Nature Environment and Pollution Technology
An International Quarterly Scientific Journal

p-ISSN: 0972-6268
e-ISSN: 2395-3454

Vol. 18 | No. 2 | pp. 679-684 | 2019

Original Research Paper | Open Access

Sustainable Development from Energy Alternatives to Mitigate Climate Change Due to Faunal Emissions - A Review

Padmanabhan Krishnan
School of Mechanical Engineering, VIT University, Vellore, India

Nat. Env. & Poll. Tech.
Website: www.neptjournal.com

Received: 06-10-2018
Accepted: 09-12-2018

Key Words:
Fauna
Homo sapiens
Livestock flatulence
Environmental impact
Climate change
Energy alternatives
Sustainable development

ABSTRACT

This is a study of an environmental event that brings out a significant but so far ignored contributions to global warming and climate change, *viz.* that of flatulence by faunal living beings and livestock in particular. A conservative estimate is arrived at on the fraction of contribution by flatulence to the total Green House Gas (GHG) emissions. Factors contributing to the increasing influence of flatulence on GHG emissions are discussed, which is observed to affect sustainable development in a significant way. Humans living in big cities breath-in air that might contain up to 20 % flatulence by weight . A query is raised as to why global organizations like the WRI and EPA have ignored this fact in the past. A significant role played by The United Nations on this topic from 2006, is highlighted. The status of flatulent contributions to climate change and environmental impact in emerging economies like India, Brazil, Argentina and China are discussed with emphasis on demography and population growth over the years. Life cycle analyses of the faunal emissions are provided taking dissociation into account and by products generated, which are the major points for concern. Due comparisons are made to GHG emissions through other sources. Generation and use of methane fuel and sequestration of carbon di oxide from flatulence through novel methods is illustrated as an alternative to the existing bio-gas technologies, thereby contributing to a more stable sustainable development. The measures being taken by the authorities in the western economies are highlighted and legislations discussed. Some basic diet based remedies to reduce flatulence, planting saplings, population control and harnessing flatulence are deliberated that would raise the bar on sustainable development.

INTRODUCTION

There are 3×10 to the 33rd power (3,000 quintillion) individual living beings on this planet and this is only a very conservative estimate. Of all the living beings, the flora to fauna ratio is about 25:75 as invertebrate insects alone outnumber other members. This makes us to conclude that about 1×10^{24} living beings are faunal members. These constitute invertebrates and vertebrates. All the faunal members emit oral, anal and perspiratory flatulence. However, only about 1×10^{13} faunal living beings can be considered to emit at least about a litre of flatulence per day, on an average, leaving the invertebrates aside. Among insects, termites are known to emit a high amount of methane into the atmosphere causing concern. This average has been arrived at by considering the amount of flatulence per day per species and the approximate number of members of that species that exist at a given time, like small flies to huge whales. Human beings emit about 1 to 2 litres of flatulence per day and are considered above average in output. Their numbers being slightly lesser compared to some of the other members of fauna, the percentage contributions to GHG are lesser. Hence, a conservative estimate of the average faunal flatulence per day is 1×10^{13} litres, which is about 10000 billion litres (American measure). Annually, this would be about 5100 million metric tons of flatulence after considering its density to be ~1.4 kg/m^3 which is higher than that of air as it contains higher proportions of GHG like CO_2, methane, sulphur containing gases, CO and traces of other hydrocarbons though the presence of very low volume of oxygen and hydrogen would tend to reduce the density marginally.

ENVIRONMENTAL IMPACT DUE TO HUMAN AND LIVESTOCK FLATULENCE

Some intelligent species of the fauna like the humans and those dependent on these intelligent species have multiplied during the last two centuries, like the human population which has grown eight-fold since 1800, contributing to climate change merely due to flatulence, leaving behind the effects due to emissions through inventions. In 1986 Paul J Crutzen and others published a study on the methane emissions by members of fauna like domestic animals, wild ruminants and human beings. This pioneering study evaluated that the methane emission contributions by domestic animals amounted to 15-25% of the total emissions. The contributions by human beings is reported to be lower than others (Crutzen 1986). Notably, the world human popula-

tion has grown by approximately 68 % since 1986 and the figures for domesticated animals could also be significant due to a rise in human population. An earlier investigative paper by a UK group on dinosaur flatulence has published an opinion that their extinction was probably triggered by their methane emissions that caused global warming (Wilkinson et al. 2012). However, it is now a known fact that in the Jurassic era, there were other sources of methane emissions that could have contributed substantially to global warming beside flatulence. Methane does not last forever in the atmosphere but oxidizes to CO_2 in about a decade. A major part of CO_2 in turn dissolves in the ocean to produce diluted carbonic acid that increases in content over decades. So we do have a continual process from the past that leads to a fractional accrual over ages. A small part of CO_2 is absorbed by plants that in turn gives out oxygen which is the only solace. Hence, there is more the reason to plant saplings.

A not too recent set of statistics published by the World Resource Institute (WRI) reports and the Environmental Protection Agency (EPA) reports provide information about a comparison of annual emissions of 900 million metric tons of GHGs by the transportation sector (www.wri.org) to 8389 million metric tons of GHG emission by industries and process industries (www.wri.org), which completely ignores the 5100 million metric tons of flatulent emissions that should have been included, though my estimate here is conservative. It should also be pointed out here that only a portion of the flatulent emissions are GHG and not the entire proportion as there are also oxygen and hydrogen emissions from members of fauna. The total GHGs were estimated at 44,153 million metric tons of CO_2 equivalent (www.wri.org) for the year 2005. However, this figure does not take the contribution of faunal flatulence in to account. The WRI and the EPA have never evaluated or estimated the GHG emissions from flatulence and included them in the total GHG emissions of the world.

Table 1 provides the data available for a few key countries and regions on human and livestock population. Based on common knowledge one can derive the total estimates of GHG emissions. Humans let out about a litre, whereas cows let out up to 500 litres per day. The other members of fauna can be slotted in between man and cow in emissions. It is seen that the overall contribution by all the members of fauna could even exceed the initial conservative estimate of 10 to 12 % of total GHG emissions by weight. Factors like demography, polity, eating habits, organic farming, regional phenomena, heredity and gender that are considered to be potential influences, should be studied in detail before any precise figures are arrived at. Currently, hardly any published literature is available on this important but ignored aspect. Life cycle analyses of the faunal emissions have to be made with dissociation and by-products as the major points for concern. It is observed that the life cycle of a meat cow or cattle is much shorter than a milking cow. In countries like India, where cow is mostly a source of milk, this is an important factor in developing sustainable solutions.

THE EUROPEAN EXPERIENCE

In 2006, an interesting report from the UN's Food and Agriculture Organization (FAO) calculated that the world's 1.5 billion cattle and buffalo, 1.8 billion small ruminants, and almost one billion pigs produce methane emissions equivalent to about 28 % of all the annual greenhouse gas emissions (www.fao.org). Though the report is only about livestock, it is no laughing matter and is only the tip of an iceberg as there are stray and wild animals for which we have no data. According to this UN report, some cattle are known to emit flatulence to the extent of 500 litres per day as they chew the cud extensively. Some European countries contemplated imposing 'fart tax' on farmers and cattle owners for the excess cattle that they rear, as their emissions will have to be monitored and countered through other means. This was based on UN's biased report from an evaluation of the situation in European countries. In the author's opinion, this does not solve the problem entirely but only to a smaller extent as the imposition of 'fart tax' only provides for the financial resources required to counter the problem and other solutions will have to be found simultaneously. The fart tax initiative was later voted out. Besides, the cattle contribute to only a fraction of the faunal population. A country like Netherlands that has significant livestock population could be used as a model to solve the crisis rather than imposing fart tax. A recent fire accident in Germany where the cattle were housed in a closed enclosure is also an eye opener on the issue that raises security concerns in addition to taxation. As methane is self-igniting, safe sequestration from a closed system is a necessary step (BBC News 2014). In 2010, UN's FAO stated that flatulence caused biodiversity loss in marine ecosystems near the South China sea. In a different study, oyster and shell fish flatulence is reported to contribute about 10 % of GHG emissions from the Baltic sea.

UNITED STATES INITIATIVES AND CONCERNS ON SUSTAINABLE DEVELOPMENT

Former President Obama's White House has released a Climate Action Plan that includes the targeting of methane emissions from cows and other barnyard animals that threaten the planet through belching and other activities. The White House is now targeting the American agricultural abundance by aiming to slash the methane emissions

Table 1: The human and livestock population of some key countries.

Region	*Homo sapiens*	Camels	Goats & Sheep	Pigs	Buffaloes	Cow and Oxen	Poultry	Others	Total
India	1.3 b		201 m		111 m	200 m	729 m	2 m	2.543 b
China	1.4 b		300 m	480 m		103 m	5.6 b		7.883 b
Brazil	203.6 m		40 m		2 m	200 m	1 b	6 m	1.451 b
Argentina	45 m		20 m			60 m		4 m	129 m
Tropical Africa	650 m	12 m	264 m	100 m		161 m	460 m	12 m	1.659 b
Bangladesh	150 m		40 m			30 m	200 m		420 m
Australia	25 m		75.5 m	2.1 m		30 m	100 m	40.3 m	272.3 m
European Union	508 m			191 m					
Europe & Central Asia						159 m	2.3 b		3.158 b
USA	320 m		10 m	70 m		100 m	2 b		2.5 b

Sources: www.fao.org, www.wikipedia.org, www.inta.gov.ar, www.sapgaya.mecon.gov.ar

from cows by 25% by 2020 to inclusively address sustainable development issues. The EPA says "cattle emit about 5.5 million metric tons of methane per year into the atmosphere, accounting for 20% of U.S. methane emissions". Such a ravaging of the planet from cow belching and flatulence must be stopped, says the EPA despite the fact that the cow population in USA is only next to that of India, Brazil and China. The concern by US authorities is welcomed as the developing model if implemented could greatly influence GHG emission cutting in other nations also. But the EPA has not officially included the GHG emissions by living beings in their total annual estimates for the planet. In the statistics published in the EPA website, only the emissions from agriculture, process industries, transportation and others are shown. Nor has it included the same in the emissions from the agricultural sectors. Besides, one has no knowledge about the number of stray and wild cattle in the USA, the underdeveloped and the developing nations. The exact figures could be significant in their impact.

Further, NASA that has conducted many studies through the EPA, has developed space stations along with Russia, astronauts living in pressurized and controlled atmosphere chambers are likely to fart accidentally during an electric short circuit or even leakage, thereby causing explosions. This can be curbed when they were inner garments are also catalytic convertors or inert dissociators.

SUSTAINABLE INITIATIVES IN BRAZIL AND ARGENTINA

Brazil and Argentina seem to have a novel method of harnessing wind energy. If you imagine turbine blades you are in for a surprise! You are made a witness to seeing cows wearing backpacks that can capture about 300 litres of methane and other gases that could be sequestered to yield only methane which would later power cars. Argentina's cows wear backpacks to capture their 'emissions' and can be termed as miniature power stations. While Europe and the USA are planning legislations, Brazil and Argentina do not seem to show any interest in them (www.sapgaya.mecon.gov.ar, www.inta.gov.ar) but in harnessing the emissions rather, accepting them as nature's gift. A soft polymer or rubber tube from the pack is inserted into the cow's digestive tract to collect the gas and the methane gas is then converted into enough energy to run a car for 24 hours. Letting out methane in to the atmosphere would mean that a gas 23 times more potent than carbon dioxide is being allowed in the atmosphere. So, a novel cost effective and non-legislational (and non-political too) method is being followed by Brazil and Argentina that could inspire nations like India and China to follow up as legislations could face stiff resistance from the farmers and landlords.

THE ASIAN SCENARIO

Table 1 provides enough information about the two Asian rising economies that have no recorded initiatives in this sensitive sector (Animal Husbandary India 2014, Huai 2013). The two nations are already an upset applecart. More than 10 billion humans and domesticated animals account for the environmental impact due to flatulence. The human to domesticated animal ratio in India is nearly 1 including the poultry. In China, the figure is about 5.6 domesticated animals per human. These figures are only approximate as there has been no precise census on all the domestic animals that include cats and dogs which also emit gases. The population density is 383 persons per sq km in India that makes it nearly 800 living beings per sq km. In China it is about 145 persons per sq km which totals up to more than 800 living beings per sq km. China and India together account for more than 200 billion litres of flatulence per day which is 4 times higher than the emissions from USA per day. It is noteworthy here that the emissions by stray and wild species are not accounted for. Further, it is agreed gen-

erally that meat eating causes more climate change. A human eats 200 grams of meat a day on an average in Europe, 140 grams in China and only about 20 grams in a country like India where the cow is sacred. This not only necessitates a perceptive difference altogether, but also urges the need to look at trading the balance between life cycle issues, population and their implications. For example, a low climatic impact due to low meat consumption can be totally offset by a large livestock population as in India which has the highest bovine population of nearly 520 million as against a worldwide population of about 1.45 billion. Other than a few solitary publications (Padmanabhan 2014, Swamy & Bhatacharya 2006) on GHG emissions from livestock, the importance of nitrous oxide emissions and the abatement options in the Indian context, no initiative has been observed on the Indian side including the government ministries. No publications have been documented from China on this issue.

In the author's opinion, the initiatives and concerns by America will have to be observed, modified and adapted for the demography and local distributions. Whether legislation is the solution or not, it is time to be concerned about the environment and steps taken to mitigate the emissions through proper diet and follow the Brazilian or Argentinian methods to not only reduce the GHG emissions into the air, but also harness the wind power of the cow. Once Europe and US come to terms with the situation and pass legislations that are also implemented, there could be sanctions on developing nations to follow suit as the situation demands a global consensus and compliance.

A CASE STUDY OF BANGLADESH AND AUSTRALIA

Let us take the example of an Asian country like Bangladesh where more than 1200 humans live per sq. km (Livestock Information Bangladesh 2015). As for every human there are nearly three domesticated animals, the actual density per square kilometre is more than 4500. Flatulence is heavier than air and tends to settle down in the plains raising concerns of health hazards due to the 16 odd billion litres of flatulence thrown out into the air every day. We have no clue as to the flatulence thrown out from wild and stray animals. The health hazards in such small but heavily populated countries should be monitored in relevance to flatulence. There has been no action from the Bangladesh government in this aspect and it is basically an agricultural country.

While considering Australia, which is a demographic dipole of Bangladesh, due to low population density despite a high animal population (www.fao.org), one takes a deep fresher breath, though for every human being there are four domesticated animals and four chicken. However, due to Australia's life style, they are called the world's worst per capita flatulence producers. Indeed, Australians throw up nearly 16 billion litres of flatulence every day into the air, just like Bangladeshis. Australians take a fresh breath because the population density is nearly 200 times lesser than that of Bangladesh. However, the number of cows that each have is more or less the same. This is a classic case of similar populations and grossly differing demography that demand totally different methods for mitigation.

FUTURISTIC PROJECTIONS

The human population has increased by 60 % ever since the first recorded article on the influence of flatulence by fauna was written and published by Paul Crutzen in 1986. Some of the livestock members have also doubled in their numbers during the course of time, while the others too have not been left behind. One has no clue as to the census of the wild and stray animals. The countries listed in Table 1 alone account for 20.01 billion domestic living beings including *Homo sapiens*. The entire planet is estimated to let out a few trillions of litres of GHGs in to the atmosphere every day (Padmanabhan 2014). By 2030 AD the emissions would have tripled compared to 1986 when the first traces of awareness were documented by Paul Crutzen and co-workers (Crutzen 1986).

The so far ignored dark continent Africa should be a subject of considerable attention. The African population is fast approaching the human population of India and China and that brings along the livestock population too as the African economy is still agricultural. The present estimates of 20 to 25 % of flatulence by weight fraction in a city environment could be humbled in AD 2030, especially in cities where there is no regulation on domestic livestock population. Developing nations would have to note this aspect and view it seriously. Africa could gain immensely from the other exercises as a late comer with a sustainable advantage. The following section spells out some sustainable solutions and the threats posed.

SUSTAINABLE SOLUTIONS, SPECULATIONS AND STALEMATES

As mentioned earlier, planting many tree saplings and growing them is a viable and major solution to the problem. Genetically modified flora that emit a high content of oxygen could also mitigate the contribution of GHG emissions by members of fauna. While we regulate our automobile and industrial emissions through filters and catalytic converters we should also evolve environment friendly technologies to not only dissociate off or digest the unwanted

components of emissions thrown into the atmosphere, but also build gases that do not contribute to green house effect, from the dissociated components through technological manipulations. Low methane emitting diet that enhances milk yields has also been formulated and agencies have begun feeding cows with these fodder with success. A community in England adds garlic to cattle feed to reduce GHG footprint rather successfully. Further, as cows emit GHGs more orally by chewing the cud than through the anus depending upon their intake, it is more practical to give them a smart mask that would solve the dual purpose of holding the food while eating and mitigating the emissions through catalytic conversion or dissociation.

The Brazilian and Argentinian methods are bound to gain popularity in countries like India and China where legislation might be very difficult. Similar to the cattle dung based fuel gas exercise, India can foray into a more direct methane producing venture through back pack exercises. Dung based biogas initiatives deplete the humus content in the soil but a flatulence based exercise does not. Thus, it is a more favourable method. Cows that have stopped yielding milk (barren cows) need not be let out in to the public but used for producing a farm based methane fuel. This also reduces the menace of stray cattle as they can be housed in a methane producing farm.

Fig. 1 provides a schematic understanding of the steps involved in the potential usage of cow and other animal flatulence as energy alternatives for a sustainable development. The purified flatulence can be used in IC engines for combustion after sequestering CO_2 and other non-inflammables from the gases that are inflammable. This way there could be a considerable reduction in the flatulence that is let out into the atmosphere by the animal. Besides, the potential of flatulence as an energy alternative can also be realized. The sequestered CO_2 can be dissociated further or used as a laboratory consumable in chemical, biochemical and metallurgical reactions. CO_2 is also a good refrigerant, pneumatic gas in devices and a recovery gas for oil fields as its use in carbonated beverages and food industry could be religiously questioned.

Quite a few hurdles exist as there is an inbuilt resistance to any change proposed. As there is a significant difference between 'later than ever and never', developing countries should maximize the late comer's advantage and perform better than the developed nations in reducing the GHG emissions through flatulence as growth rate should not lead to a counterbalance. The emissions can only be reduced but not eliminated. A 25 % reduction in GHG emissions globally in flatulence would mean a very successful feat for a beginning. The situation is more grave than the CO_2 footprint as methane is 23 times more potent as a GHG than CO_2. It takes 10 years for methane to dissociate into CO_2 that would in turn dissolve in the rivers and ocean to produce carbonic acid, only to turn water into acid. Can we wait for years and put up with more acids and a further increase in faunal population? Any study meant to suggest solutions should include more quantitative assertions and build sustainability. The investigators should touch upon standard procedures to calculate global warming potentials for the gases released from flatulence. Finally, the individuals or organizations must list any modelling developments and initiatives taken worldwide to link country-wise contributions and concomitant greenhouse gas release from flatulence. A new empirical estimate can then be derived for

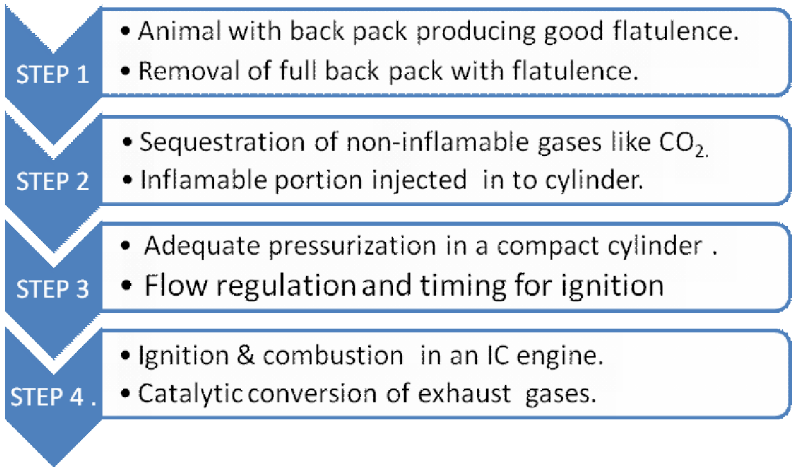

Fig. 1: A flow chart for harnessing flatulence as an energy alternative.

quantifying GHG from flatulence, viz. formal population density.

Long term sustainable solutions can be arrived at if the human and livestock population are reduced through introspection. Overgrazing by unwanted cattle can also lead to deforestation. Mitigation appears possible and it requires implementation at the individual and grass root level.

On the Earth Day, 22nd April, 2016, The Paris Agreement was concluded where 175 nations participated deliberating on environmental issues and sustainable development albeit faunal emissions were never discussed. It is sincerely hoped that the next such world summit would discuss this significant concern and create a framework for a global and local solution for a sustainable development in this burning issue.

ACKNOWLEDGEMENT

The author thank the investigators with whom he has shared his views. His thanks are also due to Prof. S. Ghosh for having come forward to provide suggestions to the work and enhance the overall appeal. He thank Prof. G. Srinivasan of IISc, Bangalore for the help with literature. He thank the VIT management for the support and encouragement.

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