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Relationship Between Production System and Methane Loss by Beef Cattle

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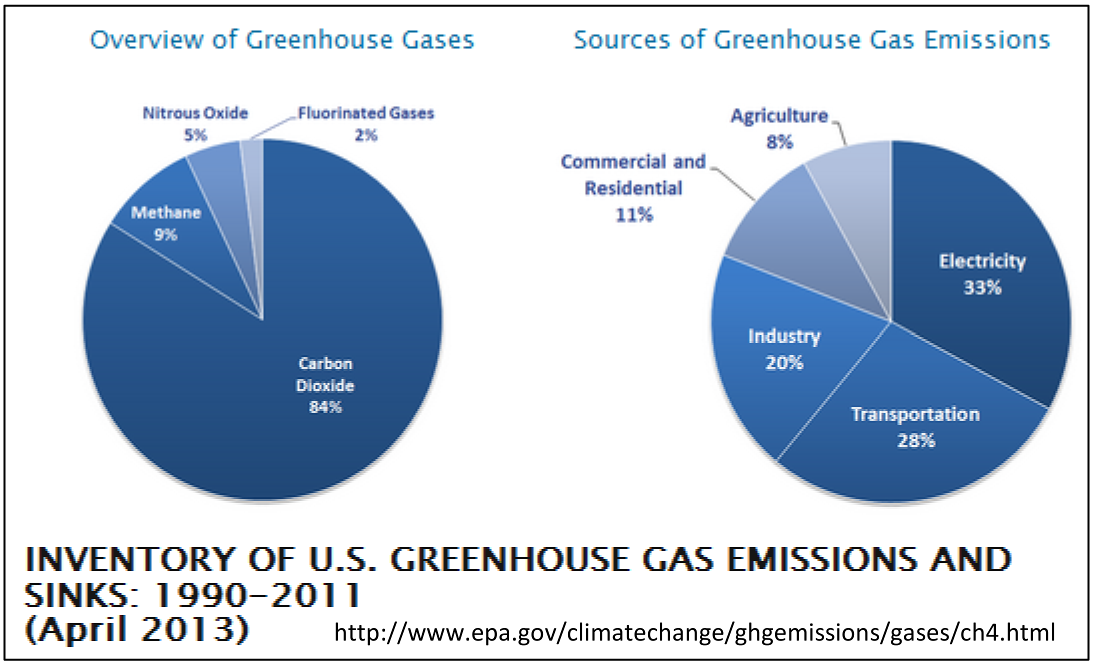
Introduction

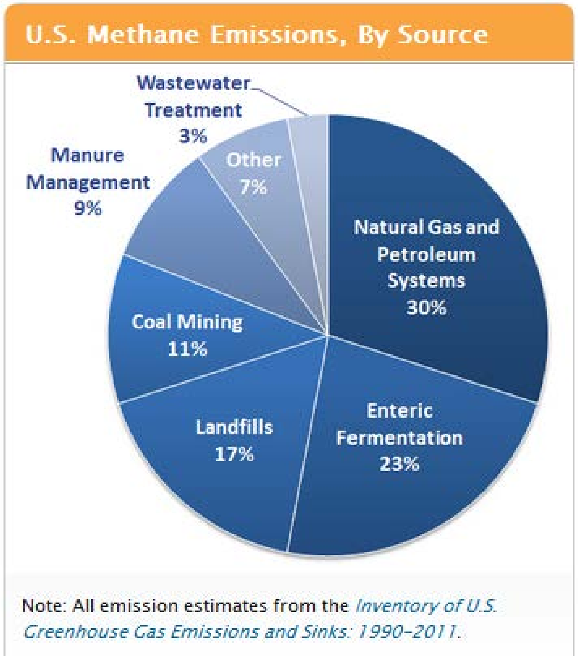
The global warming phenomenon has been researched and debated for over two decades. Greenhouse gases are frequently pointed to as significant contributors to this phenomenon. The graphic shown below from the Environmental Protection Agency website characterizes US greenhouse gas production.



Two points should be noted here: 1) methane represents only 9% of total US greenhouse gases and 2) agriculture is responsible for 8% of the total US greenhouse gas emissions.

Methane

Ruminants have a unique digestive system that allows them to use a wide array of feedstuffs, from coarse mature forages to co-products of the ethanol, beer and flour industries to cereal grains and oilseed meals. The rumen is a large anaerobic fermentation vat and home to millions of microorganisms. These microorganisms digest protein and energy substrates of the diet and produce protein and volatile fatty acids that are utilized by the animal. In the process, methane is produced. Methane (CH_4) is a loss of dietary energy.



According to the Environmental Protection Agency website:

"Globally, ruminant livestock produce about 80 million metric tons of methane annually, accounting for about 28% of global methane emissions from human-related activities. An adult cow may be a very small source by itself, emitting only 80-110 kilograms of methane, but with about 100 million cattle in the U.S. and 1.2 billion large ruminants in the world, ruminants are one of the largest methane sources. In the U.S., cattle emit about 5.5 million metric tons of methane per year into the atmosphere, accounting for 20% of U.S. methane emissions." http://www.epa.gov/rlep/faq.html

To recap the methane trail thus far:

- *methane accounts for 9% of the US greenhouse gas emissions*
- *agriculture contributes 8% of the US greenhouse gas emissions (and is also a sink for greenhouse gases)*
- *cattle contribute ~20% of the US methane release (see graph below and reference above)*
- *livestock contribute 28% of the global human-related methane emissions*
- *the US cattle population of 100 million head is 8.3% of the 1.2 billion large ruminant global population.*

Diet influences the amount of methane lost by cattle. As noted in Table 1, cattle consuming long stem forage (high fiber) diets typically lose 6% of gross dietary energy as methane, while those on high concentrate (low fiber) rations will generally lose 3-3.5% of dietary gross energy (GE) as methane.

Table 1. Ruminant Diets and Expected Methane Loss*

	% GE lost
Forages	6.0-6.5
Finishing Ration	3.0-3.5

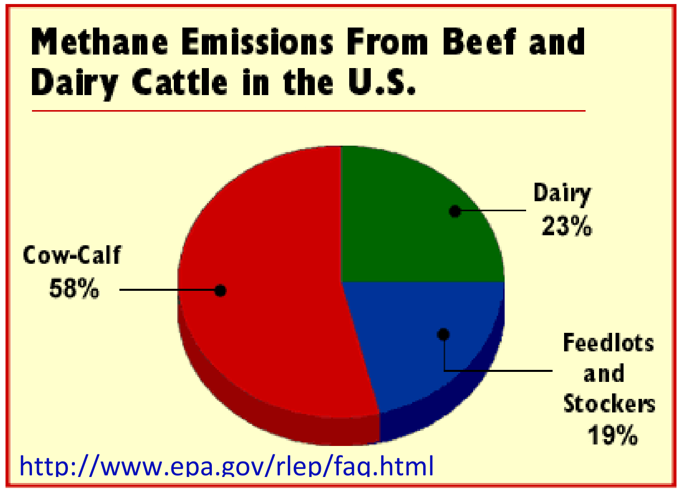
*from Johnson, K.A. and D.E. Johnson. 1995. Methane Emissions from Cattle. JAS 73:2483-2492.

It should be noted that in spite of the differences in constituents of feedstuffs, most diets for farm animals are predominately carbohydrates and vary little in GE content. Gross energy is a measure of heat produced during the complete combustion of a food or feedstuff sample. Examples of the GE content of common feedstuffs are shown in Table 2.

Table 2. Gross Energy Content of Feedstuffs.*	
	GE, kcal/g dry matter
Grass hay	4.51
Oats	4.68
Corn	4.43

*adapted from Animal Nutrition by McDonald, Edwards and Greenhaigh, 2nd Ed. 1978, Longman, Inc.

Level of intake also influences methane loss. According to Johnson et al. (*in Atmospheric Methane: Sources, Sinks and Role in Global Change. NATO ADI Series Vol. 113, Springer-Verlag, Berlin, Germany*), as the amount consumed by an animal increases, the portion of GE lost as methane decreases by an average of 1.6% per level of intake.



They elaborated further on the diet-methane relationship: "When highly available carbohydrates are fed at limited intakes, high fractional methane losses occur. At high intakes of highly digestible diets, low fractional methane losses occur.

The type of carbohydrate fermented influences methane production most likely through impacts on ruminal pH and the microbial population. Fermentation of cell wall fiber [forages] yields higher acetic:propionic acid (C_2 and C_3 rumen volatile fatty acids, respectively) and higher methane losses. The very high grain finishing diets (90+ % concentrate) commonly fed in U.S. feedlots result in strikingly different methane loss rates than are commonly predicted. Considerable variation is found among diets, but typical losses frequently fall between 2 to 3% of GE. This loss rate is approximately one-half of the commonly predicted 6% of diet GE lost as methane."

As shown in the graph above, 58% of the methane emissions associated with cattle come from the cow/calf sector, while feedlots and stockers contribute 19%. ***The cow/calf component is common to both grassfed and traditional production systems, thus any opportunity to reduce cattle methane contribution to greenhouse gasses would warrant a comparison of methane loss associated with grass and grain finishing.***

A fundamental difference between high energy and forage finishing is the time required to finish an animal. This point is illustrated in Tables 3 and 4.

Table 3. High Fiber Finishing					
Relationship between initial weight, rate of gain and finished weight					
Target End Weight, lb.			1050		
Initial			ADG, lb/day		
Wt, Lb.	1	1.5	1.75	2	2.5
			days required to finish		
600	450	300	257	225	180
700	350	233	200	175	140
800	250	167	143	125	100

Grassfed and high energy fed cattle gain at appreciably different rates. Typical ADG for yearling cattle fed 150-180 days is 2.8-3.4 lb/day. In contrast, typical ADG for grass finished cattle gaining 300-500 pounds on grass is 1.25-2.0 lb/day.

Table 4 Low Fiber/High Concentrate Finishing					
Relationship between initial weight, rate of gain and finished weight					
Target End Weight, lb.			1300		
Initial			ADG, lb/day		
Wt, Lb.	2.5	2.75	3	3.25	3.5
			days required to finish		
600	280	255	233	215	200
700	240	218	200	185	171
800	200	182	167	154	143

An obvious contrast arises – days required to finish. Using an initial weight of 700 lb. and ADG typical for the <u>entire</u> finishing period (1.5 for grassfed and 3.25 for high energy fed),

Grassfed cattle would require .... 233 days

High concentrate fed .... 185 days

A difference of 48 days and 250 pounds of live weight (1300 vs. 1050) and 196 lbs. of carcass weight (assuming dressing percentages of 63.5% and 60% for concentrate fed and grassfed respectively).

Recall from previous discussion that dietary energy lost as methane varies among feedstuffs. Energy losses (as a percentage of gross energy) are greater with fibrous feedstuffs and less with non-fibrous feedstuffs. Direct comparison of methane loss by grass finished and grain finished cattle is difficult because, though methane loss by grain fed cattle is relatively constant, methane loss by foraging cattle varies (due to variations in forage quality and quantity). Cattle consuming lesser quality forages (mature) lose a greater portion of GE as methane than cattle grazing high quality forages. And recall *cattle consuming fibrous diets such as forages lose 2X the amount of GE as methane compared to cattle consuming high concentrate relatively low fiber rations* (6 vs. 3%, respectively).

Comparing forage-fed to concentrate-fed cattle, rate of weight gain is slower and daily methane losses are greater as the proportion of roughage/forage/fiber in the diet increases. Hence, methane losses per unit of weight gain (beef production) are greater

Bottomline – When compared to a traditional beef production and grain finishing, finishing cattle on forages will not result in less methane loss (greenhouse gas production). Depending on forage quality and days required to finish, forage finishing systems may be responsible for greater total methane production per animal.

as roughage/forage/fiber constitute a larger proportion of the diet. Further, the appreciably longer finishing period often experienced by grass finished cattle means they are 'losing methane' for a greater period of time.

Prolonged grass finishing periods have a "forage opportunity cost". Compared to a traditional cow/calf enterprise where calves are sold or moved elsewhere at weaning, stocking density of cows must be significantly reduced to facilitate a birth to finish grassfed production system. The forage consumed by finishing cattle could be used by cows to generate more calves.

Additional References

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