An Exploration of Methane and Properly Managed Livestock through Holistic Management

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Questions about livestock and methane are frequently posed in discussions of Holistic Management and the use of domestic livestock for eco-restoration and as food sources. This paper offers an overview of methane as a greenhouse gas and examines the dynamic of methane in the carbon cycle and the role of livestock. We start with a short summary, followed by a more detailed discussion and references for further reading.

Summary

- Methane is a powerful short-lived greenhouse gas (a single molecule lasts in the atmosphere from 9 to 15 years) that is approximately 20 times more potent than carbon dioxide over a 100-year time span. The most important methane sink is the lower atmosphere where it is oxidized into carbon dioxide and water. But soils are also a significant sink, capturing approximately 10% of methane emissions.

- Ice core research shows that for the past 650,000 years, atmospheric methane never exceeded 788 ppb (parts per billion), and was mostly below 600 ppb. Current methane levels, rising since 1750, are approximately 1,800 ppb.

- Atmospheric methane levels did not increase between 1999 and 2008, despite a 70% increase in livestock.

- Domestic ruminants - cattle, sheep, goats, etc. - emit methane as a result of bacterial digestion of cellulose in the rumen, that is, the first of their multiple stomachs. Their methane emissions vary with size, breed and feed, but for beef and dairy cattle are in the range of 164 to 345 mg per day.

- Healthy, well-aerated soils - a characteristic quality of grasslands under Holistic Planned Grazing - harbor bacteria called methanotrophs, which break down methane. Soil-based decomposition of methane may be equal to or greater than ruminant methane production, depending on animal den sity, soil type and soil health.

- Despite large populations of grazing animals worldwide before the introduction of agriculture, atmospheric methane concentrations cycled between approximately 350 and 750 ppb, but did not increase beyond that concentration.

Therefore it is reasonable to conclude that an intact ecosystem effectively balances ruminant methane production and breakdown. While there are indeed excessive sources of methane from conventional livestock management, such as manure lagoons and land use changes (for example, conversion of forests and grasslands to croplands for animal feed), other than market-related transportation costs, Holistic Management requires none of those practices. Thus, the benefits of eco-restoration through Holistic Management far outweigh the any net positive methane balance (if there is any) resulting from Holistic Planned Grazing. In fact, the melting of permafrost and seabed methane sinks are the primary contemporary concern with respect to methane emissions.

Details

Concerns about methane emissions from conventional livestock production has been much publicized and is well-founded:

> *The livestock sector accounts for 9 percent of anthropogenic CO2 emissions. The largest share of this derives from land-use changes – especially deforestation – caused by expansion of pastures and arable land for feed crops. Livestock are responsible for much larger shares of some gases with far higher potential to warm the atmosphere. The sector emits 37 percent of anthropogenic methane (with 23 times the global warming potential (GWP) of CO2) most of that from enteric fermentation by ruminants FAO, p. xxi). Moreover, methane is the second most important greenhouse gas. Once emitted, methane remains in the atmosphere for approximately 9–15 years* (FAO, p 82).

The planning process is the most central element of Holistic Management. Accordingly, Holistic Planned Grazing is a fundamentally different approach to livestock and to ecosystem management, in which livestock production is only one element of the process.

Whereas conventional livestock production manipulates pieces of the ecosystem in an effort to maximize production and profits, thereby leading to the complication and expense of dealing with unintended consequences, Holistic Planned Grazing strives to put all of the pieces back together and relies on nature's millions of years of experience with the grazer-grassland environment to balance the whole. Decades of experience have demonstrated that it works as can be seen through these case studies http://www.savoryinstitute.com/research-and-case-studies/. The irony is that a healthy and balanced grazer-grassland system is more productive, less work, doesn't require government subsidies, and more profitable than the complicated, expensive, polluting, energy-intensive and often unmanageable conventional system.

In order to understand how the two systems are different with respect to methane production, let's start with a few words on what methane is and how it travels through the carbon cycle.

Methane is a molecule composed of 1 carbon (C) atom and 4 hydrogen (H) atoms, with a chemical formula of CH_4. In biological systems, it is produced by bacteria in anaerobic conditions, that is, conditions that are oxygen-poor. Examples of methane production are bacterial activity in melting permafrost, wetlands and rice paddies, garbage buried deep in landfills, and in the ruminant gut - cattle, sheep, goats and others. Ruminant methane emissions vary with species, size, breed and feed, but for beef and dairy cattle are in the range of 164 to 345 mg per day.

Methane is unstable in the earth's lower atmosphere (troposphere), which is, in fact, a major methane sink:

> The major sink for atmospheric methane is through chemical reaction with hydroxyl radical in the troposphere. However, oxidation of methane by soils is also a significant sink, representing about 10% of the total sink. (Topp & Pattey, 1997, p. 1)

Nature strikes a balance between methane production and decomposition. Methanotrophic bacteria, which are aerobic bacteria thrive in well-aerated soils which consume and break down methane as an energy source. Such bacterial action removes roughly 1 billion tons of methane from the atmosphere annually (Brady, 2002, p 536), the equivalent of 23 billion tons of carbon dioxide, or 11.5 parts per million of what are called carbon-dioxide equivalents. Unfortunately, conventional soil management causes considerable damage to these natural methane decomposers:

> *…the long-term use of inorganic (especially ammonium) nitrogen fertilizer on cropland, pastures, and forests has been shown to reduce the capacity of the soil to oxidize [break down] methane…. Long-term experiments in Germany and England indicate that supplying nitrogen in organic form (as manure) actually enhances the soil's capacity for methane oxidation.* (Brady, 2002, p 536)

It is therefore readily apparent that to control methane emissions we are advised to keep soils well-aerated and to discontinue all use of synthetic nitrogen soil supplements. Both of these practices are key elements of Holistic Management.

In 2006, the United Nations Food and Agriculture Organization (FAO) issued a 400+ page report entitled Livestock's Long Shadow: Environmental Issues and Options (LLS) (FAO, 2006). It was extensive in its analysis and recommendations, acknowledging that current conventional management practices have an abundance of negative consequences, of which excess methane production is only one. Others include water depletion and pollution, degradation of soils, loss of rangeland biodiversity, carbon and nitrogen emissions, and transportation impacts.

While never mentioning Holistic Management, LLS provides strong support for Holistic Planned Grazing by recommending practices, both in general and with respect to methane, that have been at the core of Allan Savory's work for decades. For example, they state that the respiration of livestock makes up only a very small part of the net release of carbon that can be attributed to the livestock sector. Much more is released indirectly by other channels including:

- Land degradation;
- Land-use changes for feed production and for grazing;
- Methane release from the breakdown of fertilizers and from concentrated animal manure that is not allowed to break down in soils;
- Burning fossil fuel to produce mineral fertilizers used in feed production;
- Fossil fuel use during feed and animal production; and
- Fossil fuel use in production and transport of processed and refrigerated animal products. (FAO, 2006, p 86).

Except for the use of fossil fuels in product processing and transport, Holistic Planned Grazing incurs none of those burdens, and in fact reverses most of them. LLS also notes that:

> *Methane released from animal manure may total 18 million tonnes per year. The anaerobic decomposition of organic material in livestock manure also releases methane. This occurs mostly when manure is managed in liquid form, such as in lagoons or holding tanks. Lagoon systems are typical for most large-scale pig operations over most of the world (except in Europe). These systems are also used in large dairy operations in North America and in some developing countries, for example Brazil.* (FAO, 2006, p 97)

Of course, Holistic Planned Grazing has no manure lagoons or holding tanks. All manure goes from the ruminant to the ground, where, on healthy soils, it is rapidly attacked by dung beetles, earthworms and other soil biota, thereby taking it to various depths in the soil and transforming it into soil organic carbon that may be stable for hundreds or thousands of years (Brady, 2002, p 535). Finally, LLS acknowledges that:

> *Manure deposited on fields and pastures, or otherwise handled in a dry form, does not produce significant amounts of methane.* (FAO, 2002, p 97).

Thus, the growing methane problem from stored animal “wastes” (which are in reality vital “food” for the soil and its inhabitants), is not an issue in Holistic Planned Grazing.

Methane is also produced by ruminant digestion, and it is a far greater part of livestock’s contribution to atmospheric methane. Estimates of yearly methane production of the typical beef and dairy cow range from 60 to 71 kg and 109 to 126 kg, respectively (EPA, 1993; Johnson, 1995, p 3). Manure, however, is a growing problem with the spread of conventional livestock management:

> *…methane emissions from animal manure, although much lower in absolute terms, are considerable and growing rapidly.* (FAO, 2006, p 114)

But ruminant digestion may be less of a problem than previously thought, as methane emissions from livestock seem to be changing. In 2008, two years after Livestock’s Long Shadow was released, another report issued jointly by the FAO and the International Atomic Energy Agency (IAEA) announced that:

> *Since 1999 atmospheric methane concentrations have leveled off while the world population of ruminants has increased at an accelerated rate. Prior to 1999, world ruminant populations were increasing at the rate of 9.15 million head/year but since 1999 this rate has increased to 16.96 million head/year. Prior to 1999 there was a strong relationship between change in atmospheric methane concentrations and the world ruminant populations. However, since 1999 this strong relation has disappeared. This change in relationship between the atmosphere and ruminant numbers suggests that the role of ruminants in greenhouse gases may be less significant than originally thought, with other sources and sinks playing a larger role in global methane accounting* (IAEA, 2008).

In any case, healthy, biodiverse soils and ecosystems give all signs of rendering moot the problem of ruminant methane emissions when herds are managed according to Holistic Management practices.

This assertion is further supported by ice-core records indicating that until the advent of industrialization, atmospheric methane concentrations didn't exceed 788 parts per billion by volume (ppbv) for 650,000 years, but was at 600 ppbv or less for most of that period (Spahni, 2006, p 55).

> *Measurements made with ice cores indicate that the concentration of this gas has been increasing rapidly since the start of the industrial age, currently at a rate of about 0.8% annually (Pearman et al. 1986; Pearman and Frazer 1988; Lelieveld et al. 1993). The current atmospheric methane concentration is about 1.7 parts per million (vol/vol)* (Topp, 2007, p 1).

That ruminant methane production is of any significance in this 250% increase in atmosphere is a vanishingly small possibility. Historical ruminant emissions from wild herds before European settlement in the United States, for example, were estimated at 86% of current emissions (Hristov, 2012, p 2). Such a difference would account for little if any of the more than double contemporary methane concentrations. Furthermore, given the lower amounts of methane concentrations prior to industrialization, there is little support for the contention that ruminant methane was a significant contributor to atmospheric methane. In sum, while any greenhouse gas is a concern in addressing climate, livestock methane production does not appear to be an issue under Holistic Management.

Working Against Nature

The following photograph illustrates what happens when an ecosystem is broken into pieces. The animals are not only feeding without their normal movement on the land, but they are eating forages isolated from the soil. When they "recycle" the grasses, the manure has nowhere to go where soil life forms will process it to perform their many beneficial functions. Soils that are thus impeded lose vital processes that in an intact ecosystem, would include stable storage of carbon from photosynthesis, scrubbing of methane from the atmosphere by methanotrophic bacteria, feeding a universe of inter-related soil biota essential for a healthy grassland ecosystem, and nourishing the new growth of grasses to begin the cycle anew.

Dairy cattle feeding on fodder in open stable. La Loma,
Lerdo, Durango – Mexico 1990,
© FAO/15228/A. Conti (LLS, p 96)

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