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Role of livestock in global warming

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Abstract
Global warming is one of the major concerns of the whole world. The greenhouse gas (GHG) emissions from the agricultural sector account for about 25.5% of total global anthropogenic emission. After carbon dioxide, methane is the most potential greenhouse gas that is contributing towards global warming and ultimately climate change. Methane is short lived climate pollutant (SLCP) with an atmospheric lifetime of roughly a decade and has 21 times more global warming potential (GWP) than carbon dioxide. Livestock emissions from manure and gastro enteric releases account for roughly 32 percent of human-caused methane emissions This article focuses on role of livestock in methane emission and their accountability in global warming and how mitigating the levels of methane can curb the global rise of temperature in a short span. Furthermore, it also suggests some ways to cut down the emission of methane from livestock.

Keywords: Global warming, greenhouse gases, livestock, methane

Introduction

Global warming is the long-term warming of overall temperature of the planet. Global warming is eventually responsible for climate change, which poses a serious threat to life on earth in the forms of melting of polar ice, widespread flooding and extremes of weather. Greenhouse gases (GHG) present in the atmosphere absorb some 90 percent of the infrared radiations reflected from earth surface. Normally these radiations would escape into space, but these GHGs, which can remain in the atmosphere for years to centuries, trap the heat and cause the planet to get hotter and this phenomenon is called as greenhouse effect. The primary greenhouse gases in Earth's atmosphere are water vapor (H_2O), carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and ozone (O_3). The present global warming is generally due to an increase in the greenhouse effect, brought about by increased levels of GHGs, chiefly due to the effects of human industry and agriculture[(1)]. The main gases responsible for the greenhouse effect include carbon dioxide, methane, nitrous oxide, and water vapor (which all occur naturally), and fluorinated gases (which are synthetic). Influence of any greenhouse gas on global warming depends on three key factors, it's concentration in the atmosphere, how long it remains in the atmosphere and how effective it is at trapping heat. This is referred to as global warming potential, or GWP, and is a measure of the total energy that a gas absorbs over a given period of time (usually 100 years) relative to the emissions of 1 ton of carbon dioxide (Figure 1).

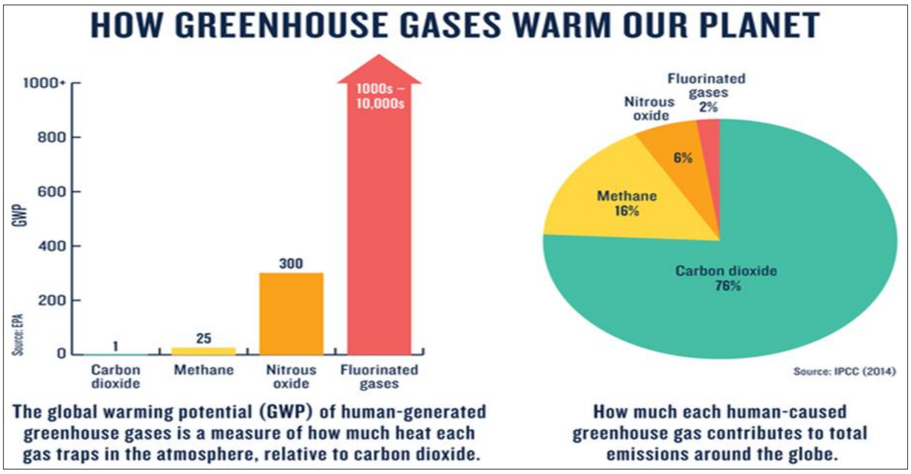

Fig 1: Source: IPCC 2014

It is estimated that between 1750 and 2011, atmospheric concentrations of carbon dioxide increased by 40 percent, methane by 150 percent, and nitrous oxide by 20 percent. In the late 1920s, we started adding man-made fluorinated gases like chlorofluorocarbons, or CFCs, to the mix. In 2017, carbon emissions rose by 1.6 percent; in 2018 they increased by an estimated 2.7 percent. Worldwide net emissions of greenhouse gases from human activities increased by 43 percent from 1990 to 2015. From 1990 to 2019, the total warming effect from greenhouse gases added by humans to the Earth's atmosphere increased by 45 percent. In fact, CH4 is considered to be the largest potential contributor to the global warming phenomenon [2, 3, 4]. It is an important component of GHG in the atmosphere and is associated with animal husbandry [5].

Why focus is on Methane?

- Methane is responsible for roughly 30 per cent of global warming since pre-industrial times and is budding faster than at any other time since record keeping began in the 1980s. Indeed, according to data from the United States National Oceanic and Atmospheric Administration, even as carbon dioxide emissions decelerated during the pandemic-related lockdowns of 2020, atmospheric methane shot up.
- Methane has 21 times more global warming potential (GWP) than carbon dioxide [6, 7]. As methane is a short-lived climate pollutant (SLCP) with an atmospheric lifetime of roughly a decade**,** has more than 80 times the warming power of carbon dioxide over the first 20 years after it reaches the atmosphere. Although CO_2 has a longer-lasting effect, methane sets the pace for warming in the near future. In fact, CH4 is considered to be the largest potential contributor to the global warming phenomenon [2, 3, 4].
- Methane is also accountable to the formation of ground-level ozone, a dangerous air pollutant. Ozone attributable to anthropogenic methane emissions causes approximately half a million premature deaths per year globally and also harms ecosystems and crops by suppressing growth and diminishing production. New studies find that tropospheric ozone may have much higher impacts on public health, particularly respiratory and cardiovascular deaths [8].
- Moreover, CH4 production is less expensive to reduce than other GHGs, like CO2emissions [9, 10, 11]. Curbing methane emissions is the fastest opportunity we have to immediately slow the rate of global warming, even as we decarbonize our energy systems [12].

Livestock as major source of methane emission:

It is stated by UNEP that more than half of global methane emissions arise from human activities in three areas: fossil fuels (35 percent), waste (20 percent) and agriculture (40 percent) [13]. Furthermore, it is also estimated that much of the global GHG emissions presently arise from enteric fermentation and manure from grazing animals [14, 15]. Some studies claim that approximately 37% of global agricultural CH4 and N2O arise from animal emissions and the remainder is associated with cropping and deforestation [16]. Livestock emissions from manure and gastro enteric releases account for roughly 32 percent of human-caused methane emissions. Unprecedented demand for animal protein has increased because diet awareness, population growth, economic development and urban migration and it is estimated that with the global population approaching 10 billion, this hunger is expected to increase by up to 70 per cent by 2050 [13].

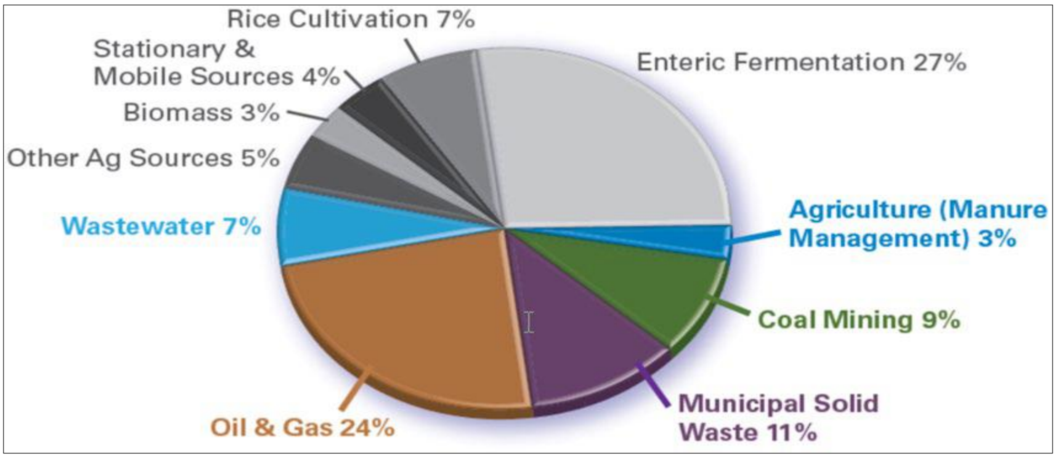

Fig 2: Estimated global anthropogenic methane emissions by source, 2020. (Source: [17])

All ruminant animals, such as cattle, sheep, buffalo and goats, have special 4- chambered digestive system. One of them, the rumen, allows them to store partially digested feed and let it ferment. They later regurgitate the food and finish the digestive process. As grass and other vegetation ferments in the rumen by microbes it produces the greenhouse gas, methane, as well as a host of other byproducts. Methane is generated by anaerobic fermentation, where bacteria break down organic matter producing hydrogen (H_2), carbon dioxide (CO_2) and methane (CH_4). This process naturally occurs in the digestive system of domesticated and wild ruminants, natural wetlands, and rice paddy fields. However, they can convert otherwise unusable plant materials, cellulose and hemi-cellulose, into nutritious food and fiber. This same helpful digestive system, on the other hand, produces methane, a potent GHG that can contribute to global climate change [18]. Much of the global GHG emissions currently arise from enteric fermentation and manure from grazing animals [14, 15].

The amount of methane produced per animal varies widely among animal's species with the extent of dependency on microbial fermentation for feed digestion (Figure 3). Enteric methane production by livestock depends on various factors and is directly related to the level of intake, the type and quality of feed, the amount of energy consumed, animal size, growth rate, level of production, and environmental temperature (Figure 4). Between 2 to 12% of a ruminant's energy intake is typically lost through the enteric fermentation process.

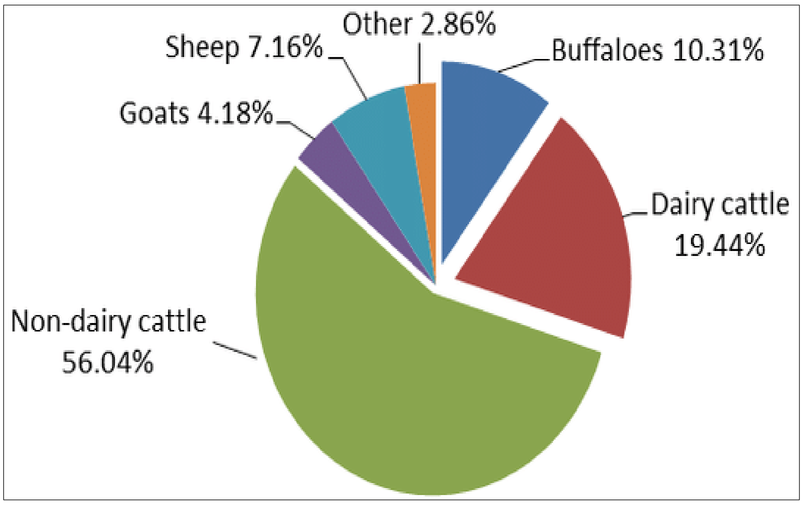

Fig 3: Contribution of different animal species and cattle types to global livestock enteric methane emission (Source: FAOSTAT, 2013).

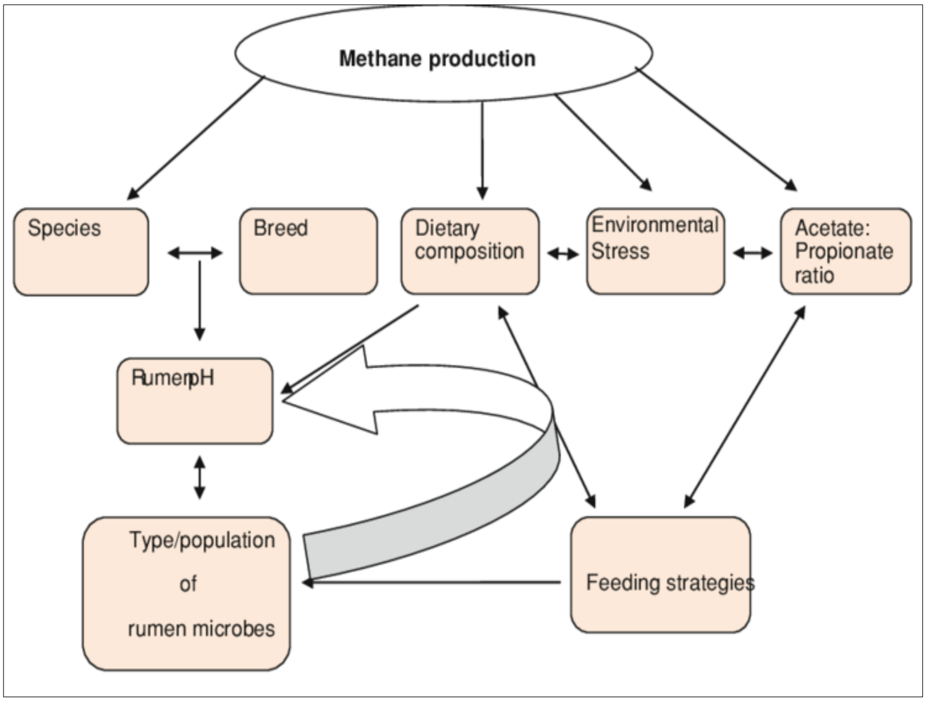

Fig 4: Factors influencing methane output from enteric fermentation. These factors can be broadly categorized into animal, feed, rumen, and environmental factors (Source: [20])

How mitigating methane emission help counter climate change?

Carbon dioxide is the major GHG but it remains in the atmosphere for hundreds to thousands of years. As a result if emissions were immediately and significantly reduced then also it would not have an effect on the climate until later in the century. On the other hand, the comparatively short atmospheric life of methane, along with its high warming potential, means that strategies to mitigate emissions can provide climate and health benefits within a few decades. So, reducing methane emissions now would have an impact in the near term and is critical for helping keep the world on a path to 1.5°C. By 2030, human-caused methane emissions can be reduced by as much as 45 percent, or 180 million tonnes a year (Mt/yr) using available targeted methane measures together with additional measures that contribute to priority development goals [13]. This would prevent nearly 0.3°C of global warming by 2045, helping to restrict the global temperature rise to 1.5˚C and putting the planet on track to achieve the Paris Agreement targets. Every year, 260,000 premature deaths, 775,000 asthma-related hospital visits, 73 billion hours of lost labour from extreme heat and 25 million tonnes of crop losses can be prevented by successive reduction in ground-level ozone [13].

Measures to mitigate methane emission from livestock

A number of alternatives have been considered for reducing methane production and emission in atmosphere by the livestock [21, 22, 23, 24]. All such approaches point towards either reduction of methane production per animals or reduction per unit of animal product [25]. Nevertheless, the specific needs of the farmers and animals must be taken into consideration while adopting a precise mitigation approach. Strategies for reducing ruminant methane output are scrutinized in relation to rumen ecology and biochemistry, animal breeding and management options at an animal, farm, or national level [5, 26]. On the top of it, if we wish farmers to adopt the mitigation strategies, they should be cost effective or cost neutral [27].

Strategies to reduce methane emission from livestock

1. By improving animal genetic pool via selection to produce low methane producing animals
2. By reducing livestock population
3. By boosting nutrition of animals ensuring proper amount of high quality feed and essential nutrients
4. By refining grassland management
5. Ensuring good health and care of animals by adopting upgraded veterinary practices
6. Increasing the ratio of concentrate feeding
7. Through feed modification like ammonia and molasses feeding can reduce methane
8. Supplementation of feed with oil and ionophores e.g., monensin and tannin
9. Defaunation and alteration in rumen microbial population
10. By reducing the demand of livestock products
11. By employing latest technology to reduce methane production

Source: [5]

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