necessary to "uncover processes, actors and structures that are silenced or obscured in current constructions of climate change" (Grist 2008*)*.

This thesis will use the discourse analysis approach to explore the selective rhetoric used in order to explain and tackle climate change nationally and internationally. The issue of climate change is not a simple matter. The complexity of climate change creates a wide range of plausible prospective, interpretations, and ways of framing the same issue. Previous research has been done to excavate discourse coalitions for ecological modernization, resources, wind power, and greenhouse gas emissions (Bulkeley 2000; Szarka 2004). This thesis will focus specifically on greenhouse gas emission action discourse coalitions. Bulkeley's acknowledgement of greenhouse action discourse coalition did not fully develop the context in relation to current day policy shifts in climate change negotiations. Climate change discourse and more particularly greenhouse

gas emissions discourse, has become one of the most prominent debates amongst the international community. My intention is to produce the structure for a discourse analysis on greenhouse gas emissions in relation to livestock production. My research will extend the previous literature by focusing on the current debates of how to measure greenhouse gas emissions. There has been a shift in discourse amid various countries on the international and national level about the most realistic and efficient means by which to measure greenhouse gas emissions. Over time, the discourse in this area is changing. As countries become more industrialized, there is some consensus to measure emission from livestock based on an intensity scale as opposed to the traditional mechanisms of measuring absolute emissions.

This research will build upon the foundational literature mentioned above by extending Hajer's conceptual framework of discourse coalitions. Authors analyzed environmental discourse that was relevant and keen for their particular time frame such the discourse on acid rain, ecological modernization, wind power, resource allocation and the ozone layer (Hajer 1995; Bulkeley 2000; Litfin 1994; Szarka 2004). I will draw from, the same structure that helped question those topics to analyze the current environmental concern on which metrics are most appropriate to calculate greenhouse gas emissions. More specifically, this thesis will be researching GHG emissions from the agricultural sector. A study of the discourse analysis approach and discourse coalitions on this topic of rearing livestock and GHG emissions will shed light on the agents, institutions, and motives. This research recognizes a current gap in the literature of policy implication and environmental discourse. Not until recently has the correlation between the production and consumption of animals stimulated national and international concern.

The growing scientific research on this issue is quite contemporary and shifts in information have the capacity to add drastic stress on the changing climate. With this, there is a story that must be told. The correlation between GHG emission metrics, policy formation, and the livestock industry has significant implication and ramifications on the future of climate change. As Bulkeley states:

> The concepts of discourse coalitions and storylines could be used to examine how, and why, understandings of environmental issues are constructed across policy networks, the process through which new networks and coalitions are formed, and the ways in which the range of acceptable policy solutions and outcomes are outcomes are delimited (2000).

This is the outline of my research to further the discussion within the global environmental political discourse. The point of this analysis is not to stress the rights and wrongs of greenhouse gas emissions metrics in relation to livestock production. Rather the focus is to highlight the different framings and which discourses are becoming more dominant at the expense of others. As with all political processes, certain elements are marginalized while others enter the spotlight. As Lindseth (2006) states, "politics is a discursive struggle" therefore my aim is to research the transition emissions discourse is in the midst of. This research will also acknowledge the common flaws of discourse analysis to oversimplify and narrowly conceptualize a complex issue.

Chapter III: Methods

This thesis uses a discourse analysis approach to explain the rise of the term emissions intensity in relation to measuring greenhouse gas emission from livestock production. I conduct this analysis through an examination of international reports and documents, in tandem with interviews of key actors. I track the linguistic turns in policies and metrics to measure livestock emissions and analyzes the actors and interests behind the rise of the emissions intensity storyline.

Climate Change Policy Document Analysis

First, I draw from key climate change policy documents to chart the origins and rise of the term "emissions intensity." I chose to analyze the five Intergovernmental Panel on Climate Change (IPCC) assessment reports for mitigation strategies. The IPCC is an international body that was set up in 1988 to address the science related to climate change and provide background for policymakers. These documents are an accumulation of all the relevant scientific, technical, and socio-economic information published on climate chnage, and represent global thinking and opinion at the time of publication. (Brough and Bruce 1989).

The reports are composed from three separate Working Groups each focused on a certain aspect of climate change. The three groups each respectively focus on the physical science; impacts, adaptation, and vulnerability; and mitigation of climate change. The assessment reports are a credible source that highlight all the common rhetoric and changes in climate change language over the years. The IPCC assessment reports are heavily cited in international research and environmental policies relating to climate change. They provide a foundation to track the frequency, usage, and fluctuation in

climate change discourse. I use information from the report series from Working Group III which assesses the mitigation strategies of climate change. The subjects emphasized from Working Group I and II were not as applicable for this research since emissions intensity as a metric is considered a mitigation strategy. I use IPCC documents exclusively because they address which metrics are most commonly recognized to measure greenhouse gas emissions from each sector, and are more acclaimed than other organizations.

To chart the rise of the term "emissions intensity", I first searched for the term "intensity" in all the Working Group III documents for all five years. I recorded the frequency and usage of the term in each successive report. I then narrowed my search to record the usage of the terms "energy intensity", "carbon intensity", "emissions intensity", and "per unit." I included a word search for "per unit" because, in many of the reports the term intensity was not used in relation to livestock. Instead, the texts refer to "per unit of protein", or "per unit of meat". The reports enabled me to trace the changes in international discourse through the years with the publication of each new series. The IPCC assessment reports were foundational to the historical genealogy used in this thesis.

Following this sequence, I analyzed the United Nations Framework Convention on Climate Change (UNFCCC 1997). The UNFCCC is an international treaty adopted in 1992 that countries join to collectively combat climate change on an international scale. The physical science behind the UNFCCC directly links the IPCC assessment reports to validate the need for treaty mechanisms. The UNFCCC is comprised of 197 countries also known as Parties, 169 of which have ratified the most recent Paris Agreement in 2016 (Paris Agreement-Status of Ratification 2017). The Convention, in summary,

recognized that there was a problem, set specific goals, and puts the onus on developed countries to address global climate change (UNFCC 1997). This source is important to highlight in this thesis because it encapsulated the individual targets and intended nationally determined contributors (INDCs) each country set to contribute to the mitigation of greenhouse gas emissions.

The series of IPCC reports in combination with the UNFCCC treaty agreements set the platform for how emissions intensity is used in international discourse. They also reflect how experts and nation-states viewed the most appropriate way to measure and think about emission from livestock. The assessment reports outline the scientific setting of intensity metrics and how they have changed in various sectors and national inventories over time. The UNFCCC treaty shows which countries have set intended mitigation tactics to be calculated on an intensity basis in comparison to their GDP. Whereas the IPCC reports are able to illustrate emissions intensity within a given sector. In conjunction, the IPCC and UNFCCC served as core sources for my later research. Both sources are import because the IPCC serves a source highlighting the scientific background for policy makers while the UNFCCC shows which policies have been implemented within each country.

Interviews

I conducted 12 interviews with experts on livestock-related greenhouse gas emissions. These interviews were organized to contextualize the research on emissions intensity. The interviews situated the reasons why emissions intensity emerged as an internationally recognized metric and strategy for dealing with livestock emissions. The interviews helped to situate the various storylines that materialized to justify research and

the usage of emissions intensity. Interviews served as a beneficial mechanism to identify prominent proponents of the term "emissions intensity" and to unearth the motivations and individual interests of these actors.

All the interviews were conducted via Skype or telephone. I connected with many other informants who I did not schedule official interviews. Instead they provided me with additional research documents and other sources to find information on greenhouse gas emissions calculations, animal science, and how climate change issues are framed. Many of these informants directed me to similar international sources including the Global Research Alliance on Agricultural Greenhouse Gas (GRA), the Food and Agricultural Organization of the United Nations (FAO), the Consultative Group on International Agricultural Research (CGIAR), and others who are expanded upon in future sections.

The initial interviews were semi-structured in nature. The questions were open ended and formulated to allow for open dialogue to learn more about emissions intensity. The interviews were used to help me understand the basic language and implications of emissions intensity in relation to livestock production. From the initial interviews, I learned about the central research institutes, organizations, and other actors involved in emissions intensity research. The first two actors I interviewed were professors who published research on animal science and climate change. Their publications mentioned the use of emissions intensity as tactics to combat climate change from agriculture production. The following interviews included: IPCC authors, employees from various government positions, active members of research institutes, non-governmental activists. I selected these individuals based on their active involvement in this field of research.

The last four interviews were structured to fill gaps in my analysis and provided extra clarification for the discourse on emission intensity and livestock production. The people I interviewed were selected to highlight a sample of the main actors who support or disagree with emissions intensity as a metric to mitigate emissions. These actors helped to shape the political economy of greenhouse gas emissions and livestock production. The individuals I spoke with enlightened my research by providing their professional stance as reflected in their official publications. However, many of the actors stressed their personal outlooks on the various implications of using emissions intensity. The interviews, unlike many official documents, were able to provide me with information regarding the framing of emissions intensity. The official scientific reports often come from the same sources which highlight the historical changes in rhetoric. However, these interviews were able to take the research a step farther. The interviewees informed me on the various ways emissions intensity can be framed and the implications a simple switch in metrics can have on the global calculations of greenhouse gas emissions.

Scope and Limitations

The selected research methods have a set of limitations. One of the limitations of this study is the contemporary nature of the research. The notion of emissions intensity as a metric to measure greenhouse gas emissions is emergent and draws from newly published sources. This is a limitation because most of the published material on this topic has not received considerable attention, and not does it sufficiently explore the implications of this discursive shift. It took a great deal of searching and interviews to understand who is behind this political shift and what the possible ramifications could be.

Emissions intensity is a well-established metric in the energy sector but new to the livestock sector. Research on livestock production and climate change has only recently entered international discourse. It was not until 2006 that the United Nations published a document illustrating the significant contributions of livestock to climate change. Since then, there has been a greater focus on strategies to mitigate emissions from agriculture, one of which is emissions intensity calculations. Some of the funders involved in this research are difficult to identify. There is a web of actors, researchers, and funders who work in a web which is not easily separated. This served as a limitation because they are many other actors involved that I did not have the chance to reach out to for further information.

The scope of this research also served as a limitation. Emissions intensity research is global in scale. The sheer ability to understand country dynamics and production in regards to livestock is intensive and requires a great deal of time to record which was not permitted within the timeframe of this project. Emissions produced by livestock differ greatly between region, economies, and production systems. Due to these details, this thesis could only create an overview of the complexities and extend to differences. The methods used took into consideration the timeframe and the provided access to information to answer my research question.

Chapter IV: Data Analysis

Historical Analysis

This section is a genealogy of the term emissions intensity as found in major reports and policy statements on global climate change. Emissions intensity is a metric used to understand the contribution of a particular sector or activity to greenhouse gas emissions. The metric initially was used to measure carbon emissions from the energy sector. It later became more dominate when countries were provided the opportunity to measure national greenhouse gas emissions based on gross domestic product. Emissions intensity is an increasingly utilized metric for measuring the contribution of emissions of an activity, taking the place of total emission calculations. Researchers are placing more attention on how to effectively use intensity metrics in various sectors as a way to mitigate climate change.

The purpose of this section is to create a detailed analysis on the evolution of the term emission intensity. This analysis will allow for an understanding of where and when the term originated and how it has emerged as a commonly used metric for measuring greenhouse gas emissions from livestock production. Initially, I will outline the discussion of how the energy sector settled on emissions intensity as an agreed upon metric, what the other metrics are, and the implications of using intensity metrics for livestock production as opposed to energy.

I begin this historical analysis by dissecting the First Assessment Report (FAR). Since this earliest publication, the IPCC reports have summarized different ways for thinking about and measuring anthropocentric sources of greenhouse gas emissions. The measurements vary for different sectors and have changed overtime. The earliest ways that IPCC reports measured the greenhouse gas emissions was in relationship to per unit

of output. This process started with accounts that were used in measurements for the energy sector and which were later applied to calculate emissions from the livestock sector.

Measuring Emissions: Total vs. Emissions Intensity

In the early documents on climate change, research recognizes the urgency for international policy aimed at reducing future greenhouse gas emission (Hoeller 1991). However, there was and still is a debate on the most consistent, equitable, and accurate methods to reduce greenhouse gas emissions. The FAR in 1990 concentrates on the importance of implementing legal and institutional mechanisms to address greenhouse gas emission inventories. The inaugural report deliberated:

> The introduction, as appropriate, of sound scientific bases for establishing emissions targets (such as total emission levels, per capita emissions, emissions per GNP, emissions per energy use, climate conditions, past performance, geographic characteristics, fossil fuel resource base, carbon intensity per unit of energy, energy intensity per GNP, socioeconomic costs and benefits, or other equitable considerations) (IPCC 1990).

The language used in the initial target setting documents states that emissions will be measured on a per unit or per capita basis.

The range of approaches to account for national emissions inventories is guided by the notion of the best available techniques. The best available techniques "means the most effective and advanced stage in the development of activities and their methods of operation which indicate the practical values design to prevent and, where that is not practicable, generally to reduce emissions and their impact on the environment as a

whole" (United Nations Conference on Environment & Development 1992). This concept takes into account that future levels of GHG emissions are a product of a very complex system by forces such as population growth, socio-economic development, and technical progress (Nakicenovic 2000). The best available techniques to address countries emissions inventories are left to the discretion of each country based on their common but differentiated scenarios. The United Nations Convention on Climate Change uses the information from the IPCC reports in order to guided countries to set national targets and policies.

Since the Paris Agreement, countries have resubmitted emissions targets called intended nationally determined contributors (INDCs). The INDCs establish each country's commitment for the post-2020 period (Levin 2015). Pledges have been communicated and documented in the United Nations Framework Convention on Climate Change (UNFCCC) after the twenty- session of Conference of the Parties. These targets are recorded in terms of absolute emissions, business-as-usual strategies, intensity targets, peaking targets, and specific policy and action (Conference of Parties Twenty Second Session 2016). Only a handful of countries have committed to intensity targets including: China, India, Malaysia, Singapore, Tunisia, Chile, Sierra Leone, and Uruguay have all pledged national emission intensity targets (UNFCCC 2016; Energy Efficiency 2016).

In regards to this research, a majority of countries do not measure their national emissions inventories in terms of intensity. This is significant because the major supporters and funders of emissions intensity research are not committed to intensity targets. These countries are committed to emissions intensity in livestock but not in regards to their entire GDP. Mitigation of emissions intensity related to livestock does not

relate the same of emissions intensity targets to the United Nations. As production systems reduce intensity, it does not necessarily correlate with the INDCs targets which are used for countries to address climate change.

Changes in GDP and energy consumption frequently move in tandem. When GDP rises, emissions tend to increase simultaneously. This is critical because energy is the cornerstone of economic activity in a country. This means that a country's targets are floating based on each country's economic productivity in comparison to other approaches which are set on a fixed mark. Emissions intensity targets have the ability to reduce cost uncertainties because the target is constantly changing with the GDP. Nevertheless, the reduced cost uncertainties of setting a floating target rather than a fixed one also comes with greater environmental uncertainties (Baumert 2005). This is because intensity measures may be reduced with GDP growth but absolute emissions targets can increase. Increases in GDP create increases in energy usage which in turn creates lower emissions intensity calculations but increased absolute emissions numbers. For example, "in several countries, declines in emissions intensity were accompanied by significant increases in GDP, leading to increases in absolute CO_2 level. China and the U.S. are notable cases" (Baumert 2005).

Countries have the ability in their INDCs to report which subsectors will be addressed. However, it is notable that 99% of all Parties explicitly highlight actions to achieve energy efficiency while 1% does not mention it. Many of the Parties retrieve their data from national statistics and international databases especially the IPCC statistics which measure subsectors like energy and more recently livestock in terms of intensity ("Conference of Parties Twenty Second Session" 2016). This section outlined

the formal international types of mitigation emissions options on a national scale. The next sections will analyze the rhetoric used in terms of energy and livestock which serve as two prominent subsectors that shape international policies and calculations.

Energy and Intensity

Energy usage and efficiency has been a central concern since the earliest climate mitigation dialogue. From the decade between 1980 to 1990, the sources of anthropocentric greenhouse gases broke down into energy (46%), chlorofluorocarbons (24%), forestry (18%), agriculture (9%), and other (3%) (FAR, 1990). These percentages of anthropocentric greenhouse gases sources led policymakers to concentrate on the energy sector due to the sheer quantity of emissions produced in comparison to others. In an IPCC Emissions Scenario Summary for Policymakers production from 2000, the logic behind this term is clearly defined. It states:

> In all scenarios, economic growth outpaces the increase in energy consumption, which leads to substantial reductions in the ratio of primary energy consumption to gross world product, also known as 'energy intensity' … With all other factors being equal, the faster the economic growth, the higher the turnover of capital, and the greater the decline in energy intensity (Nakicenovic, 2000).

Global energy intensity is measured as total primary energy supply per unit of gross domestic product (International Energy Agency 2016). An important distinction to make is that energy intensity is energy consumed divided by GDP where as carbon intensity takes it one step farther. Carbon intensity is CO_2 emitted from burning fossil fuels divided by the amount of energy produced (TAR 2001). The international discourse

acknowledges targets in terms of energy intensity and more narrowly implying research on carbon emissions.

Carbon dioxide is the greatest emission released from the energy sector and therefore the metric translated into measuring the carbon intensity as opposed to all the major GHG (FAR, 1990). Successive reports continue to emphasis the need for improved technology that deals with efficiency and productivity of energy. Energy is a unique sector because it is incorporated into many other industries. Intensity is important for energy calculations because of the ability to be substituted for more efficient sources. The Third Assessment report emphasizes a "shift away from high carbon fuels such as coal and natural gas, through energy conversion efficiency improvements and the introduction of hydro and nuclear power" (Banuri 2001). Renewable fossil fuels such as solar, nuclear, hydro, or wind power can be less energy intensive in comparison to non-renewable like coal or gas. These substitutions can allow for emissions intensity reduction while decreasing absolute emissions, such cannot be said for other section like livestock. Even as absolute emissions increase in correlation with economic growth, researchers continue to mention reductions in energy intensity as progress. The logic behind measuring emissions intensities per GDP and in the energy sector, has advanced over time to become a model. Emissions intensity from livestock production incorporated non-CO_2 emissions such as methane and nitrous oxide which are more potent than CO_2.

Global Energy Intensity Trends

Improving energy efficiency has created growing consideration as a significant module to confront climate change (Voigt 2014). The IPCC AR5 later projects that CO_2

from the energy sector will almost double or triple by 2050 unless there are significant improvements in the development of energy intensity (IPCC 2014).

In the years between 1981 and 2010, global energy intensity patterns decreased by 20.5% or 0.8 annually while overall emissions continued to increase (Yoder 2016). This period of decline was a result of the most developed countries switching their economies from energy intensive heavy industries to new technologies and a more knowledge-based economy (Yoder 2016). However, the pace of improvements is too slow to achieve the goal of preventing global temperatures from rising 2°C (International Energy Agency 2016; IPCC 2014).

Developed and newly industrialized countries are those that have peaked in decreasing energy intensity. The economies in industrialized countries are comprised of lower-carbon service sectors as opposed to developing countries where a larger share of the economy comes from energy-intensive manufacturing industries (Baumert 2005). With a switch to more knowledge-based economies, highly industrialized and transitioning countries are able to increase economic productivity without simultaneously increasing energy use (Yonder 2017). Transitioning and non-OECD countries have the most potential to reduce intensity targets due to a combination of opportunity for new technology, structural economic changes, and efficiency improvements ("Worldwide Trends" 2008). China, for example, was a main contributor to the improvement of global energy intensity trends. In 2015 China's energy intensity improved 5.6% which was up from an average of 3.1% per year over the previous decade (Energy Efficiency 2016). China has experienced immense growth amongst the major economies which followed by an increase of energy consumption in all industries. However, the new demand for energy

was matched by rapid economic growth. This is crucial because without the single contribution of China's progression, global energy intensity would have improved 1.5% rather than the 1.8% marked in 2015 (Energy Efficiency 2016). GHG targets measured in terms of intensity introduce new complexities as they are used in different sectors. It is notable that "intensity targets would make international climate negotiations more complex (and domestic policy-making) more complex, especially if they are being adopted by many countries" (Baumert 2005). In regards to this research, there is less of a concern for countries making their national commitments in terms of intensity. Rather it highlights the relevancy of these same concerns as intensity metrics are transitioning to methodological approaches in the international production of livestock.

International discourse, as apparent through the IPCC assessment reports, illustrate the historical genealogy for the term emissions intensity. As previously stated, over the years, this metric has become a more popular way to calculate GHG inventories and create mitigation strategies. The frequency of the terms energy intensity, carbon intensity, emissions intensity, and per unit as found in each series of IPCC reports from Working Group III are all illustrated in Table 3. I selected these terms to demonstrate the drastic increase in usage over the years. I selected the term per unit because prior to referring to emissions intensity from livestock, many of the reports referred to per unit measurements such as emissions per unit of meat, protein, milk, etc. which will be expanded upon in the following section.

Table 3. Frequency of Key Terms in IPCC Report Series (1990-2014)

	First Assessment Report 1990 (FAR)	Second Assessment Report 1995 (SAR)	Third Assessment Report 2001 (TAR)	Fourth Assessment Report 2007 (AR4)	Fifth Assessment Report 2014 (AR5)
Energy Intensity	9	37	68	73	267
Carbon Intensity	14	6	50	73	138
Emissions Intensity	0	4	1	6	53
Per Unit	20	34	41	6	85
Total	**43**	**81**	**160**	**158**	**543**

The table clearly shows an increase of these terms with each new publication of assessment reports. Intensity as a metric to record emissions has created a great deal of attention in both the energy and agricultural sector.

Improvements in energy intensity are a prominent way to track trends in global emissions. The need to concentrate on methods to make global energy usage more efficient is important in the face of growing energy demands. The production of more efficient energy sources is a cornerstone component to a countries development and economic growth. However, it has not generated the quantity of success needed to impact the climate so seems unfitting to extend the same logic into other areas. Globally, progress toward increasing energy efficiency falls at the hands of developing and transitioning economies who are left to replicate developed countries. In these scenarios, as economic growth increases their demand for energy also increases. Energy intensity

has decreased but at a pace that does not secure enough reduction in absolute emissions in order kept global temperatures under 2° C.

The same model of measuring emissions from the energy sector has more recently expanded into the agriculture sector in the form of livestock production. The ability for the energy sector to transition into renewable and low-emission technology is important ways to decrease intensity. However, this same logic of measuring emissions for livestock does not translate as directly. The same alternative of substituting non-renewable to renewable resources does not apply in the same sense with livestock for several reasons. Cattle produces the most emissions in comparison to any other species as it is responsible for 65 percent of the livestock sector emissions (Gerber 2013). In theory, switching from the species that produce the greatest concentration of emissions to species with significantly less contribution would lower total emissions. In practice, this would mean farmers would produce less cattle and buffalo to pigs and chickens. However, the livestock has an additional element which is consumer demand. For consumers, there is relatively little difference if they supply-side changes the type of energy produced. For consumers, there is minimal awareness of the source by which energy is produced. On the other hand, substituting species requires a larger change in the demand side. With this, the only way to achieve better emissions intensity in livestock is by using better techniques. This shift entails putting more animals in smaller spaces and place attention on components related to breeding and feed production and digestibility. At its origin, this huge development in favor of more capitalized farmers and does not actually do anything about total emissions other than boosts them.

The ability to transplant emissions intensity from the energy sector to the livestock includes various shortcomings that will have a huge impact on global climate mitigation strategies.

Livestock and Intensity

In the FAR, the term intensity was never referenced in relation to agriculture. Nevertheless, the report has one mention that livestock-related emissions could be measured on a per unit basis (Table 2). The reference stated there could be a reduction of methane from "livestock systems between 25%-75% per unit of product in dairy and meat production although many uncertainties exist" (IPCC 1990). The specific terminology of intensity is not used until later reports as an approach to reduce emissions related to livestock raising.

In 2006, the Food and Agriculture Organization of the United Nations (FAO) published a groundbreaking document titled "Livestock's Long Shadow." This text changed the entire discourse on the relationship to livestock raising and climate change. This text was one of the first instances highlighting the steadfast correlation between livestock and climate change. The FAO highlights how the production and consumption of livestock is responsible for approximately 18% of the world's total greenhouse gas emissions (Steinfeld 2006; Gerber 2011). This percentage and detailed analysis illustrated how other scientific research grossly underestimated the significance. With the new information from the FAO and the proceeding IPCC reports, countries began mentioning livestock in their INDC strategies to address climate change. Countries such as Ethiopia, Kenya, Malawi, Uganda, Afghanistan, Myanmar, and Guatemala, since the FAO report, have included plans to transform livestock production.

In 2007, the next series of IPCC reports following the FAO research, placed significant attention on mitigation solutions in agriculture, particularly on the livestock industry. The report acknowledges the shift in food demands is expected to generate changes in consumption patterns to include more livestock and fewer staple crops (IPCC 2007). The Fourth Assessment Report (AR4) alludes to the fact that the measurements from 2004 of methane (CH_4), nitrous oxide (N_2O), carbon dioxide (CO_2) were presented with great uncertainty in regards to agriculture and forestry (IPCC 2007). Over the years, more evidence has surfaced to support the initial FAO findings and expanded to a more in depth study. By the time AR4 was issued, there was a shift toward measuring many aspects of livestock based on per unit metrics. Multiple sections of the text amplify the notion that more intensive techniques and improved technology will reduce emissions per unit centered on separate categories but under the same rational. These categories include per unit of food, per unit of protein, methane per animal, emissions per kg-feed intake, and emissions per kg-product (IPCC 2007).

AR4 uses the semantic of intensity without using the exact term emissions intensity in relation to livestock. Prior to the later IPCC reports which focus more on livestock, other scientific journals, and government ministries referred to a need to focus on emissions per unit of product (Gerber 2011; Rosin 2013). There is no difference between referring to emissions intensity related to livestock production and emissions per unit of animal product. The two terms are interchangeable, but certain countries participated to switch the discourse to conduct research specifically on emissions intensity. This transition is important because it ushers actors to converge behind the same strategy and present it as a mitigation strategy rather than using the more technical

term of a per unit metric. It allowed for discourse coalitions to form and organize behind seemingly new mitigation interventions while continuing production and profitability. This roots from the energy sector as previously mentioned. Rather than creating a completely new plan, actors took the term and concept from the energy sector and transplanted it into the livestock sector. This allowed for minimal alternations in the structure of the livestock industry and instead rearranged the rhetoric to fit those that benefit foremost.

The beginning stage of the shift in discourse took place in 2009 after the United Nations meeting in Copenhagen. Here, New Zealand introduced the Global Research Alliance with the sole purpose of researching emissions intensity related livestock production. The GRA was instrumental in setting up regional research institutes, a point I develop in the section below.

The complete shift in discourse is later reinforced in The Fifth Assessment Report (AR5) where emissions intensity is used as a metric to gauge livestock emissions. The document quotes:

> In addition to the per-area and per-animal mitigation options described in AR4, more attention has recently been paid to options that reduce emissions intensity by improving the efficiency of production (i.e. less GHG emissions per unit of agricultural product) … The scope to reduce emissions intensity appears considerable since there are very large differences in emissions intensity between different regions of the world (IPCC 2014).

AR5 positions emissions intensity in the management of livestock as a clear and forerunning metric after the 2013 FAO publication titled "Tackling Climate Change

Through Livestock". The term emissions intensity per unit of animal product is used as a principal strategy on both the supply-side and demand-side of the issue.

It is not until AR5 that the discourse around livestock management is bracketed under emissions intensity. A key difference in emissions intensity in relation to livestock is the emphasis placed on non-carbon dioxide (non-CO_2) emissions such as methane (CH_4) and nitrous oxide (NO_2). The chapter on agriculture in AR5 uses the term emissions intensity fourteen times compared to previous reports which had no mention of emissions intensity in relation to agriculture (IPCC 2014).

The term emissions intensity has become a much more mainstream term when discussing livestock management from a variety of sources. The term and logic used for intensity metrics was initially set up to measure carbon emissions from the energy sector and emissions in comparison to economic growth. However, as research expanded around the agriculture sector in relation to climate change, so has the usage of emissions intensity in the sector. National and international government policies, the livestock industry, non-governmental organizations, scientists, and academia are all places where the term emissions intensity in regard to livestock is reoccurring. Each of these sources, the ways in which they use the term, and the various implications will be further dissected in the upcoming sections.

Actors

The previous section created a genealogy for the evolution of the emissions intensity in both the energy and livestock sector. The purpose of this section is to situated the actors involved in researching, justifying, and encouraging the usage of emissions intensity metrics in the livestock industry. It establishes the interests of the individual actors and what they each gain from transition international discourse to focus on emissions intensity. This shift in discourse has brought about the particular actors mentioned in this section and embody new physical and social realities.

Many of the actors involved have overlapping funders, partners, and individual actors, but they all support a similar system for addressing livestock-related emissions. One side focuses on climate strategies centered around technological advances toward efficiency and productivity. Those on this side each benefit from creating interventions based on emissions intensity because they place the onus and responsibility on others while continuing their profitable systems of production. This stance is in opposition to actors encouraging a more holistic system referring to consumption and dietary alterations to mitigate emissions from livestock. Many of the organizations, government ministries, and alliances in support of emissions intensity work within an interlocking web that is tough to dismember. This section will summarize each of the major organizations individually and guide readers through the interconnection between funding, interactions, and publications.

Who is Behind Using the Metric?

The premise of these actors, alliances, institutes, and government ministries is to explore opportunities to improve the efficiency of livestock productivity. This is the common rhetoric used by the organizations publishing research on livestock emissions

intensity. This approach is based on the implementation of new practices and technologies that result in higher yield per animal. Table 4 demonstrates the missions and objectives outlined by the major investors and endorses of intensity research. These actors are members collectively form discourse coalitions supporting this intervention and individual have economic, social, and political aspirations.

Table 4. Major Actors and Mission Statements Endorsing Emissions Intensity

Actors	Branch/ Program	Purpose
Global Research Alliance on Agricultural Greenhouse Gases (GRA)	Livestock Capacity Building	"Helping farmers improve the productivity of ruminants is a key way to improve rural livelihoods and food security, at the same time as reducing emissions intensity." Low Emissions Livestock Development (n.d.).
Global Research Alliance on Agricultural Greenhouse Gases (GRA)	Livestock Research Group (LRG)	"More productive and efficient farm systems generally produce food at much lower greenhouse gas emissions per unit of product."
International Livestock Research Institute (ILRI)	Consultative Group on International Agricultural Research (CGIAR)	"The outcomes of these research partnerships help people in developing countries keep their farm animals alive and productive, increase and sustain their livestock and farm productivity, find profitable markets for their animal products, and reduce the risk of livestock-related diseases." (Notenbaert 2013)
Consultative Group on International Agricultural Research (CGIAR)	Research Program on Livestock 2017-2022	"To date, the limited growth response of livestock production in developing countries is mainly due to the increasing numbers of animals reared by small-scale producers rather than improvements in productivity." (CGIAR Research Program on Livestock 2017-2022)
Australia	Department of Agriculture and Water Resources	"The Department of Agriculture and Water Resources has a key role in promoting more profitable, competitive and sustainable food and agriculture industries, such as the important meat, wool and dairy industries." (Meat, Wool and Dairy n.d.)
New Zealand	Agricultural Greenhouse Gas Research Group	"Our research programme aim is to deliver efficient, cost effective, highly productive, on-farm solutions to ensure New Zealand agriculture is economically and environmentally sustainable through the reduction of agricultural greenhouse gas emissions." (New Zealand Agricultural Greenhouse Gas Research Centre)
New Zealand	Ministry for Primary Industries	"The aim should be a reduction of greenhouse gas emissions intensity of grazed livestock systems without compromising productivity and profitability." (Global Partnership in Livestock Emissions Research)
The Netherlands	The Ministry of Economic Affairs	"To increase agricultural production with lower emissions." ("Dutch Contributes to the Global Research Alliance")

United States	Department of Agriculture (UDSA) Agricultural Research Services (investors in IRLI)	"The mission of animal production and protection national programs is to improve the health, well-being, and efficiency of livestock, poultry, and aquatic food animals to ensure a productive and safe food supply." (Silverstein 2017).
Food and Agriculture Organization of the United Nations (FAO)	Reducing Enteric Methane for Improving Food Security and Livelihoods	"Improving productivity of ruminant livestock and efficiency of farm systems in developing countries is therefore a key way to improve rural livelihoods and improve food security and to minimize GHG emissions from the sector at the same time." (Reducing Enteric Methane for Improving Food Security and Livelihoods)

The table illustrates the major actors mentions above and their goals and mission statements. All the organizations, partners, and governments used the same discourse to address the growing livestock industry in the face of climate change. The key rhetoric revolves around improving productivity and efficiency while remaining economic productive. This angle only tackles the issue for the narrow lens of economic stability rather than the true target of climate change mitigation.

Economic stability and growth, especially for developing countries, is a major reason these actors quote for why a switch to emissions intensity it critical. However, this seemingly basic transition in terminology and the narrow focus on efficiency benefits the economic growth of already developed countries and economies. Most farmers in the developing world rely on small pastoral systems of production rearing small herd sizes for basic income. A switch to using emissions intensity as an intervention means more heavily capitalized livestock operations and countries benefit from creating this intensity discourse. This is because they are already fall into the category of more efficient and intensive production. Therefore, the problem falls onto the operations within the global south to make drastic changes. Consolidating farms and herds in these regions reduces the cost of animal products and increasing consumption. Therefore, the concentration on economic benefits falls into the hands of the wealthy arguably increasing elite consumption globally and further complicating the entire dynamic.

The quoted organizations and actors were selected specifically based on their interrelated research, partners, and investors. I will give a brief explanation for why each of the given actors are prominent in this field and later dissect their contributions. The actors work in a symbiotic system rather than a linear relationship, so this analysis will start with one of the most prevalent coalitions known as the Global Research Alliance.

The Global Research Alliance on Agricultural Greenhouse Gases (GRA) is the leading contributor to research on livestock production and greenhouse gas emissions reductions. The GRA has laid the foundation by which nearly all research on livestock emissions intensity builds on. The GRA was launched in 2009 at the United Nations Climate Change Conference in Copenhagen. The alliance is an initiative currently comprised of 49 countries and 14 formal partners working together to provide a framework for government ministries and partners to collaborate toward more efficient agriculture practices. I interviewed several individual actors from the GRA to understand the logistics and structure of the alliance. I spoke to representatives from the United States, the Netherlands, and New Zealand who informed me that the GRA does not function like a typical organization. The GRA is a virtual network where countries voluntarily can work together on similar research agendas. The Alliance "promotes an active exchange of data, people and research… members will work with farmers and farmer organizations, the private sector, international and regional research institutions, foundations, and non-governmental organizations" (About Us 2015). A representative from each country attends an annual meeting to synthesize the previous year's results and creates a platform for future collaboration. There is no central headquarter or office, so the annual conference serves as the only time and place where the entire alliance gathers.

Similarly, the GRA only has two permanent positions: The Secretariat and the Special Representative. All other positions are made up of independent research teams from their own respective government ministries. For example, all the email addresses are directed to their specific government ministries rather than a GRA server. The GRA also does not have a budget that is allocated to central projects. The funding comes from the same sources, but distributed on an individual project basis.

Through formal partnerships and international research centers, the GRA aims to ensure methods that address emissions reductions by increasing efficiency and productivity in global agricultural systems. The entire network is focused on emissions intensity research. The GRA has four research groups focusing on paddy rice, livestock, croplands, and an integrative research group. The GRA Livestock Research Group (LRG) argues that "livestock development and climate change outcomes can support each other. More productive and efficient farm systems generally produce food at much lower greenhouse gas emissions per unit of product" (Greenhouse Gas Inventories for Livestock 2017).

I am using the GRA as a starting point in this analysis because they are the largest alliance of countries working on this research. The GRA is a foundation for collaborative research and development program to create a repository of agricultural research and climate solutions. It is difficult to address who exactly is responsible for their published research so I concentrate on the major funders. After looking into each of the GRA's partners and funders, it is clear that majority of the research on emissions intensity from livestock derives from similar government ministries with Australia, the Netherlands, New Zealand, The United Kingdom, and the United States being the GRA and its

partners' top contributors. The following subsections will address each of the listed countries and their relations and contributions to the GRA and further emissions intensity research.

Government Ministries

The following countries provide large sums of funding toward transitioning storylines on international livestock emissions intensity research. The same government ministries that are heavily supporting research based on emissions intensity metrics are also those with prosperous domestic meat and dairy sectors. This section highlights the financial and technical assistance offered by each of the prominent government departments. New Zealand is one country in particular who has led the shift to emissions intensity and for good reason as the production and export of livestock is central to its economy. New Zealand is responsible for about 80% of the GRA's funding and fundamental in the escalation of emissions intensity research. However, the other countries that are heavily recorded to sponsor the GRA and its partners are not as open in documenting their involvement.

New Zealand

New Zealand provides a majority of funding for global research on emissions intensity and altering this international discourse. Reducing emissions from livestock farming and changing political framing is essential the New Zealand economy. New Zealand's Ministry for Primary Industries has created two corridors to support research for sustainable farming practices and emissions intensity. The Global Partnerships in Livestock Emissions Research and the New Zealand Agricultural Greenhouse Gas Research Centre are the two sectors funding and publishing this research.

The Global Partnerships in Livestock Emissions Research (GPLER) was created by the New Zealand government as an international fund in support of the GRA ("Global Partnerships in Livestock Emissions Research" 2017). The fund was established to accelerate global research into greenhouse gas mitigation from pastoral livestock farming (The New Zealand Fund 2011). The fund centers on research and development toward "improved tools and practices for minimizing farm system-level greenhouse gas emissions intensity in predominantly grazing livestock systems" (The New Zealand Fund 2011). The purpose is to reduce emissions intensity "without compromising productivity and profitability" (The New Zealand Fund 2011). In 2011, The first round of funding started at NZ $16 millions over the duration of 4 years. As of May 30, 2016, GPLER has initiated its fourth round of funding by allotting another $9.2 million to allocate to projects over a 3-year timespan (The New Zealand Fund 2011).

The New Zealand Agricultural Greenhouse Gas Research Centre (NZAGRC) is a partnership between leading researchers from New Zealand and the Pastoral Greenhouse Gas Research Consortium (PGGRC). The NZAGRC is investing $48.5 millions into agricultural greenhouse gas emissions over the duration of 10 years. Agricultural research is a central concern for New Zealand based on the structure of its economy as a major food exporting country. Since its reconstruction to fit emissions intensity calculations, it has been recognized as a world-renowned source for funding and guidance (New Zealand Agricultural Greenhouse Gas Research Centre 2017). A majority of research on emissions intensity has the NZAGRC emblem at the bottom acknowledging the involvement of the department. Most notably, the NZAGRC is cited to support the research funding numerous initiatives from the FAO dealing with low emissions in global

beef and dairy industries in developing nations. Between the two programs, New Zealand has committed $45 million to the GRA and recently announced contribution of $20 million by June 2020 (New Zealand n.d.). The funds are split into two categories of research and development and capacity building programs which implement new practices in various countries.

New Zealand's support for the GRA is paramount to the creation and continuation of the alliance. I was informed after several interviews with NZAGRC staff that New Zealand and the GRA are synonymous because of the sheer amount of funding from country. New Zealand is a founding member, the current Secretariat, one of the Co-Chairs of the Livestock Research Group, and was the Council Chair from June 2011-June 2012 (New Zealand n.d.). In 2009 at the United Nations Climate Change Conference in Copenhagen, New Zealand brought the idea of the Global Research Alliance to the center stage. The government launched the alliance as a mechanism for countries to work together and create open dialogue about livestock production and climate change through the lens of emissions intensity reductions. However, the collaborating member countries at first were not willing to support the idea monetarily. In order to keep this narrative of emissions intensity, New Zealand responded by funding a majority of the alliance. This funding also includes providing money for scientists from a variety of countries, especially developing countries, to attend international meetings in order to continue participation which is not documented in the overall budgeted contributions. I was informed directly that the creation and continuation of the GRA is a political ambition from New Zealand to continue their current means of production. The New Zealand government, for this reason, was fundamental in the shift in international discourse

toward emissions intensity as a common metric for livestock production. Interview conversations provided multiple answers as to why New Zealand spearheaded this transition.

New Zealand is an exporting country. Agriculture is responsible for 38 percent of the country's total exports. Most notably, dairy is the country's most profitable export as New Zealand is the world's number one supplier of dairy in global trade. Similarly, beef, wool, and sheep meat serve as other large national exports (Agricultural Greenhouse Gases & the New Zealand Beef & Sheep Sectors n.d.). As a result, in 2015, agriculture accounted for 48 percent of New Zealand's total greenhouse gas emissions. (Agricultural Greenhouse Gases & the New Zealand Dairy Sector n.d.). Since 1990, New Zealand's gross emissions have increased 24.1 percent with one of the key drivers coming from methane livestock digestive systems (New Zealand's Greenhouse Gas Inventory 2017). However, emissions per unit of agriculture, specifically livestock, has declined annually by 1% (Lee-Jones 2015). Since 1990, policies, practices, and technology has been geared toward transforming the entire agricultural sector to be more productive and efficient while remaining profitable. Accordingly, the government records improvements in terms of lower emissions intensity. The country is labeled progressive and efficient even though overall emissions continue to increase.

The New Zealand's sheep industry is cited for its notable increase in efficiency and productivity on a national scale. Figures from 2015 illustrate that flock numbers dropped to the lowest numbers since World War II (Shuttleworth 2015). As a result, "levels of production gain in sheep farming in recent years has been very impressive—farmers are producing the same amount of product from far less sheep" (Shuttleworth

2015). In other words, the emissions intensity of sheep production has decreased at remarkable rates. One of the personnel from the NZAGRC explained that this transition in New Zealand was a direct result of market fluctuations and government interventions rather than anything related to strategic climate change mitigation. The transition was due to the elimination of government subsidies which increased competition and forced farmers to become more efficient or leave the industry (Rosin 2013). The government's transition to efficiency in the livestock industry was based purely economic and productivity goals. However, such market changes aligned nicely for manipulating the language of efficiency into rhetoric for climate change strategies. The government realized there can be synergies between economic trends and climate change. From this stand point, New Zealand strategically aligned itself as a pioneer for policies and scientific research to justify emissions intensity as the new discourse in the face of climate change and global food demand while continuing economic prosperity.

In order for New Zealand to reduce its absolute emissions, all other industries would have to be reduced to zero because agriculture is at the cornerstone of their economy. The government justified their increase in emissions by acknowledging that they were addressing global food demand with lower intensity than other countries. Farmers retained "a strong belief in their capacity to 'feed the world'' (Rosin 2013). The New Zealand government is responsible for changing the storyline of livestock production in relation to climate change. New Zealand is commended for creating the GRA and establishing a language by which countries could talk about emissions from livestock.

Australia

The Australian government is cited as another funder for several agricultural research projects supporting emissions intensity. The Climate Change Research Program (CCRP) was created under The Department of Agriculture and Water Resources to identify ways farmers can reduce emissions from agriculture while increasing productivity. Within two years, the program has invested a total of $130 million toward partnerships, collaborative research, industry groups, and international projects ("Climate Change Research Program" 2015).

In the context of the GRA, Australia is a founding member and a major contributor in the Livestock Research Group. Australia's participation in the GRA erects from the governments investment under Carbon Farming Future which earns credits under the Emissions Reduction Fund (ERF) (Australian Agriculture: Reducing Emissions and Adapting to a Changing Climate" 2013). The Climate Change Authority sector of the government created the Carbon Farming Initiative (CFI) Act was revised in 2014 to support arrangements for the Emissions Reduction Fund (ERF) which serves as a central component of Australia's emissions reductions policy (Review of the Carbon Farming Initiative Legislation and the Emissions Reduction Fund n.d.). The ERF combines crediting emissions reduction activities as offset projects coupled with government purchase of the resulting carbon credits (Review of the Carbon Farming Initiative Legislation and the Emissions Reduction Fund n.d.). Australia's involvement with the GRA furthers the countries emissions reductions policies to reduce methane emissions from the livestock sector. Similarly, Australia is one of the top donors to research groups live the Consultative Group on International Agricultural Research (CGIAR),

International Livestock Research Institute (ILRI), Climate and Clean Air Coalition, amongst other focusing on livestock intensification projects.

The economy of Australia, similar to New Zealand, is centered around the meat and dairy industry. The Department of Agriculture and Water Resources states that "promoting, competitive and sustainable food and agriculture industries, such as the important meat, wool, and dairy industries" are paramount to the countries success (Meat, Wool and Dairy 2017). Beef cattle production, dairy, wool, and lamb are Australia's largest exports. Due to the mass production and trade of such products, the country is ranked as one of the top dairy and cattle producers in the world. The dairy industry is highly acclaimed for its efficiency and system innovations. Agriculture is responsible for 10 percent of Australia's total greenhouse gas emissions (Meat, Wool and Dairy 2017). The foundation of Australia's climate policies highlight research and development that focuses on productivity and efficiencies that simultaneously maintain and increase profitability. The development and usage of more intensive livestock production both domestically and internationally is the premise of agricultural advancement (Dickson 2009).

The United States and the Netherlands

The United States and the Netherland government ministries are less transparent in comparison to New Zealand and Australia. It is easy to dissect the connection between the GRA and New Zealand and Australia because the financial and technical contributions were clearly. The ministries for each country utilize the language of emissions intensity in their livestock and dairy industries. The same is not true for the United States and the Netherlands who offer minimal recognition on their involvement

with research on emissions intensity. However, they are both noted to be key investors in the GRA, as a benefactor of the Livestock Research Group, and the CGIAR Livestock Research Programs.

The United States is much more discrete in their association with emissions intensity research than any other government entity. The GRA website states that the US is a donor, has researchers in the Livestock and Crop Research Groups, and created the Borlaug Fellowship Program through The United States Department of Agriculture Foreign Agricultural Service to fund GRA research. The United States Department of Agriculture committed up to $90 million over four years at the inception of the GRA (Vilsack 2009). Following this initial donation, it is challenging to trace the United States involvement in emissions intensity research. There is one mention in a United States Department of Agriculture publication stating emissions intensity. It quotes, "the emissions intensity of the production of meat and milk in the United States is already much lower today than it was even a few decades ago. Due to improvements in production efficiency, it's amongst the lowest in the world… providing another 'win-win' for farmers, communities, and the nation" (Biogas Opportunities Roadmap 2014). Other reports and publications measure livestock based on per unit calculations but limited usage of the term emissions intensity. The GRA's website description on the US' contribution centers on statements with broken links for the United States Department of Agriculture. The United States' involvement in livestock research for the GRA is grouped together with other projects and other member countries. However, the United States is a country acknowledged for the launching of the GRA and one of the four top contributors to the CGIAR livestock research program as well. The CGIAR, which will

be further explained, is a key research institute that publishes international research endorsing intensity measures. Finding out more information about any of the branches of the United States Department of Agriculture association with emissions intensity research is challenging but they are major funders through a variety of international research centers encouraging livestock-related emissions intensity research.

The GRA has published a series of case studies to recognize the success of various countries' reduction of intensity of enteric methane emissions. The United States and the Netherlands are two of the countries highlighted for their success in reducing emissions from the dairy sector while increasing productivity. The United States is one of the world's largest producers of dairy and milk products. The Dairy industry accounts for $140 billion and more than 900,000 jobs (Cryan 2004). The modern US cows are larger and consume more which in turn require more feed. However, the GRA highlights that the intensity per animal has dropped immensely from the levels in 1924 (Reducing the Intensity of Enteric Methane Emissions from the US Dairy Herd 2017). The Netherlands similarly, is recorded to have made improvements in dairy productivity over the years with limited changes in ratio of emissions emitted.

The Netherlands contributes to the GRA through its Ministry of Economic Affairs. The role of this ministry within the GRA is financing and contracting, contributing ideas and coordinating policy components (Dutch Contribution to the Global Research Alliance n.d.). The Netherlands has been a member if the GRA since 2011 and served as the vice president of the GRA between 2013 and 2015 (Dutch Contribution to the Global Research Alliance n.d.). The Netherlands has continued to increase collaboration and involvement with the GRA of international organizations like the

Worldbank, FAO, and CGIAR. The Dutch continue to deepen relationships with key partners of the GRA to create efficient production and supply chain optimization in the livestock sector (Lemmen 2015; "Dutch Contribution to the Global Research Alliance" n.d). The Dutch ambition is to aid the sustainable intensification development of livestock farming by serving as the co-chair of the research groups Livestock and Inventories and Monitoring. The Netherland's Ministry Economic Affairs web page offer limited information on livestock. Domestically, livestock generates €9.3 billion per year from meat, dairy, eggs, wool, and leather (Livestock Farming n.d.) The Netherlands publicizes the active role it takes in contributing to the GRA and affiliated organizations, but unlike Australia and New Zealand, the ministry does not report how much it donates towards these projects.

As for many countries like New Zealand, Australia, the United States and the Netherlands are all active in their contributions to global livestock emissions reduction research through the GRA. Agriculture serves as a key driver of the national economy in each of the mentioned countries. Therefore, emissions intensity metrics aligns to be a logical method for allowing continued economic growth with seeming reductions in emissions. The ability to dissected the interconnected aspect of funding and technical support is often unclear. These government ministries are dynamic in their advancement of emissions intensity research through internationally funded research centers, but their promotion of the published research on their government websites is not prominent. To find the avenues by which certain funders participate in these advanced alliances is chaotic and misleading.

Multi Stake-holder International Institutes

Consultative Group on International Agricultural Research (CGIAR)

The CGIAR is an organization aiming to reduce poverty, improve food and nutrition security and improve natural resources and ecosystem services. The purpose of the CGIAR System is "to advance agri-food science and innovation to enable poor people, especially women, to better nourish their families, and improve productivity and resilience so they can share in economic growth and manage natural resources in the face of climate change and other challenges" ("Charter of the CGIAR System Organization" 2016). The CGIAR is a joint venture between international agricultural research centers who work to advance the missions toward improvements in food security. The research comes from the 15 centers "in collaboration with hundreds of partners, including national and regional research institutes, civil society organizations, academia, development organizations and the private sector" ("Charter of the CGIAR System Organization" 2016).

The CGIAR website itself is not abundant with information on livestock emissions intensity. None the less, several of the organization's research centers are heavily cited in livestock emissions intensity research from its partners. The two main research groups highlighted in studies are the Research Program on Livestock and the Climate Change, Agriculture and Food Security program (CCAFS). These two organizations along with the main CGIAR logo are embellished on many of the reports from their partners and other international organizations.

The CGIAR has a Research Program on Livestock that "will seize opportunities presented by rapid increases in demand for animal-source food in developing countries." The Research Livestock Program is intended to provide research-based solutions to

evolve smallholder farmers and pastoralists in a transition to more sustainable and productive practices. This program is often cited in tandem with the Climate Change and Agriculture and Food Security under their livestock branch. One of the goals of this program is to address emissions in developing countries. It states:

> Higher income regions, such as Europe and North America exhibit lower emissions intensities per unit livestock production when compared with production in Africa, Asia, and Latin America. So, the greatest technical potential for reducing emissions intensities lies in these low-income regions (Herrero 2013).

For this reason, many of the organizations are funded by countries like New Zealand, Australia, the Unite States, and the United Kingdom but implement projects in certain developing nations. The Research Program on Livestock and CCAFS partner with the International Livestock Research Institute, Global Research Alliance, the International for Agriculture in the Dry Areas (ICARDA). Each of these organizations are working in target countries in Latin America, West and East Africa, and Asia.

Food and Agriculture Organization of the United Nations (FAO)

The Food and Agriculture Organization of the United Nations (FAO) is the largest international organization who is endorsing emissions intensity measurements in livestock. It is a key sponsor for many organizations working on transitioning global metrics to measure livestock based on emissions intensity inventories. The FAO most notably works closely with the GRA and the CGIAR as a donor and distinguished partner. Additionally, the FAO publishes its own research and programs supporting the usage of emissions intensity for meat and dairy production. This research addresses the existing emissions intensity gap which is caused due to variations in production systems

and management practices (Opio 2013). As a multi-lateral organization, the FAO "works with a variety of resources partners, International Financing Institutions, the private sector, foundations, and national governments. Partners may provide both financial and non-financial support as well as knowledge sharing and expertise" (Resources Partners n.d.). The FAO works on climate change research through a multitude of projects and funders.

One of the branches of the FAO focuses on "reducing enteric methane for improving food security and livelihoods" across the globe (Reducing Enteric Methane n.d.). The program is framed to improve productivity of ruminant livestock to improve global food security. The FAO has created three pioneer programs to combat this gap starting in Ethiopia, Bangladesh, and Uruguay. The programs are focused on low emissions development in the beef and dairy cattle sectors of each respective country. These three projects are funded by the New Zealand Agricultural Greenhouse Gas Research Centre and the Climate and Clean Air Coalition to alter animal husbandry systems in each country. The GRA is also highlighted as a key supporter on the homepage of this project (Reducing Enteric Methane n.d.). The aim of the programs is to reduce the methane emissions from the enteric fermentation of beef and dairy cattle.

Industry

In media related sources, there is constant mention of the relationship of the meat lobby. This issue is rooted in the strong financial interactions between the private industry and government authority. This situation is a critical piece to international regulations and livestock operations. I have researched the relationship between the private sector and the main actors, however there is limited access to credible sources of

information. A limited quantity of meat and dairy corporations directly mention emissions intensity metrics on in the addresses of climate change and emissions reduction strategies. However, it is critical to shed light on the contribution of the largest meat and dairy companies. It is reported that "three meat companies—JBS, Cargill and Tyson—emitted more greenhouse gases last year than all of France and nearly as much as some of the biggest oil companies, like Exxon, BP and Shell" (Big Meat and Dairy Superzised 2017). Initially, it could be assumed that industrial livestock systems would be supporters of the implementation of emissions intensity, however there is no obvious connection between these private companies and the main actors promoting emissions intensity.

Actors Against Intensity Metrics

The Agricultural and Rural Convention (ARC2020), the Institute for Agriculture and Trade Policy (IATP), and GRAIN

The Agricultural and Rural Convention (ARC2020), the Institute for Agriculture and Trade Policy, and GRAIN are all organizations drawing public attention to controversies and narratives on farming, food, and rural policies. The debates from each of these organizations will be excavated in later sections. In essence, each of them criticize technocrats and governments who are attempting to justify current economic models of production rather than finding solutions to mitigate emissions from livestock production. Each is critical of the emission intensity metric as being obscure in terms of visibility and technical language.

The ARC2020 is an alliance-building campaign with European NGOs and farmers networks. The organization focuses on more than just greenhouse gas emissions but published a series of debates titled the #LivestockDebate which the narratives being

told on the relationship between livestock and climate change. A key article in this series, "Climate, Livestock, Carbon & the Lobby," contests the implications of technocrats and governments establishing standards for intensity reduction from industrial animal agriculture.

The Institute for Agriculture and Trade Policy (IATP) "works locally and globally at the intersection of policy and practice to ensure fair and sustainable food, farm and trade systems" (About IATP n.d.). The organization is composed of a community of activists, farmers, activists and organizers who work to promote resilient food, farm and trade systems. In terms of criticizing emissions intensity research, they collaborate and post collaborate information with the ARC2020 in their #LivestockDebate.

Lastly, GRAIN "is a small international non-profit organization that works to support farmers and social movements in their struggles for community-controlled and biodiversity-based food systems" (Activity Report 2016). GRAIN is financed by grants from other NGOs from Germany, Switzerland, and The United States. Tackling climate change through alternations in dietary habits and steering away from industrialized livestock production are key focuses for GRAIN.

The ARC2020, GRAIN, and the IATP are frank in their resistance to using intensity metrics as a method to calculate livestock production. The organization is vocal about their stance and discontent with the current and futuristic agenda for livestock production which will be expanded upon in another section.

Conclusion

The actors involved in livestock related emissions intensity research are all similar in their research objectives. The research institutes, international organizations,

and government ministries collaborating in this field are all addressing livestock emissions using the rhetoric of increased productivity and efficiency. The main donor and funders of this research are western industrialized countries who are rank higher than other countries in terms of the efficient production of meat and dairy. They work on conducting research on emissions intensity in order to implement new findings to change the structure and technology of animal husbandry in developing countries.

The research in this field is funded and organized from the same central sources. The GRA, CGIAR, and FAO are significant actors who frame emissions intensity metrics slightly differ, focusing on their contribution to food security. But they fundamentally address the issues in the same way as their major contributors—that efficiency is the appropriate way to address livestock emission. Below I consider the different storylines used by these actors to frame their interventions related to livestock emissions.

Storylines

The previous section is to examine the storylines prominent actors use to frame their interventions in regards to livestock emissions generally, and emissions intensity specifically. This section will put the various viewpoints in conversation and highlight the logic for supporting or opposing this approach. I have separated the paradigms into subcategories that explain the major explanations of why actors agree or disagree with the usage of emissions intensity as a standard for measuring emissions from livestock. I have conducted several interviews with personnel working for many of the networks and organizations previously mentioned, along with supporting NGO activists and scholars. The data used for section is derived from these interviews and the responses to questions regarding why their work is important and the contribution it makes to greenhouse gas reductions. A major finding is that the narratives are framed in ways that advance the agendas of particular countries in the face of international negotiations on climate change.

I begin by outlining some of the key statements researchers and activists have published to endorse global projects and methodologies on emissions intensity. Next, I develop the reasons and examples of why others oppose the implementation of emissions intensity strategies. What emerges an explanation the political agendas used by actors to justify emissions intensity. The storylines highlight the different implications transitioning to emissions intensity research has on developed verse developing countries. The main storylines promoting emissions intensity support the larger world view to continue industrial production of livestock globally.

The Emissions Intensity Storyline

On the international level, the New Zealand government played the central role in the advancement of emissions intensity research. I interviewed two directors from the New Zealand Agricultural Greenhouse Gas Research Centre (NZAGRC) and authors of the IPCC Fifth Assessment Report. These interviews outlined many of the reasons emissions intensity discourse has become central to climate change dialogue amongst the international community. Emissions intensity serves as an entry point for actors to address livestock emissions. According to these supporters of emissions intensity, the discourse focusing on reducing absolute emissions from livestock production was not making any progress toward getting farmers or governments to talk about climate change. In the face of growing economies, overall development, global food demand, and food security, farmers and governments are not open to conversations about reducing absolute emissions from livestock. However, actors are willing to engage conversations in regards to emissions intensity because it focuses on increasing efficiency and productivity. Therefore, one of the arguments in favor of emissions intensity implementation is that it is a step in a positive direction toward reducing emissions. Emissions intensity allows for developing and developed countries to collaborate on methods and ways to meet the projected doubling of food demand and food security without a corresponding doubling of emissions.

From this logic, a tightly woven storyline has emerged to rationalize emissions intensity research rather than focusing on total emissions reductions. The storyline is heavily supported because it acknowledges that using emissions intensity strategies help food security, allows for economic growth, improves people access to more nutritious diets, and creates an avenue for some actions to be taken since nothing was happening in

discussions from total emissions. These represent the pillars of the emissions intensity storyline that is established and strongly endorsed by actors.

Under this rational, emissions intensity is referred to as a win-win approach because it allows for continued economic grow and overall development while addressing climate change. One advocate for improved efficiency stated:

> Reducing emissions intensity on-farm will not necessarily translate into lower absolute emissions, as these depend on total production and responses of farmers to wider market and policy signals. Nonetheless, since overall food demand is largely out of the control of individual farmers and even major individual business, a focus on emissions intensity on-farm presents a realistic approach to reduce supply-side emissions without precluding other actions to manage the demand for livestock products (Andeweg 2013).

It is important to note that scientific supporters clearly note that other actions are needed in order to manage demand and other none technical interventions. There must be mitigation from every aspect of the supply chain including: energy use, transport, feed production, food waste, and overall food consumption patterns (Andeweg 2013). These points are mentioned in greenhouse gas emissions related to agriculture mitigation but not as much in the emissions intensity reduction strategies. Instead, the storyline narrowly focuses on the scientific interventions involving genetics, feed digestibility, rumen modification, and animal health. This narrow focus makes the framing revolve solely around intensity rather than mitigation from the greater livestock industry. This narrative makes it seem as if emissions intensity will fix the ultimate problem of reducing emissions.

Emissions intensity research from the prominent supporting actors such as the FAO, CGIAR, GRA, NZAGRC, and partners are shifting the international storyline. Concentrating on emissions intensity allows the opportunity for countries to engage in discourse around agriculture and climate change.

Opposing Emissions Intensity

International dialogue creates an avenue for farmers and governments around the world to start talking about emissions related to livestock production. The goal of emissions intensity reduction is to make each animal productive and farming systems more efficient. However, as previously mentioned, it does not address absolute emissions. This is problematic because climate change is a byproduct of global increase in absolute emissions. The concern is that as emissions per animal decrease, farmers will increase the number of animals resulting in an overall increase in absolute emissions. Each animal will produce less direct emissions but production increases, so will the number of animals resulting in more profit and more absolute emissions. The implementation of emissions intensity as a mitigation strategy has little to do with climate change and more so to with changes productivity and profitability. More often than not, progress in emissions intensity is a reflection of economic and political externalities rather than voluntary shifts in production for the sake of climate science.

Those in opposition acknowledges that emissions intensity is a starting point for international discourse. It opens a window of opportunity for synergy between economic development and climate change. It is not a viable strategy to address climate change in isolation. It should instead be analyzed as a steppingstone toward reducing absolute emissions. There must be a transition where countries move from focusing on improving

efficiency toward other mitigation techniques that address the rest of the supply side as well as the demand for animal products.

Minimizing herd sizes and the overall number of animals is not yet a practical option for many developing countries whose economies and livelihoods center on the production of livestock. As such, "livestock is the world's fastest-growing highest-value agricultural subsector. It already accounts for about 40% of agricultural GDP globally, often much more in many developing countries" (Randolph 2017). Majority of emissions intensity research focuses on ways to mitigate emissions from developing countries to manage their food demand and food security. The following sections will dissect the current situation and the implications emissions intensity research has on livestock production worldwide.

Spectrum of Production Systems in Developed vs Developing Countries

Global population and income are increasing rapidly. As income rises, dietary preferences and patterns are shifting toward animal-based products (Alexanratos 2012). Regionally, the scenarios of livestock production, intensity, consumption, and purpose of production differ greatly (Steinfeld 2006). However, the circumstances in developing and developed countries can be broadly categorized. In many developing countries, smallholder production remains the predominant model for a large number of household farms (FAO animal production livestock and livelihoods printed). Accordingly:

> The world's one billion poor people (those living on less that $1 a day) are fed primarily by hundreds of millions of small-holder farmers (most with less than 2 ha of land, several crops, and perhaps a cow or two) and herds (most with fewer than five large animals in Africa and Asia (Hererro 2010).

Typically, livestock in developing countries are used as multifunctional assets offering many advantages. Traditional livestock production systems are key sources of income, labor, capital, and create environmental co-benefits for 70% of the world's rural poor. Without external inputs, smallholder farming systems function in a sustainable equilibrium (Steinfeld 2006). Livestock production is interwoven with crop production which in turn enhances local nutrition because it gives people access to both animal and plant based foods (Grabbing the Bull 2017).

On the other hand, developed countries usually produce livestock under an intensive and highly industrial system. Varying from country to country, these systems consist of highly profitable concentrated farms such as feed lots or massive grazing pastures. Industrial animal production sits on the opposite side of the spectrum compared to traditional pastoral and mixed farming structures (Grabbing the Bull 2017). The prevailing socio-economic structure and biophysical terrain of a country have a great deal of influence on the type of production system. For example, Europe and South America use more pasture based techniques using large concentrations of maize and soya. This is in comparison to North America, China, and India who use more confined feed lots and factory farming methods (Herrero 2013). Factory farming is the most rapidly growing segment of meat and dairy sector responsible for 80% of the growth of this industry in recent years (Grabbing the Bull 2017). Large-scale operations with advanced technology, enhanced metrics, and access to international trade, are projected to cater to the growing demand for animal-based products (FAO Livestock and Animal Production n.d.). Large intensive production units have emerged in many regions in the developing world, particularly pig and poultry production, to address the market demand (Steinfeld 2006).

This shift of production has created cheaper costs for meat and dairy products resulting in increased supply and demand.

In order to meet the new demand, countries are expected to produce at the highest level of efficiency. Increasing scientific research and technological advances are cited to be foundational in future livestock production. As consumption increases for the world's growing population, it is imperative to do so in a way that emits the least amount of greenhouse gas emissions. Increased productivity for small to medium farming systems are constrained by lack of skill, knowledge, and proper technology (FAO Livestock and Animal Production n.d.). Therefore, the production in many of these regions are noted to be underperforming and functioning below full potential. This is where the major actors, government ministries, and research institutes come into the picture.

Research programs from the CGIAR, the GRA, and key partners such as the FAO are focused on capability building opportunities for farmers. For example, the CGIAR Livestock Research Program provides research based solutions for small-scale enterprises to become more productive in a sustainable manner. Also, it will "improve local and global food and nutritional security and reduce poverty among poor households who keep livestock or contribute to livestock commodity systems" (Randolph 2017). This group has the same basic principle of the GRA Livestock Research Group which has "the dual purpose of reducing emissions intensity of food production while also supporting and enhancing food security" (Clark 2016). The premise is that "as animals increase their productivity, their emissions intensity decreases because less of the energy they consume is used for body maintenance and more is used to produce milk and meat" (Clark 2016).

The capability building projects aim to reduce emissions intensity through productivity gains in Latin America, Southeast Asia, and East and West Africa.

Implications of Emissions intensity and Livestock Production

Capacity building is the mechanism used to alter the production systems in many of the worlds developing countries. Some of the pioneer projects on low emissions development are spearheaded by the FAO and funded by the New Zealand Agricultural Greenhouse Gas Research Center and the Climate and Clean Air Coalition. Three of the projects focus on supporting options for low emissions development of the beef cattle sector in Uruguay and the dairy cattle sectors in Bangladesh and Ethiopia. The purpose of the projects is "reducing enteric methane for food security and livelihoods" (FAO & New Zealand Agricultural Greenhouse Gas Research Centre, 2017). These projects along with the great field of research on low emissions development aim to alter the techniques used in livestock farming in developing nations for the sake of food security. Attention is given to:

> Improved practices and technologies such as better pasture management, strategic supplementary feeding, and substitution of high fiber forages, adequate animal health control, and genetic improvement of animals are some techniques that can improve livestock productivity and reduce emissions intensity (FAO & New Zealand Agricultural Greenhouse Gas Research Centre, 2017).

This research is intended to address food demand and the unique circumstances of developing countries by encouraging the production systems of developed countries (Steinfeld 2010; Andeweg 2013). These include improvements in: feed and nutrition, genetics and breeding, rumen modification, animal health, and manure management

(Andeweg 2013). Several of the publications of reducing emissions intensity from livestock production focus predominately on these broad categories. The options to reduce intensity narrowly focus on on-farm mitigation tactics as a realistic approach. In the publications from the GRA, NZAGRC, and FAO all share similar methods to address ways to improve efficiency in livestock production. The main focus is on-farm mitigation however, this lens of analysis excludes many of the other aspects that emit GHG. GHG is emitted from ever level of the supply chain in the production of livestock. This includes energy use, transportation, feed production and processing, food waste, and consumption patterns (Andeweg 2013). These factors are briefly acknowledged in emissions intensity research but excluded from the specific metric of emissions intensity. However, I argue that these other aspects of the supply chain cannot be negated in emissions intensity research.

Emissions intensity research focuses heavily on reducing emissions from feed digestibility. However, without a more holistic approach, regulating feed supplements, substitutions, and improving diet quality all neglect the emissions emitted from the larger picture (FAO 2017). The logic here is that improving feed digestibility will reduce the concentration of natural methane from an animal's digestive track. This is an important aspect but it ignores the fact that not all livestock around the world is reared on grains and the same type of feed. Feeds have drastic variations in composition. Different farming systems such as pastoral, intercropping, or intensive all use feed quality on a ranging scale. For example, poor quality feed includes dry fodder, straw, and crop residue as opposed to better feed quality such as millet, sorghum, soya, and corn/maize (Andeweg 2013). More industrialized systems of farming are known to have higher feed

efficiencies based on precision and the grains used for animal feed. The on-farm emissions in such systems are lower, but the indirect off farm emissions must take into account the increased concentration of emissions generated to product this higher quality feed. The indirect off farm emissions have the potential to drastically increase emissions. The off-farm emissions include: "deforestation for grazing land and soya-feed production, soil carbon loss in grazing lands, the energy used in growing feed-grains and in processing and transporting feed-grains and in processing and transporting grains and meat, nitrous oxide released from the use of nitrogenous fertilisers and gases from animal manure" (McMichael 2007).

The FAO publication *Tackling Climate Change Through Livestock* highlights that emissions reductions can be accomplished in all species, systems, and regions. The text assures that there is mitigation potential within existing systems through improved practices rather than changing production systems (i.e. shifting from grazing to mixed or from backyard to industrial) (Gerber 2013). However, it is controversial that the proposed methods and focus on emissions intensity metrics will make necessary reductions in emissions while not corralling developing countries to shift systems of productions. There is no pushback for making livestock more productive or efficient. Given the choice improvements in efficiency is a good thing, however altering productivity does not occur in isolation. Improvement in efficiently correspond to changes in farming and production practice and systems.

Low emissions development from livestock is significant in the face of rapid population growth and expanding dietary demands. With the growing global demand for animal based foods it is imperative to reduce as much extra greenhouse gas emissions

production as possible. There are some aspects of emissions intensity research can be implemented to stimulate progress in global livestock production. However, the many of the unacknowledged implications that can occur if the world transition to emissions intensity metrics. These implications impact and reflect the common but differentiated circumstances of livestock production in developing and developed nations.

Emissions intensity research is presented to be a mitigation solution that addresses the global demand for meat and dairy products. Much of the attention is tailored to developing nations. However, the problem is not necessarily the increasing demand in developing nations but rather the current and growing demands of industrialized economies. In common discourse, developed nations get a pass because they are already the forerunners in low intensity development. They are the ones who are leading the research and innovate strategies which are later implemented in developing nations. A cow in the United States, for example, is deemed more efficient than a cow in Uganda because in the US a cow produces less emissions per kg of meat, liter of milk or unit of protein (Grabbing the Bull 2017). However, the cow in the US consumes more feed usually grains, produced more manure, and is processed and transported to farther distances. Using emissions intensity as an international standard will always place developing countries behind because developed countries already utilize what is considered the most efficient means of production. The very nature of small-holder farming systems is less efficient than large scale production operations measured on a per unit basis. Thus:

> Measured this way, animal that are intensively raised for maximum output of meat and milk—by a few million farmers mostly in the US, Europe, Brazil, New

Zealand, and a few other rich countries—have lower 'emissions intensity' than the animals of poor farmers, which are raised for many more uses and without access to the high protein feed, antibiotics, growth promoters and hormones used by intensive livestock industries. Poor farmers are thus said to suffer from an 'emissions intensity gap' and should be pushed into what is termed 'sustainable intensification' or, more broadly, 'climate smart agriculture' (Grabbing the Bull 2017).

The most drastic improvements in emissions intensity occur in the developing world because of the current low ranking in efficiency.

Figure 1. Relationship between total greenhouse gas emissions and output per cow

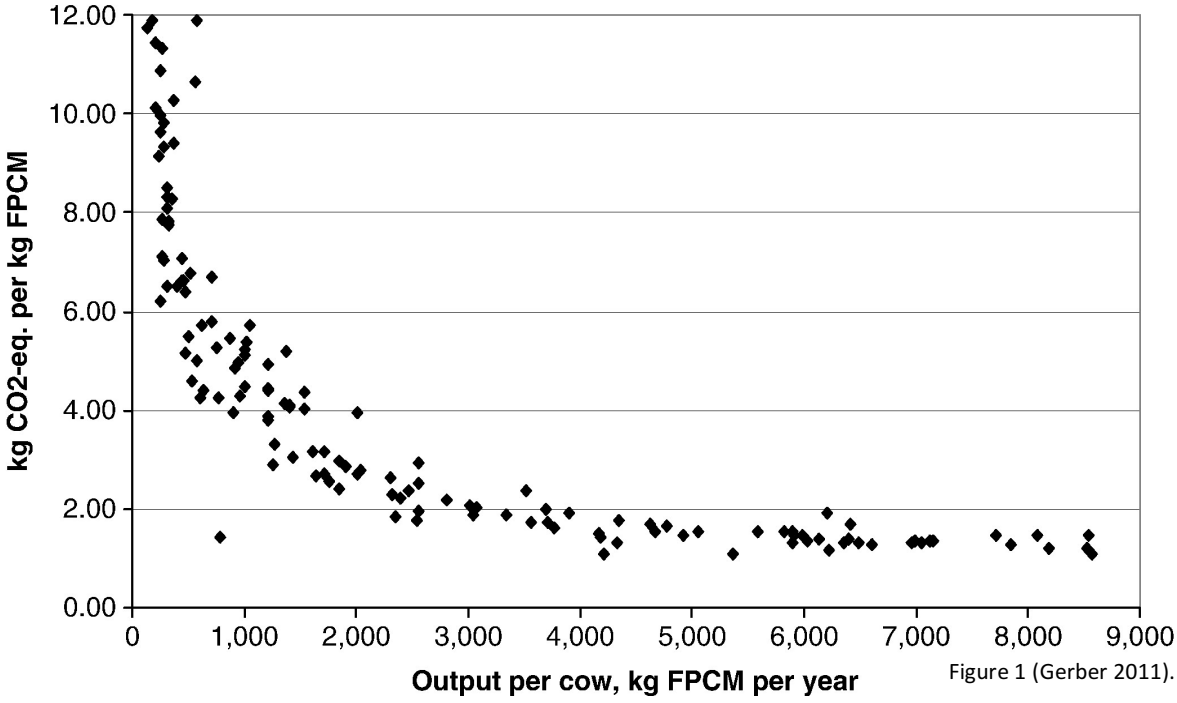

Figure 1 (Gerber 2011).

Figure 1 illustrates the spectrum of production in terms of emissions intensity. Many of the world's developing countries rank on the left side of the graph. Incremental improvements in production per animal has much more significant changes in

comparison to countries who are already production with high efficiency. The developing world has high absolute emissions but significantly lower emissions intensity in comparison to the developing world. Many countries in the developing countries on average have high emissions intensities due to low productivity and large numbers of animals particularly in parts of Africa and Latin America (Herrero 2016). Therefore emissions intensity, if implemented, should only be used in regards to tracking process in the developing countries. The developed world rather must be held accountable for reducing their overall emissions rather than highlighting progress in intensity metrics. Research is mainly focused on livestock production in the developing world because the slightest of changes can improved emissions intensity at a greater rate but will be encouraging industrial systems of production.

Global Trends

Currently, the biggest meat and dairy consuming countries are China, India, the European Union, the United States and Brazil (Bailey 2014). The largest consumers of meat worldwide consume unsustainable quantities ranging between 90- 125 kg per person annually compared to the world aggregate of 43 kg per person (Grabbing the Bull 2017; Weis 2013; Eisler 2014). The cited countries are already considered to be producing with low emissions intensity based on the quantity of emissions per meat, milk, or protein.

Consumption levels of meat and dairy are higher in the developed world. The concern is that as dietary preferences shift with increasing incomes, developing countries will exceed developed countries consumption rates. However, even with this level of growth, the consumption of meat and milk per capita in 2050 in the developing world

will still be less than half that in the developed world (Herrero 2009). It is important to focus on mitigation strategies that allow for developing countries to produce the livestock necessary to attend to the needs and economic growth of the given country. But, the developing world should not be the recognized as the prominent location for future livestock mitigation. Small and medium livestock production systems contribute less absolute emissions than to large scale production systems. Developed nations must find other ways to reduce emissions intensity. Focusing on intensity allows for the justification of a capitalistic and profit driven industry that leads to excessive consumption of animal-based foods. The ARC2020 argues that "governments are rapidly embracing the key notion behind this alliance: how to continue our current economic model of production while producing less emissions. This means extracting even more meat and milk from animals than we currently do in the extremely extractive and debilitating industrial animal production model" (Sharma 2016). The premise of emissions intensity begins with the notion that demand must be met. With this as the logic, all strategies revolve around increasing production rather than systematic and structure modifications to reduce demand and production. Industrialized nations must address agriculture related mitigation solutions along the lines of absolute emission reductions. Drastic improvements in emissions intensity will fail if excessive consumption does not diminish.

Food Security

A key rational for emissions intensity is that it is a viable mechanism for feeding the world's growing population. Many of the research centers and programs target the objective to tackle poverty and food security. I spoke to an adamant activist in one of my

interviews who disagreed with the narrative that emissions intensity research is important in the face of food security. She acknowledged that intensive livestock production is dictated by profit and not concerned about feeding the world. This is because if nations are truly concerned with feeding the growing population, it would not be looking in the direction of animal production. Animal-based foods are a high protein source. However, they are not the only acceptable means of constructing nutrient rich diets to address hunger. Furthermore, "given that the resource-use efficiency of livestock production is low in comparison with crops, and that about a third of the world's cereal production is fed to animals, reducing consumption of livestock products in some places could greatly reduce the need for more food" (Herrero 2016). The perspective of food security tackles the problem from a completely different angle. (FAO & New Zealand Agricultural Greenhouse Gas Research Centre 2017). Food security is an important issue to tackle, but switching to emissions intensity is not being out in place in the name of food security.

Significance

Emissions intensity is emerging in international discourse, but why is this so important to analyze? The simple answer is because this transition impacts the further of climate change and the future of livestock production. For developing countries, it allows for small-holder farmers to continue producing the livestock that is essential to their livelihoods. It is also a way for developing nations to engage in discourse around one aspect of emissions in the face of rapidly growing populations with changing dietary needs. However, transitioning to more efficient production from various government funded research inherently shifts systems of production. This shift moves toward more technologically based industrial means of production.

On the other hand, for developed countries, making emissions intensity a global standard justifies the mass industrial production and overconsumption of animal-based products. These countries are able to manipulate the political language to continue the current economic processes. Developing countries have the means to reduce animal production. There is a surplus of grain feed and trends of overconsumption of livestock which is not supporting food security or the livelihoods of small scale farmers. It is branded as a win-win approach, but while it may be a win for the livestock sector, it is not a winning scenario for climate change. The evolution of emissions intensity instead can lead to the exact opposite through a process known as the rebound effect. The rebound effect may be the number one concern illustrating the downfall of this metric.

This effect reflects the interactions of a normal economic supply and demand curve. The rebound effect occurs when industrial production alters the prices for goods and changes the demand. It is further defined "whereby increased productivity drives down prices and increases demand for meat and dairy, potentially reducing the extent of emissions savings" (Bailey 2014). Therefore, increasing efficiency will actually increase the access and quantity of livestock produced. Instead of reducing emissions, it will in turn greatly increase global emissions generated by this sector. In this sense emissions intensity will fail as a mitigation strategy. Moreover, "we need to find strategies to reduce the demand of livestock products in the developed world, while on the other we need to sustainably intensify to meet demand in the developing world" (Herrero 2009).

In sum, emissions intensity is not substantial alone. Depending on a particular countries political economy, it must be analyzed in tandem with other strategies that address both supply and demand. The global acceptance of emissions intensity allows for

the justification of excessive livestock production and continued abundance of greenhouse gas emissions. Emissions intensity reflects changes in the market and economic fluctuations more so than advances in climate science. Governments must intervene with incentives and policies that also manage absolute emissions simultaneously with reductions in intensity. Emissions intensity is only a mitigation solution if farmers reduce intensity while maintaining or reducing herd sizes. This step of the process is not globally being implemented or discussed. Intensity reductions may be the first step in talking about emissions but must follow with systematic changes by government intervention. The next and most important phases is not yet acknowledged in the changing international discourse.

Chapter 5: Conclusion

There is a problem. The climate is changing drastically. The composition of the Earth is changing due to the increasing concentration of greenhouse gas in the atmosphere. Human activity is driving the surge in carbon dioxide, methane, and nitrous oxide. The livestock sector is the number one culprit as it contributes 18% of total greenhouse gas emissions. At the same time, human diets around the world are in the midst of a great transformation (Weis 2013). The mass production and consumption of animal products are at the heart of this transition. It is noted that "the average person today eats almost twice as much meat as did the average person only two generations ago, along with more eggs, in a world with twice as many people now as then" (Weis 2013). The trend will continue as global production of meat is projected to double by 2050 from 229 million tons in 1999 to 465 million tons and from 580 million tons to 1,043 million tons in terms of dairy (Steinfeld 2009). The main solution to emerge as the means to deal with this problem has been to improve the emissions intensity of livestock production.

Emissions intensity is now a common and accepted metric used to measure emissions from livestock production. Emissions intensity is calculated through a ratio comparing emissions per unit of output. In the framework of this thesis, the output is per unit of animal product for example per unit of meat or per unit of milk. Research on emissions intensity focuses on altering the technology and on farm practices in given production systems, regions, and climates that allow for potential mitigation options (Gerber 2013). This research on emissions intensity is significant because it allows for increased production and efficiency while simultaneously reducing one aspect of

greenhouse gas emissions. As the demand and production of animal products increases, it will be important to produce animals in a way that limits as much extra greenhouse gas emissions as possible.

Prior to discourse on emissions intensity, there was minimal talk about emissions and livestock production. This created a dichotomy in response to climate change. Countries such as the United States, New Zealand, Australia, and Brazil are the top meat and dairy exporting countries where larger farms dominate production (Herrero 2017). These affluent regions are also the highest consumers of animal products worldwide. For example, the countries mentioned above consume an estimated 90 kg of meat per person per year ("Grabbing the Bull" 2017). These countries are noted to have low emission intensities but a high volume of production (Gerber 2013). The major countries exporting and consuming substantial quantities of animal products are those pioneering the push toward emissions intensity. These countries are the major funders of the institutions like the GRA pushing for the discourse on emissions intensity. These countries are already leading the process of lower intensity while maintain and increasing production and profit. It is in the best interest of these countries to further advance the usage of emissions intensity in international discourse.

Emissions intensity is becoming more of an accepted metric because it allows for production to continue and seems like a viable approach to address demand. Emissions intensity emerged from a productivist ideology which was "evident in the benefit derived by capitalist interest from the global food trade and by developed world governments" (Rosin 2013). However, rather than acknowledging this fact in the scientific literature,

emissions intensity is framed as a way to feed the world, address food security, and combat climate change.

Emissions intensity research concentrates on the livestock sector in the developing world. As income and wealth increases in the developing world, the concern is that emission will skyrocket. The ability to reduce herd sizes or prevent these countries from consuming more animal products is less favorable for many reasons. One of which is that the livestock sector "employs 1.3 billion people and created livelihoods for one billion of the world's poor. Livestock products provide one-third of humanity's protein intake…and a potential for undernourishment" (Steinfeld 2009). Many of the low emissions development programs and capacity building from the FAO and the GRA target developing nations. The usage is emissions intensity generates two main scenarios. First, it puts all the onus on the developing world to change. I do want to acknowledge that improving emissions intensity can be beneficial by making some production systems more efficient. However, these sorts of benefits reproduce the larger systematic problem of striving to produce cheap meat, driving more consumption, and growing emissions. The benefits result in bypassing of the bigger issues at play. This places the obligation on developing countries to change their ways when they are not the ones responsible for creating the problem. A global transition focusing on emissions intensity keeps this game going.

Emissions intensity is not a mitigation strategy in isolation. In order to address climate change and work toward keeping temperature from rising 2°C, emission intensities will need to be reduced in relation to absolute emissions. The intention of emissions intensity is not to diminish overall greenhouse gas emissions. As farmers

become more efficient and productive, there is nothing stopping them from continuing to increase the number of animals. If farms have lower intensities, but increase herd sizes, their absolute emissions will continue to grow and emit even more emissions than before. As improvements are made in the efficiency of meat and dairy products, the price of these commodities also decreases. This means more people can afford to buy and consume larger quantities of animal products. This creates a vicious cycle whereby more meat and dairy is being consumed because it is cheap and efficient to product.

Emissions intensity reductions may be a first step but cannot be acknowledged as a mitigation strategy without discussing absolute emissions. Developed countries who already have low intensities must move toward reducing absolute emissions. These countries should be held responsible for address absolute emissions because the diversity of their economies and ability to make such shifts as opposed to developing countries. Countries around the world have differentiated scenarios and therefore should not be placed under an umbrella of the same mitigation strategies. In a developing country, even the smallest incremental changes in intensity can result in large emissions reduction for future production (Gerber 2013).

One approach is to couple emissions intensity research with policy and government subsidies to drive producers to reduce intensity without increasing herd sizes. These subsides are not the same ones that prop up industrial meat production. Rather, these government policies must be framed to encourage farmers to produce a baseline quantity of animal product. With the extra land not used for livestock production, farmers are subsidized to designate the land they are not using toward reforesting or carbon sequestration. The goal of these policies is to create emission offsets in hopes of reaching

zero-emission production. This usage of emissions intensity research is effective in the response to climate change because it responds to emissions intensity and absolute emissions in tandem. Emissions intensity is not a mitigation strategy if it does not acknowledge the need for absolute emission reductions.

So what's at steak? Climate change is altering the composition of our planet. We are throwing off Earth's equilibrium. Greenhouse gas emissions are not visible, but the ramifications of their presence in the atmosphere are become more apparent every day. The temperature is rising, droughts and heatwaves are becoming more frequent, natural disasters are more devastating, and sea are rising and become more acidic. Those who currently contribute the least to the problem are the ones who will experience the worst of its consequences.

The purpose of this thesis is to answer the question what lead to the global convergence of emissions intensity as common metric to measure livestock emissions? And what are the implications on global livestock production? I conducted a discourse analysis on the term emissions intensity to track its emergence and further development as a common metric to measure emissions related to livestock production. Using a discourse analysis approach, I was able to explore the main actors involved and how they are actively working to change the ways emissions are measured to continue the status quo and continued mass production of livestock. The narrative to address livestock and climate change is transitioning toward emissions intensity. This shift is complex and if not analyzed in its entirety, will continue to exacerbated the ramification of climate change. Emissions intensity should be considered a point of entry. It allows governments to talk about livestock production and climate change. However, emissions intensity

research must work in conjunction with policies and subsides that incentives reductions in absolute emissions.

To address climate change, we must address the main actors: cows, chickens, and pigs, and those who justify their mass production and consumption.

References

About IATP. (n.d.). *Institute for Agriculture & Trade Policy.* Retrived from https://www.iatp.org/about

About Us. (2015). *The Global Research Alliance.* Retrieved from https://globalresearchalliance.org/about/

Activity Report. (2016). *GRAIN.* Retrieved from https://www.grain.org/article/entries/5681-grain-in-2016-highlights-of-our-activities

Agricultural Greenhouse Gases & the New Zealand Beef & Sheep Sectors. *New Zealand Agricultural Greenhouse Gas Research Centre*. Retrieved from http://www.nzagrc.org.nz/beef-sheep-sector.html

Agricultural greenhouse gases & the New Zealand dairy sector (n.d.). New Zealand Agricultural Greenhouse Gas Research Centre. Retrieved from http://www.nzagrc.org.nz/dairy-sector.html

Alexandratos, N., Bruinsma J. (2012). World Agriculture Towards 2030/2050. *Food and Agriculture Organization.* Retrieved from http://www.fao.org/fileadmin/templates/esa/Global_persepctives/world_ag_2030_50_2012_rev.pdf

Aiking, H. (2011). Future protein supply. *Trends in Food Science & Technology*, *22*(2), 112-120.

Andeweg, K., Reisinger, A. (2013). Reducing Emissions Greenhouse Gas Emissions from Livestock: Best Practices and Emerging Options. *Sustainable Agriculture Initiative and Global Research Alliance. Retrieved from* http://www.saiplatform.org/uploads/Modules/Library/lrg-sai-livestock-mitigation_web2.pdf

Australian Agriculture: Reducing Emissions and Adapting to a Changing Climate. (2013). *Government of Australia Department of Agriculture.* Retrieved from http://www.agriculture.gov.au/Style%20Library/Images/DAFF/__data/assets/pdffile/0006/2359815/reducing-emissons-adapting-changing-climate.pdf

Bailey, R., Froggatt, A., & Wellesley, L. (2014). Livestock–climate change's forgotten sector. *Chatham House*.

Bäckstrand, K., & Lövbrand, E. (2007). Climate governance beyond 2012: competing discourses of green governmentality, ecological modernization and civic environmentalism. *The social construction of climate change: Power, knowledge, norms, discourses*, 123-147.

Banuri, T., Barker, T., Bashmakov, I., Blok, K., Bouille, D., Christ, R., Davidson, O.,

Edmonds, J. (2001). Climate Change 2001: Mitigation. *Intergovernmental Panel on Climate Change.* Retrieved from http://ipcc.ch/ipccreports/tar/wg3/pdf/WGIII_TAR_full_report.pdf

Baumert, K. A., Herzog, T., & Pershing, J. (2005). Navigating the Numbers Greenhouse Gas Data and International Climate Policy. 25-29. Retrieved August 2, 2017, from http://pdf.wri.org/navigating_numbers_chapter5.pdf

Billig, M. (1990). Rhetoric of social psychology. *Deconstructing social psychology*, 47-60.

Biogas Opportunities Roadmap. (2014). *U.S. Department of Agriculture, U.S. Environmental Protection Agency, U.S. Department of Energy.* Retrieved from https://www.usda.gov/oce/reports/energy/Biogas_Opportunities_Roadmap_8-1-14.pdf

Bulkeley, H. (2000). Discourse coalitions and the Australian climate change policy network. *Environment and Planning C: Government and Policy*, *18*(6), 727-748.

Brough, A., Bruce, J. (1989). Memorandum of Understanding Between the United Nations Programme (UNEP) and the World Meteorological Organization (WMO) on the Intergovernmental Panel on Climate Change (IPCC). *Intergovernmental Panel on Climate Change.* Retrieved from https://www.ipcc.ch/docs/MOU_between_UNEP_and_WMO_on_IPCC-1989.pdf

Charter of the CGIAR System Organization (2016). *The Consultative Group on International Agricultural Research.* Retrieved from https://cgspace.cgiar.org/bitstream/handle/10947/4370/Charter%20CGIAR%20Organization.pdf?sequence=4

Clark, H.,Reisinger, A., Scholten, M., van der Mheen, H. (2016). Livestock Research Group Newsletter. *Global Research Alliance.* Retrieved from https://globalresearchalliance.org/wpcontent/uploads/2016/01/2015_12_Dec_Newsletter.pdf

Climate Change Research Program (2015). Australian Government Department of Agriculture and Water Resources. Retrieved from http://www.agriculture.gov.au/ag-farm-food/climatechange/australias-farming-future/climate-change-and-productivity-research

Conference of Parties Twenty Second Session. (2016). Aggregate Effect of the Intended Nationally Determined Contributions: an update. *United Nations Framework Convention on Climate Change.* Retrieved from

http://unfccc.int/resource/docs/2016/cop22/eng/02.pdf

Cryan, R. (2004). The Economic Impact of the Dairy Industry. *U.S. Dairy Economics. Retrieved from* http://future.aae.wisc.edu/publications/US_Outlook_May_2004.pdf

Dickson, J., Donnelly, D., Mercer, R., Wu, E. (2009). Australia's Farming Future Final Marker Research Report. *Australian Department of Agriculture.* Retrieved from http://www.agriculture.gov.au/SiteCollectionDocuments/climatechange/australias-farming-future/aus-farming-future-mrr.pdf

Dutch Contribution to the Global Research Alliance on Agricultural Greenhouse Gases in the period 2016-2019. (n.d.). *The Global Research Alliance and Netherlands Ministry of Economic Affairs.* Retrieved from https://globalresearchalliance.org/wp-content/uploads/2015/07/LR_87322_Factsheet-GRA-16-19-ENG.pdf

Dryzek, J. S. (2013). *The politics of the earth: Environmental discourses*. Oxford university press.

FAO & New Zealand Agricultural Greenhouse Gas Research Centre. 2017. *Supporting low emissions development in the Ethiopian dairy cattle sector – reducing enteric methane for food security and livelihoods*. Rome. 34 pp.

FAO & New Zealand Agricultural Greenhouse Gas Research Centre. 2017. *Low emissions development of the beef cattle sector in Uruguay – reducing enteric methane for food security and livelihoods*. Rome. 34 pp.

FAO & New Zealand Agricultural Greenhouse Gas Research Centre. 2017. *Options for low emission development in the Bangladesh dairy sector – reducing enteric methane for food security and livelihoods*. Rome. 34 pp.

Gerber, P., Vellinga, T., Opio, C., & Steinfeld, H. (2011). Productivity gains and greenhouse gas emissions intensity in dairy systems. *Livestock Science*, *139*(1), 100-108.

Greenhouse Gas Inventories for Livestock. (2017). *Global Research Alliance.* Retrieved from https://globalresearchalliance.org/?s=GREENHOUSE%20GAS%20INVENTORIES%20FOR%20LIVESTOCK

Gerber, P.J., Steinfeld, H., Henderson, B., Mottet, A., Opio, C., Dijkman, J., Falcucci, A.

& Tempio, G. 2013. *Tackling climate change through livestock – A global assessment of emissions and mitigation opportunities.* Food and Agriculture Organization of the United Nations (FAO), Rome.

Global Partnerships in Livestock Emissions Research (2017). *Ministry for Primary Industries New Zealand.* Retrieved from http://www.mpi.govt.nz/funding-and-programmes/farming/global-partnerships-in-livestock-emissions-research/

Goodland, R., Anhang, J. (2009). Livestock and Climate Change What if the key actors in climate change are cows, pigs, and chickens? *World Watch Institute.* Retrieved from https://www.worldwatch.org/files/pdf/Livestock%20and%20Climate%20Change.pdf

Hajer, M. A. (1995). *The politics of environmental discourse: ecological modernization and the policy process* (p. 40). Oxford: Clarendon Press.

Hajer, M., & Versteeg, W. (2005). A decade of discourse analysis of environmental politics: achievements, challenges, perspectives. *Journal of environmental policy & planning*, *7*(3), 175-184.

Herrero, M., Henderson, B., Havlík, P., Thornton, P. K., Conant, R. T., Smith, P., ... & Butterbach-Bahl, K. (2016). Greenhouse gas mitigation potentials in the livestock sector. *Nature Climate Change*.

Herrero, M., Thornton, P. K., Gerber, P., & Reid, R. S. (2009). Livestock, livelihoods and the environment: understanding the trade-offs. *Current Opinion in Environmental Sustainability*, *1*(2), 111-120.

Herrero, M., Thornton, P. K., Notenbaert, A. M., Wood, S., Msangi, S., Freeman, H. A., ... & Lynam, J. (2010). Smart investments in sustainable food production: revisiting mixed crop-livestock systems. *Science*, *327*(5967), 822-825.

Herrero M, Havlík P, Valin H, Notenbaert A, Rufino MC, Thornton PK, Blümmel M, Weiss F, Grace D, Obersteiner M. (2013). Biomass use, production, feed efficiencies, and greenhouse gas emissions from global livestock systems. *PNAS* 110 (52): 20888-20893

Herrero, M., Thornton, P. K., Power, B., Bogard, J. R., Remans, R., Fritz, S., ... & Watson, R. A. (2017). Farming and the geography of nutrient production for human use: a transdisciplinary analysis. *The Lancet Planetary Health*, *1*(1), e33-e42.

Hopwood, N., & Cohen, J. (2008). Greenhouse gases and society. *Retrieved April*, *8*, 2008.

Hytten, K. (2013). The Social Construction of Climate Change: Desconstructing the Climate Change Debate in Australia. *Griffith University.* Retrieved from https://www120.secure.griffith.edu.au/rch/file/85769a2d-d5fc-46e0-a977-547e8177520c/1/Hytten_2013_02Thesis.pdf

Houghton, J. T. (Ed.). (1996). *Climate change 1995: The science of climate change: contribution of working group I to the second assessment report of the Intergovernmental Panel on Climate Change* (Vol. 2). Cambridge University Press.

International Energy Agency (2016). *Energy Efficiency Market Report.* IEA. Retrieved from https://www.iea.org/eemr16/files/medium-term-energy-efficiency-2016_WEB.PDF

IPCC First Assessment Report. (1990). *Intergovernmental Panel on Climate Change.* Working Group III: The IPCC Response Strategies.

IPCC 2014 Climate Change 2014: The Physical Science Basis. Contribution of Working Group I to the 5th Assessment Report of the IPCC Retrieved from www.ipcc.ch/report/ar5/

IPCC, 2014: *Climate Change 2014: Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* [Edenhofer, O., R. Pichs-Madruga, Y. Sokona, E. Farahani, S. Kadner, K. Seyboth, A. Adler, I. Baum, S. Brunner, P. Eickemeier, B. Kriemann, J. Savolainen, S. Schlömer, C. von Stechow, T. Zwickel and J.C. Minx (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

IPCC, 2013: *Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovern- mental Panel on Climate Change* [Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 1535 pp.

Jørgensen, M. W., & Phillips, L. J. (2002). *Discourse analysis as theory and method*. Sage.

Kenis, P., & Schneider, V. (1991). Policy networks and policy analysis: scrutinizing a new analytical toolbox. *Policy networks: Empirical evidence and theoretical considerations*, 25-59.

Lee-Jones, D. (2015). New Zealand Climate and Greenhouse Gas Emissions Policy.

United States Department of Agriculture Foreign Agricultural Services. Retrieved from https://gain.fas.usda.gov/Recent%20GAIN%20Publications/New%20Zealand%20Climate%20and%20Greenhouse%20Gas%20Emissions%20Policy_Wellington_New%20Zealand_7-6-2015.pdf

Lemmen, I., Mheen, H. (2015). Global Research Alliance on Agricultural Greenhouse Gases in the Netherlands. *The Global Research Alliance.* Retrieved from https://globalresearchalliance.org/wp-content/uploads/2015/07/GRA-reporting-2015.pdf

Levin, K., Rich, D., Bonduki, Y., Comstock, M., Tirpak, D., McGray, H., Noble I., Mogelgaard, K. Waskow, D. (2015). Designing and Preparing Intended Nationally Determined Contributor (INDCs). *World Resources Institute & United Nations Development Program.* Retrieved from https://www.wri.org/sites/default/files/designing-preparing-indcs-report.pdf

Litfin, K. (1994). *Ozone discourses: science and politics in global environmental cooperation*. Columbia University Press.

Liu, N., & Ang, B. W. (2007). Factors shaping aggregate energy intensity trend for industry: Energy intensity versus product mix. *Energy Economics*, *29*(4), 609-635.

Livestock Farming. (n.d.) *Government of the Netherlands.* Retrieved from https://www.government.nl/topics/livestock-farming

Lindseth, G. (2006). Political Discourse and Climate Change: The Challenge of Reconciling Scale of Impact with Level of Governance.

Lovell, H. (2008). Discourse and innovation journeys: the case of low energy housing in the UK. *Technology Analysis & Strategic Management*, *20*(5), 613-632.

Lovell, H., Bulkeley, H., & Owens, S. (2009). Converging agendas? Energy and climate change policies in the UK. *Environment and Planning C: Government and Policy*, *27*(1), 90-109.

Low Emissions Livestock Development (n.d.). *The Global Research Alliance.* Retrieved from https://globalresearchalliance.org/research/livestock/capability-building/low-emission-pathways-for-livestock-development/

Marsh, D., & Smith, M. (2000). Understanding policy networks: towards a dialectical approach. *Political studies*, *48*(1), 4-21.

McMichael, A. J., Powles, J. W., Butler, C. D., & Uauy, R. (2007). Food, livestock

production, energy, climate change, and health. *The lancet*, *370*(9594), 1253-1263.

Meat, Wool and Dairy. (2017). *Australian Government Department of Agriculture and Water Resources.* Retrieved from http://www.agriculture.gov.au/ag-farm-food/meat-wool-dairy

Nakicenovic, N., Swart, R. (2000). Special Report on Emissions Scenarios. *Intergovernmental Panel on Cliamte Change Working Group III.* Retrieved from http://www.ipcc.ch/ipccreports/sres/emission/emissions_scenarios.pdf

NASA (2017). Global Climate Change Causes. Retrieved October 19, 2017 from https://climate.nasa.gov/causes/

Notenbaert, A., Smith, J., Herrero, M., Ballantyne, P., Tarawali, S., Staal, T., Randolph, T. (2013). Livestock research for food security and poverty reduction: ILRI strategy 2013–2022. *International Livestock Research Institute.* Retrieved from https://cgspace.cgiar.org/bitstream/handle/10568/27796/ilristrategy2013_.%20%20complete.pdf?sequence=4&isAllowed=y

New Zealand's Greenhouse Gas Inventory (2017). *Ministry for the Environment New Zealand.* Retrieved from http://www.mfe.govt.nz/climate-change/state-of-our-atmosphere-and-climate/new-zealands-greenhouse-gas-inventory

The New Zealand Fund for Global Partnerships in Livestock Emissions Research (2011). *The Global Research Alliance.* Retrieved from https://globalresearchalliance.org/n/the-new-zealand-fund-for-global-partnerships-in-livestock-emissions-research/

New Zealand Agricultural Greenhouse Gas Research Centre (2017). *Ministry for Primary Industries New Zealand*. Retrieved from http://www.mpi.govt.nz/funding-and-programmes/farming/new-zealand-agricultural-greenhouse-gas-research-centre/

New Zealand (n.d.) *The Global Research Alliance.* Retrieved from https://globalresearchalliance.org/country/new-zealand/

Opio, C., Gerber, P., Mottet, A., Falcucci, A., Tempio, G., MacLeod, M., Vellinga, T., Henderson, B. & Steinfeld, H. 2013. *Greenhouse gas emissions from ruminant supply chains – A global life cycle assessment.* Food and Agriculture Organization of the United Nations (FAO), Rome.

Overview of Greenhouse Gases. (2017). *United States Environmental Protection Agency.* Retrieved from https://www.epa.gov/ghgemissions/overview-greenhouse-gases

Paris Agreement- Status of Ratification. (2017). *United Nations Framework Conventions on Climate Change.* Retrieved from http://unfccc.int/paris_agreement/items/9444.php

Peterson, J. (2003). 'Policy Networks'. *Institutional Repository at HIS Vienna.*

Randolph, T. (2017). *CGIAR Research Program on Livestock 2017-2022.* Consultative Group on International Agricultural Research. Retrieved from http://www.cgiar.org/about-us/our-programs/cgiar-research-program-on-livestock-2017-2022/

Reducing Enteric Methane for Improving Food Security and Livelihoods (n.d.). *Food and Agriculture Organization of the United Nations.* Retrieved from http://www.fao.org/in-action/enteric-methane/en/

Reducing the Intensity of Enteric Methane Emissions from the US Dairy Herd. (2017). *The Global Research Alliance.* Retrieved from https://globalresearchalliance.org/wp-content/uploads/2017/05/USA-Dairy-CH4_LRG-case-study.pdf

Review of the Carbon Farming Initiative Legislation and the Emissions Reduction Fund. (n.d.). *Australian Government Climate Change Authority.* Retrieved from http://climatechangeauthority.gov.au/sites/prod.climatechangeauthority.gov.au/files/files/CFI%202017%20August/Fact%20Sheet.pdf

Rosin, C. (2013). Food security and the justification of productivism in New Zealand. *Journal of Rural Studies*, *29*, 50-58.

Rydin, Y. (1999). Can we talk ourselves into sustainability? The role of discourse in the environmental policy process. *Environmental Values*, 467-484.

Schils, R. L. M., Verhagen, A., Aarts, H. F. M., & Šebek, L. B. J. (2005). A farm level approach to define successful mitigation strategies for GHG emissions from ruminant livestock systems. *Nutrient cycling in agroecosystems*, *71*(2), 163-175.

Scrase, J. I., & Ockwell, D. G. (2010). The role of discourse and linguistic framing effects in sustaining high carbon energy policy—An accessible introduction. *Energy Policy*, *38*(5), 2225-2233.

Sharma, S. (2016). Climate, Livesotck, Carbon & the Lobby #LivestockDebate. *Institute for Agriculture & Trade Policy.* Retrieved from https://www.iatp.org/blog/201602/climate-livestock-carbon-the-lobby-livestockdebate

Shuttleworth, K. (2015). New Zealand Sheep Numbers Fall to Their Lowest for 75 Years.

The Guardian. Retrieved from https://www.theguardian.com/world/2015/jan/07/new-zealand-sheep-numbers-fall-to-their-lowest-for-75-years

Silverstein, J. (2017). Animal Production and Protection. *United States Department of Agriculture.* Retrieved from https://www.ars.usda.gov/animal-production-and-protection/

Steinfeld, H., Wassenaar, T., & Jutzi, S. (2006). Livestock production systems in developing countries: status, drivers, trends. *Rev Sci Tech*, *25*(2), 505-516.

Steinfeld, H., Gerber, P., Wassenaar, T., Castel, V., Rosales, M., & de Haan, C. (2006). Livestock's Long Shadow. *Environmental issues and options*.

Szarka, J. (2004). Wind power, discourse coalitions and climate change: breaking the stalemate?. *Environmental Policy and Governance*, *14*(6), 317-330.

The Carbon Cycle: Feature Articles. NASA Earth Observatory. Retrieved October 19, 2017 from https://earthobservatory.nasa.gov/Features/CarbonCycle/page5.php

Thornton, P.K. & Gerber, P.J. Mitig Adapt Strateg Glob Change (2010) 15: 169. https://doi.org/10.1007/s11027-009-9210-9

Tilman, D., Cassman, K. G., Matson, P. A., Naylor, R., & Polasky, S. (2002). Agricultural sustainability and intensive production practices. *Nature, 418*(6898), 671-7. doi:http://dx.doi.org/10.1038/nature01014

Tilman D, Balzer C, Hill J, Befort BL. 2011. Global food demand and the sustainable intensification of agriculture. *PNAS* 108(50):20260–20264. Retrieved from http://www.pnas.org/content/108/50/20260

UNFCCC (1997) Kyoto Protocol to the United Nations Framework Convention on Climate Change adopted at COP3 in Kyoto, Japan, on 11 December 1997.

United Nations Conference on Environment & Development. (1992). *United Nations.* Rio de Janerio, Brazil. Retrieved from https://sustainabledevelopment.un.org/content/documents/Agenda21.pdf

United States Environmental Protection Agency (2017). *Overview of Greenhouse Gases.* Retrieved April 14, 2017 from https://www.epa.gov/ghgemissions/overview-greenhouse-gases

Vilsack, T. (2009). Global Research Alliance Launched at the U.N. Climate Change Conference in Copenhagen. *U.S. Department of Agriculture.* Retrieved from https://www.usda.gov/media/blog/2009/12/16/global-research-alliance-launched-un-climate-change-conference-copenhagen

Weible, C. M., Sabatier, P. A., Jenkins-Smith, H. C., Nohrstedt, D., Henry, A. D., &

DeLeon, P. (2011). A quarter century of the advocacy coalition framework: An introduction to the special issue. *Policy Studies Journal*, *39*(3), 349-360.

Yoder, S. (2016). Energy Intensity of Global Economy Rises, Reversing Longtime Trend. *Worldwatch Institue.* Retrieved from http://www.worldwatch.org/energy-intensity-energy-efficiency-gross-world-product-emerging-economies-infrastructure-development