# THE RUMINANT RATIONALE: GLOBAL RUMINANT EMISSIONS AND THE FUTURE OF AGRICULTURE

SHORT COMMUNICATION

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# THE RUMINANT RATIONALE: GLOBAL RUMINANT EMISSIONS AND THE FUTURE OF AGRICULTURE

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## SUMMARY

The role of domesticated ruminants on a global scale cannot be understated, despite sweeping generalizations that oversimplify complex and intricate cattle and livestock systems existing from local to multi-national levels. Grazing and mixed systems, predominantly in the global south, are a crucial and necessary component of rural socio-economic structures and provide a source of food security and livelihood for small-holder and sustenance farmers. Ruminant production, specifically the emissions associated with dairy and beef cattle production, is a highly polarizing and contentious topic in climate change discourse. Current and potential forthcoming challenges and opportunities will require changes and possible trade-offs, optimizing transition risk to ensure future stability and longevity. Going forward, novel technologies and advancements in animal breeding and animal diet can reduce emissions and contribute to global and national emission reduction targets.

## THE IMPORTANCE OF RUMINANT PRODUCTION IN SMALL HOLDER, GRAZING, AND MIXED SYSTEMS

Although most may only associate ruminants as domesticated cattle selectively bred for dairy and beef production, ruminants represent a much more complex and diverse group. Sheep and goats, small ruminants domesticated before cattle, are more populous than their bovine cousins and support pastoral systems across the globe. Llamas and alpacas, also classified as small ruminants, are concentrated predominately in grasslands and regions of South America and Asia. Bison, buffalo, and yaks are partially domesticated, and are a source of milk, meat and hide, mostly in Central and South Asia. In 2010, the total number of ruminants was estimated to be approximately 3.6 billion worldwide, of which 40 percent were classified as cattle, 55 percent as small ruminants, and five percent as buffalo, bison, and yaks (Hackmann & Spain, 2010). Beyond domesticated species, ruminants include the Cervidae family, encompassing deer, moose, elk, and caribou, which provide ecosystem services to northern populations (Hummel & Ray, 2008).

When you think of a dairy farm or dairy farmer, what image comes to mind? Ruminant operations can differ vastly, from local to regional to global scales, depending on factors such as population, demand, and climate. Modern ruminant production operations, involving herds consisting of over 100 head, may be the default image when considering dairy production. The global reality is much different. The importance of milk producing ruminants in global farm holdings cannot be understated; at least one milk producing ruminant is reported at over a quarter of the 570 million farm holdings worldwide. However, only 0.3 percent of global dairy farm operations have more than one hundred milking cows (FAO, 2016). The dairy industry also plays a principal factor in the representation of women and the impact of gender roles in rural and remote global populations. Small scale livestock ownership, particularly small ruminant dairy production, especially goats, is important to meet household level food security, with opportunity to grow into larger-scale livestock development initiatives and cooperatives through development programs (FAO, 2011). Livestock are an important asset and represent economic and societal empowerment that is easier to access and obtained compared to land, and holds potential for income and economic opportunity, in addition to food security (FAO. "*The role of ruminants in food security and livelihoods | Reducing Enteric Methane for improving food security and livelihoods*"). Ruminants are an established source of income and food security to hundreds of millions of people, especially in lower-middle income countries with high rural economic activities (Sansoucy, 1995). Resolution between rural societal development and environmental resource management is necessary to ensure future sustainability, food security and prosperity.

The role of ruminants, especially in small holder subsistence farming-based systems extends beyond economic contexts and into ecosystem services in the environment. Grazing ruminants represent a unique role in pasture ecosystems, actively participating in the carbon and nitrogen cycle. Appropriately managed pasture-based ruminant production has demonstrated beneficial environmental effects, with potential to stabilize nutrient cycles through carbon sequestration and nitrogen fixation, depending on environmental factors (Teague & Kreuter, 2020). Modern schemes that integrate or combine agricultural production, such as silvopastoral or integrated crop and livestock systems, reduce emissions in ruminant production and strike balance between required inputs and outputs between the different productions (Ministerio do meio ambiente, 2018; Henderson et al., 2020; OECD, 2020). Despite this, emissions from mixed and grazing systems are higher compared to industrialized conventional agricultural operations, linked to decreased forage, decreased feed quality and digestibility, and limited animal production efficiency (OECD, 2021).

## RUMINANT PRODUCTION CHALLENGES AND PROSPECTS

The pressure to reduce greenhouse gas emissions and align with sustainability goals has put immense pressure to swiftly find comprehensive and progressive solutions across sectors. Agriculture, and the impact it has on the environment, is a growing concern. Global food systems contribute an estimated 21 to 37 percent of annual global greenhouse gas emissions (Lynch et al., 2021). Livestock are estimated to use approximately two billion hectares of grasslands globally, although less than half is suitable for crop production (Mottet et al., 2017). Within ruminant production, this is especially highlighted in Central and South America, where feedstuff production is driving swift land change (Aldrich et al., 2020). The Global Livestock Environmental Assessment Model (GLEAM) from the FAO indicates that the livestock sector specifically is a significant contributor to anthropogenic GHG emissions, with cattle contributing more than 60 percent of the sector's emissions (Figure 1) (FAO, 2017).

Figure 1: The Global Livestock Environmental Assessment Model – Cattle

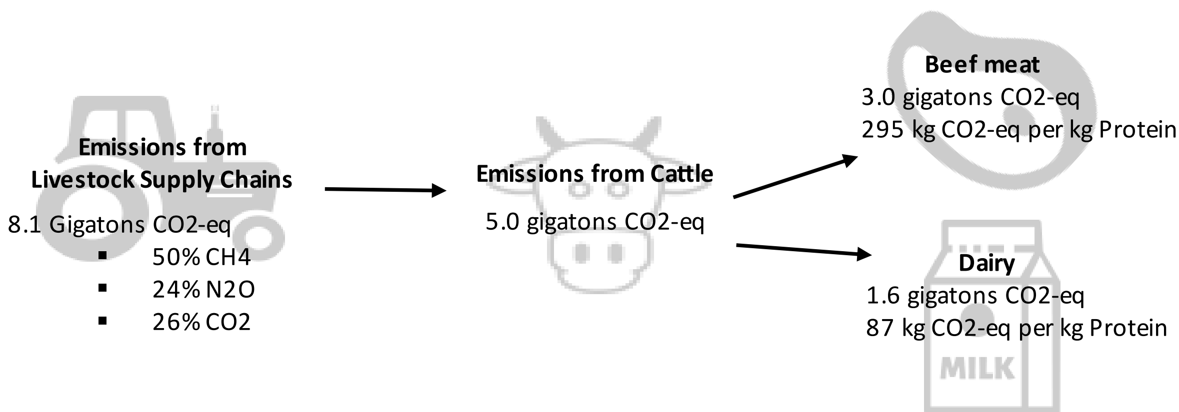


*Figure 1: Adapted from FAO. 2017. Global Livestock Environmental Assessment Model (GLEAM) [online]. Rome. [Cited 18 May 2017]. www.fao.org/gleam/en/*

Land use for ruminant milk, meat, and hide production is a highly complex, contentious, and often overly generalized topic in the court of public opinion (Weishaupt et al., 2020). As a polarizing subject, contending viewpoints and perspectives must be examined critically and without bias, supported with peer-reviewed research and resources, to determine policy implications at local, regional, and global scales, and identify possible tradeoffs in the paths forward.

Ruminants are uniquely capable of converting plant carbohydrates, predominately cellulose, a polysaccharide indigestible by humans found in forages and grasses, into amino acids and protein (Clauss & Hummel, 2017). Ruminants' capacity to convert forages into protein is an area of ruminant nutritional research and production efficiency with immense potential. Beyond forages, increased feed conversion and efficiency in modern ruminant breeds and production systems facilitates potential for future feed systems that incorporate higher percentages of marginal lands, agro-industrial byproducts, crop residues and food processing waste as dietary feed components within rations (FAO. "*The role of ruminants in food security and livelihoods | Reducing Enteric Methane for improving food security and livelihoods*"). In 2010, more than 95 percent of dry matter intake of ruminants was inedible to humans (OECD, 2021). Emission intensity of ruminants has declined in cattle production and are on the precipice of further decline, as innovative technology is introduced to the industry, with short- and long-term impacts. Further focusing research to increase ruminant feed efficiency through breeding and genetic selection, including feed additives and nutritional management, and manipulating the rumen microbiome, will continue to relieve dependence on grains as a component of ruminant diets (Sauvant, 2019). This shift is critical in emission mitigation and reduces contentious and carbon intensive inputs in future production systems.

Despite the crucial role of ruminants in environmental and socio-economic functions, ruminant production is often challenged by consumer perception and opinion. As the agri-food industry and supply chain grapples with growing populations and associated demand for stable and secure food systems while maintaining or shrinking inputs and land use, reducing ruminant populations is a suggested approach, but one that requires careful consideration as a mitigation strategy. Rather, prioritizing changes in cattle management and operation practices in pasture-based systems or incorporating methodology to increase ruminant efficiency through selective breeding and ration formulation should be at the forefront of emission mitigation initiatives, supporting environmental and economic longevity across the globe (Zubieta et al., 2021).

## FEASIBILITY OF NOVEL TECHNOLOGY IN RUMINANT PRODUCTION

The recent review "Methane Emissions from Ruminants in Australia: Mitigation Potential and Applicability of Mitigation Strategies" by Black et al. (2021) identifies and discuses different mitigation technologies and applications within the Australian livestock industry. The review highlights the goal of reducing ruminant methane emissions into the future, underpinning the Australian red meat industry's goal of reaching carbon neutrality by 2030. Strategies were then ranked, based on potential for financial benefit to the Australian ruminant industries. Overall, the use of processed red marine alga, *Asparagopsis taxiformis*, and 3-NOP as feed additives were identified as the first and second most viable interventions, followed by microbial manipulation of the ruminant microbiome. The introduction of processed red marine alga and the use of 3-NOP as feed additives has prompt effects on methane emissions, demonstrating variable ranges in reduction potential. The authors suggest that the inclusion of one or both feed additives, once commercially available and approved by national regulatory authorities, should be coupled with efforts to maintain the manipulated rumen within herds to support future generations. Currently, 3NOP, commercially known as Bovaer®, is approved for use in Brazil and Chile, and was reviewed by the European Food Safety Agency for use in the European Union in late 2021 and received market approval in February 2022 (Bampidis et al., 2021; Heerlen, 2022). Other strategies, currently in place in Australia, demonstrated less potential to mitigate emissions, such as the use of various forages and the inclusion of by-products in the diet.

The paradox is clear: animal agriculture and production are integral to the global agri-food system as a source of protein and livelihoods, yet the sector emits large quantities of greenhouse gases, specifically methane. Suggestions to eliminate or reduce animal agriculture, despite being the most direct method to reduce emissions, are not accessible or inclusive to farmers and pastoralists globally (Eisen & Brown, 2022). Applied systems modelling approach simulating the elimination of animal agriculture in the United States only marginally decreased GHG emissions and increased food security risk and potential for dietary deficiencies in essential nutrients (White & Hall, 2017). In a Canadian context, these type of policy recommendations would face critical scrutiny and opposition, especially in Western Canada, where cattle are crucial to local and provincial economies, accounting for 85 percent of Canadian beef production (Modongo & Kulshreshtha, 2018). With the growing global population projected to reach close to 10 billion by 2050, the importance of ruminants and ruminant production as a source of protein through milk and meat, is further propagated, especially in small scale productions in the global south. Investigation and research in several solutions which integrate environmental, social, and economic dimensions into policy measures and implementation is the way forward, rather than fixating on "one-size-fits-all" solutions. Managing transition risks and focusing on precision technology accessibility and adoption, identifying strategies to reduce emissions while maintaining or expanding current scale of production and focussing on minimizing further expansion into arable land through improving breeding and feed conversion in ruminant production in the global south should be prioritized by government and policy actors (FAO, 2019).

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