Fact Sheet: Tough Questions about Beef Sustainability

Project Title: What are Enteric Methane Emissions?

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Beef cattle are ruminants, which means they have a specialized digestive tract with a four-compartment stomach. The largest of these compartments is the rumen. The rumen houses trillions of microbes (bacteria, protozoa, and fungi) that break down and digest the fiber and other carbohydrates that ruminants eat. The microbes and the animal have a mutually beneficial relationship – the microbes get a nice environment to live in and a constant supply of food, while the cattle receive the nutrients that the microbes liberate from the feed the cattle eat. Interestingly, without the microbes, the cattle would be just as unable to digest grass as humans.

As the microbes break down carbohydrates (cellulose, starch, etc.), they release glucose molecules, and these simple sugars are then fermented into several products. Some of these fermentation products, namely volatile fatty acids, are absorbed by the animal and used as an energy source to eventually power growth and milk production. One of the waste products of fermentation is methane, which is a greenhouse gas. Methane produced directly from the digestive tract of these animals is known as enteric methane.

According to the FAO, enteric methane emissions from domesticated ruminants (wild animals excluded) account for 30% of all global human-caused methane emissions. In the United States, beef cattle are responsible for just 18% of methane emissions, or 1.8% of total human caused greenhouse gas emissions (Figure 1).[1]

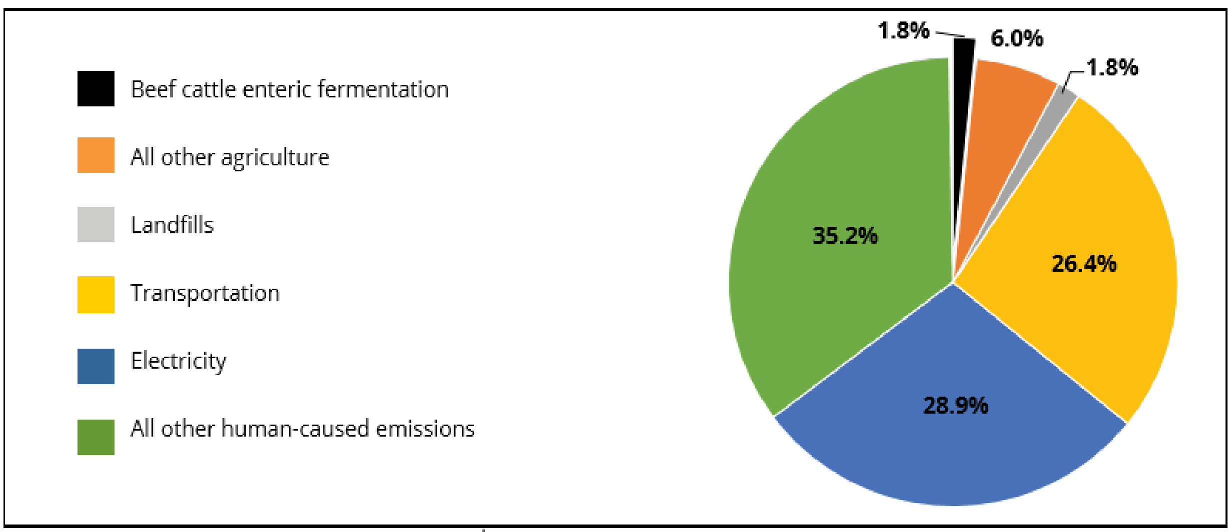

Figure 1. 2015 US Greenhouse Gas Emissions (GHG) Inventory in carbon dioxide equivalent emissions. Methane emissions from beef cattle represented 1.8% of all human-caused GHG emissions in the U.S. in 2015.[1]

Enteric methane emissions are expected to increase as the global population becomes larger and more affluent;[2] however, in the United States, enteric methane emissions from beef cattle have declined 34% since 1975.[3] The total amount of emissions from U.S. beef cattle are similar to the enteric methane emissions that were emitted by wild ruminants (e.g., bison, deer, elk) prior to the European settlement of North America (Figure 2).

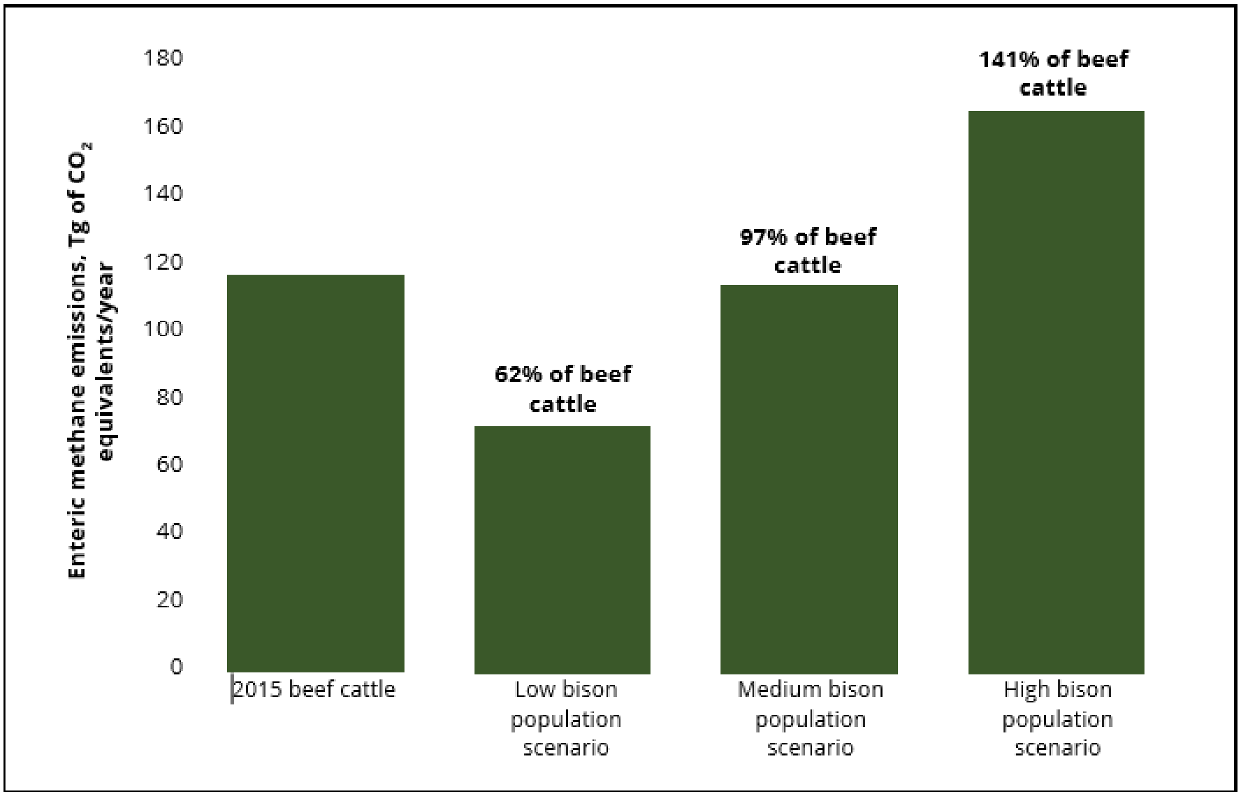

Figure 2. Comparison of enteric methane emissions from US beef cattle in 2015[1] to the estimated enteric methane emissions from wild ruminants prior to the 15th century.[11] The three scenarios represent three estimated bison population sizes (30, 50, or 75 million) as the exact size of bison herds is unknown.

It isn't possible to eliminate methane production from ruminants, short of eliminating the rumen. Obviously, this would be undesirable. Without ruminant animals, much of the land mass of Earth would be unusable for food production. Further, the ecology of many of our grazing lands depends on large herbivores, and cattle grazing is used to maintain these ecosystems in a productive, healthy state. Emissions of enteric methane is the cost of this unique service that ruminants provide. Rather than eliminating methane, reducing the amount of methane produced during food production is a sustainable goal.

Farmers and ranchers have an incentive to reduce enteric methane emissions not only for environmental reasons, but also because methane represents a loss of the energy value of feed. Thus, if methane emissions are lower as a percentage of feed energy intake, cattle can extract more calories from every pound of feed consumed to meet their energy needs.

There are several opportunities to alter the formation of enteric methane across all sectors of the beef industry.[6] The amount of methane an animal emits is mostly a function of how much feed it eats and the quality of that feed. Less feed consumed results in less methane produced, and higher-quality feeds (i.e., more digestible feeds) reduce the amount of methane produced per unit of feed consumed. Both factors can be managed in forage and feedlot systems through diet, feed supplements, etc.

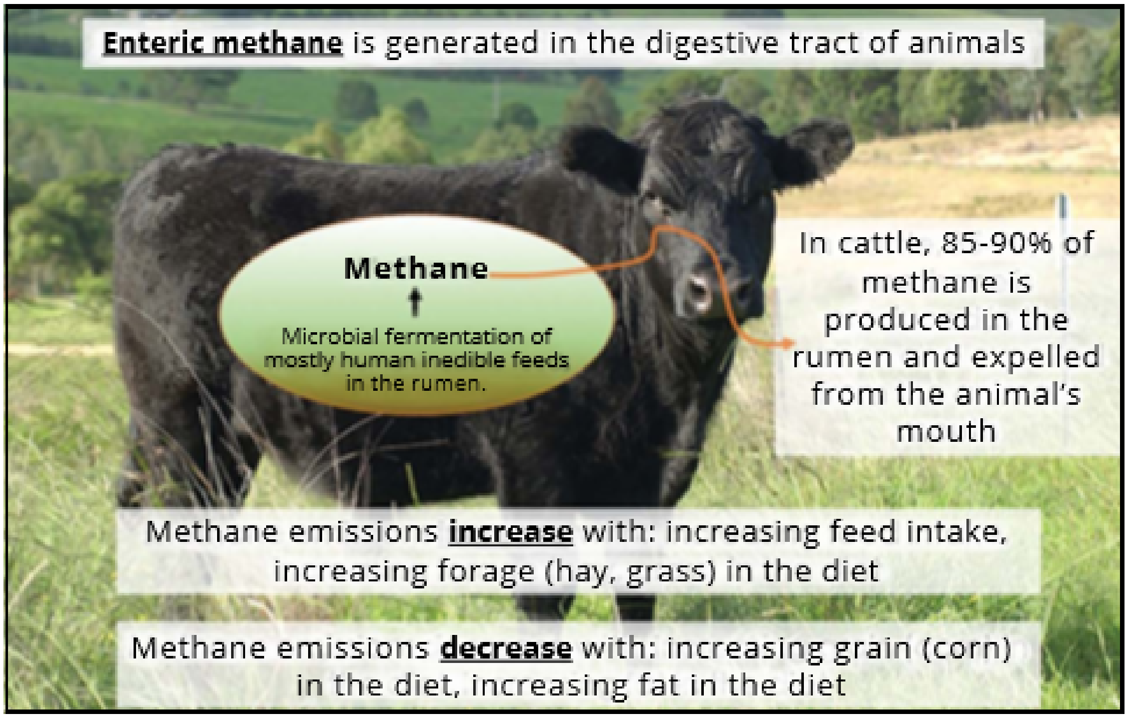

Figure 3. Key facts about enteric methane emissions from cattle. The production of methane is a naturel process and essential for normal rumen function.

Photo courtesy of Commonwealth Scientific and Industrial Research Organisation of Australia.

Enteric methane accounts for about 47% of the total carbon footprint of beef in the United States, when everything from cattle feed production to cooking energy in homes and restaurants is considered.[7] The nation's brood cow herd produces about 70% of beef cattle's carbon footprint in the United States.[8] Cows are typically grazed on forages, which have a greater propensity to produce methane than grains, like corn. A three-year study comparing a basic cow management system to one that utilized best management practices (fertilization, advanced grazing management, etc.) found that methane emissions from both systems varied across the year.[9] However, the best management practice system produced 22% less methane per cow than the basic system.[9]

Other approaches, such as supplementing a small amount of fat into the diet of ruminants, can reduce methane production. Certain supplements (ionophores, methane inhibitors, etc.) can be given to animals in very small amounts and alter the fermentation process to reduce methane, often improving feed efficiency of the animals.[6] While feedlot systems have a lower carbon footprint than forage based systems, they still account for about 20% of the beef industry's carbon footprint.[8] Management practices such as grain processing can help. Steam flaking corn reduced methane per unit of feed consumed by 17%, compared to feeding dry rolled corn.[10]

Some of these management practices may not fit into all production environments. Cattle producers must balance methane emissions with other factors such as animal health, logistics, costs, ecology and genetics so that they can cost-effectively and sustainably produce food for the long run.

Bottom line: Enteric methane is a natural byproduct of the mutually beneficial relationship between ruminant animals and the specialized microbes in their gut. Methane must be released to protect the health of the animal and to maintain the viability of the microbes. Enteric methane emissions from beef cattle represent 1.8% of total US greenhouse gas emissions. Best management practices such as good grazing management and strategic feed supplementation help reduce enteric methane emissions from beef cattle and cost-effectively increase human food production, thereby improving sustainability.

Literature Cited

1. EPA. 2017. Inventory of U. S. Greenhouse Gas Emissions and Sinks: 1990-2015. U. S. Environmental Protection Agency, Washington, D. C.

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

3. U.N. Food and Agriculture Organization. FAOSTAT Database – Food and agricultural data. Accessed June 15, 2017, available at: http://www.fao.org/faostat/en/#home

4. Hill J., C. McSweeney, A. G. Wright, G. Bishop-Hurley, K. Kalantar-zadeh. 2016. Measuring methane production from ruminants. Trends in Biotechnology. 34:26-35.

5. McAllister T.A. Newbold. C. J. 2008. Redirecting rumen fermentation to reduce methanogenesis. Australian Journal of Experimental Agriculture. 48: 7-13.

6. Hristov, A. N., J. Oh, J. L. Dijkstra, E. Kebreab, G. Waghorn, H. P. S. Makkar, A. T. Adesogan, W. Yang, C. Lee, P. J. Gerber, B. Henderson, and J. M. Tricarico. 2013. Mitigation of methane and nitrous oxide emissions from animal operations: I. a review of enteric methane mitigation options. J. Anim. Sci. 91:5045-5069.

7. Battagliese, T., J. Andrade, R. Vinas, K. Stachouse-Lawson, C. A. Rotz, and J. Dillon. 2015. U.S. Beef – Phase 2 Eco-efficiency Analysis. http://www.beefresearch.org/CMDocs/BeefResearch/Sustainability%20Completed%20Project%20Summaries/BASF_NCBA%20US%20Beef%20Industry%20Phase2_%20NSF%20EEA%20Analysis%20Report_FINAL.pdf

8. Rotz, C. A., B. J. Isenberg, K. R. Stackhouse-Lawson, and E. J. Pollak. 2013. A simulation-based approach for evaluating and comparing the environmental footprints of beef production systems. J. Anim. Sci. 91: 5427-5437.

9. DeRamus, H. A., T. C. Clement, D. D. Giampola, and P. C. Dickison. 2003. Methane emissions of beef cattle on forages: efficiency of grazing management systems. J. Environ. Qual. 32: 267-277.

10. Hales, K. E., N. A. Cole, and J. C. MacDonald. 2012. Effects of corn processing method and dietary inclusion of wet distillers grains with solubles on energy metabolism, carbon-nitrogen balance, and methane emissions of cattle. J. Anim. Sci. 90: 3174-3185.

11. Hristov, A.N. 2012. Historic, pre-European settlement, and present-day contribution of wild ruminants to enteric methane emissions in the United States. J.Anim. Sci. 90:1371-1375

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