World Journal of Pharmaceutical and Life Sciences
WJPLS
www.wjpls.org
SJIF Impact Factor: 6.129

METHANE MITIGATION IN LIVESTOCK: A TOOL TO FIGHT BACK CLIMATE CHANGE.

F. Rahman[1], I. A. Baba*[2] and I. U. Sheikh[3]

[1]MVSc Student (LPM), Division of Livestock Production and Management.
[2]Assistant Professor (LPM), Faculty of Veterinary Sciences and Animal Husbandry Shuhama.
[3]Professor (LPM), Sher-i-Kashmir University of Agricultural Sciences and Technology (Kashmir), Shalimar.

Corresponding Author: I. A. Baba
Assistant Professor (LPM), Division of Livestock Production and Management.

Article Received on 07/02/2021 **Article Revised on 27/02/2021** **Article Accepted on 17/03/2021**

ABSTRACT

14.5% of total anthropogenic greenhouse gas (GHG) emissions are contributed by livestock industry. Cows contribute more to climate change in a year than cars do in the same amount of time because cows produce methane and cars carbon dioxide. Methane is 21 times more potent GHG than carbon dioxide. Enteric fermentation and manure from ruminants represent 30-40% of total anthropogenic methane emissions. Methane yield is not only harmful to global environment but also leads to loss of gross energy intake, the energy that otherwise could be used by the animal for production. This paper summarizes various methods for mitigating methane emissions from ruminant animals given emphasis to dietary manipulation and supplementation, selecting and breeding livestock of high genetic potential for production traits and low methane emissions per unit of product. Ionophores such as monensin have been used for increasing production and reducing methane emissions in beef and dairy industry. Manipulating rumen by defaunation can be done using natural feed additives such as plant secondary metabolites or chemical agents. Grass land management and reducing stocking density are other strategies that could be employed to improve the condition of degraded pastures and increase overall productivity. Vaccinating ruminants against methanogenic archae of rumen is a comparatively new technique in the field of methane mitigating strategies. There is a need of providing relevant information to the producers about adopting various methane mitigating techniques in their farming systems and management practices to reduce methane yield per unit product and mitigate climate changes.

KEYWORDS: Green House Gas, Climate Change, Green house Gases, Diets and Economics.

INTRODUCTION

We as living beings enjoy the creations that feed and nourish us. One among them is our largest livestock population. Livestock as a lucrative enterprise, supplementary income for marginal farmers or as human companions, play an important role in our sustenance. But unfortunately, to every livestock product there is a byproduct that may or may not be useful torest ofthe nature. Any substantial change in earth's climate that lasts for an extended period of time is known as climate change and the consequence of climate change that causes an increase in the average temperature of earth's lower atmosphere is known as global warming. Global warming has scores of causes, natural as well as anthropogenic, but the most common being human interference, specifically release of excessive amounts of greenhouse gases (EPA 2006, Naqvi and Sejian 2011, Santra *et al*. 2012). The most important greenhouse gases are; carbon dioxide (CO2), methane (CH4) and nitrous oxide (N2O). As compared to CO2, CH4 and N2O are released in mere amounts but have much higher warming potential. Using CO2 as a base, the global warming potentials of CO2, CH4 and N2O are 1, 23 and 298 respectively (Ramaswamy *et al*. 2001; Solomom *et al*. 2007). The global atmospheric methane concentration has increased by 250% i.e. 715 ppb to 1774 ppb, between pre-industrial times and 2005, as is communicated by the reports of Intergovernmental Panel on Climate Change (IPCC).The specialized digestive system of ruminant animals like cattle, buffalo, sheep and goat, on one hand enable them to convert unusable plant materials into nutritious food and fiber, but on the other, produces methane. Methane as a greenhouse gas, contributes 15% to the global warming(IPCC 2001), remains in atmosphere for 9-15 years and is 21 times more potent than CO_2 in trapping heat over a hundred year period(FAO, 2006).Livestock plays a pivotal role in food security. 34% of protein, consumed globally, is provided by eggs, milk and meat (FAO 2007).Among all the food sources, livestock products are responsible for more greenhouse gas emissions via feed production and processing, enteric fermentation, animal waste and land-use change (from forests to pastures). The enteric fermentation and manure represent 80% of agricultural methane emissions (Table 1) and about 30-40% of the total anthropogenic methane emissions (FAO, 2007). Livestock supply chains account for 7.1 GT CO_2, equivalent to 14.5% of global anthropogenic greenhouse gas emissions. Cattle are in control of about two-thirds of that total, largely due to methane emissions brought about by rumen fermentation (FAO, 2018).

Methanogenesis and Methane Production in the Rumen

Feed ingested by ruminants is acted upon by a consortium of rumen microbes (bacteria, fungi and protozoa) under anaerobic conditions, leading to degradation of plant polysaccharides and production of volatile fatty acids (VFA), microbial proteins and gaseous by-products (CO_2, hydrogen) (Kamra, 2005). The major substrates for methane production areCO2 and hydrogen (Ellis and Dijkstra, 2008). Due to the presence of methanogenic archae and other hydrogen utilizing microbes, hydrogen does not accumulate as a gas in rumen instead reduces CO2 and leads to production of methane by a dynamic process called methanogenesis. Due to continued methane yield, a steady fermentative process is maintained in rumen (Wolin, 1975). If the cycle of methanogenesis is not maintained in rumen, hydrogen will accumulate and prevent the re-oxidation of reducing co-factors (NADH, FADH) required for VFA production. 2-12% of gross dietary energy (GDE) is lost in the form of methane depending upon the quality and quantity of feed offered and consumed by the animal(Johnson and Johnson, 1995). Rumen yields 87% of enteric methane while remaining 13% is contributed by large intestine (Locker and Jarvis 1995; Lassy *et al*. 1997). Larger the livestock population more is the contribution to global agricultural methane emissions of a country on a million-metric-ton basis(Kappa *et al*, 2014).India is one among the hot biodiversity spots of the world sharing the largest livestock population of 535.78 million (Anonymous, 2019). In India, the total bovine population is 302.79 Million among which the total cattle population is 192.49 million(Anonymous, 2019).Uttar Pradesh, Rajasthan and Madhya Pradesh are three main methane emitter states with contribution of 1.75 Tg/year (14.9%), 1.07 Tg/year (9.1%) and 1.00 Tg/year (8.5%) respectively. These states together contribute 32.5% of the country's estimated total methane emissions from livestock (Chhabra *et al*. 2009).

Table 1: Methane emission rates by different sources.

Agricultural source	Methane emission rates (million tons per year)
Enteric fermentation	80
Paddy rice production	60-100
Biomass burning	40
Animal waste	25
Total	205-245

Source: Watson *et al*. (1992)

Table 2: Carbon footprints at product level.

Product	Emissions/unit product
Milk production from dairy cattle	2.8 Kg CO_2-eq/kg FPCM
Milk production from buffalo	3.4 Kg CO_2-eq/kg FPCM
Milk production from small ruminants	6.5 KG CO_2-eq/kg FPCM
Beef	46.2 KG CO_2-eq/kg meat
Buffalo meat	53.4 KG CO_2-eq/kg meat
Meat of small ruminants	23.8 KG CO_2-eq/kg meat

Source: EPA (2009).

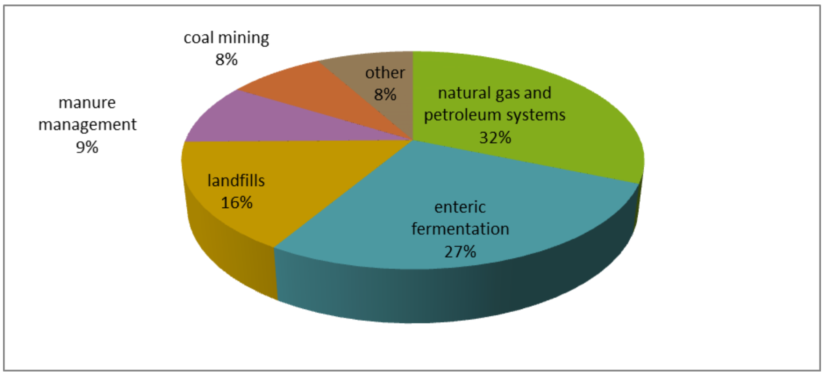

Figure 1: Different sources of methane emissions.

Source: U.S. Environment Protention Agency(2019). Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2017.

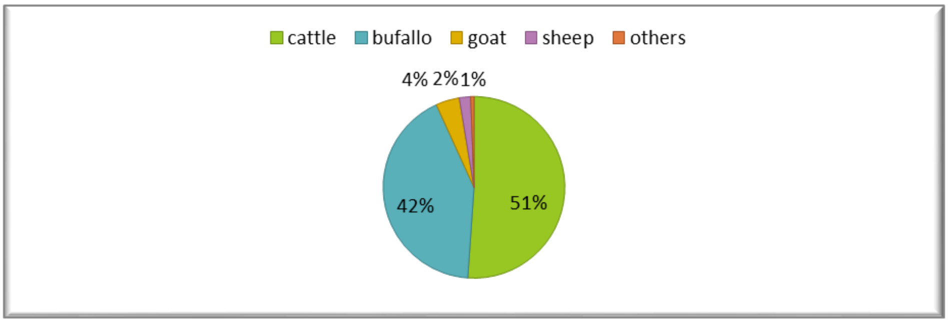

Figure 2: Livestock contibution in enteric emissions.

Source: Chhabra *et al*. (2009).

Table 3: Strategies to reduce methane emissions.

S. no.	Different strategies to reduce methane emission from farm animals
1.	Improved nutrition by providing high quality feed, strategic supplementation of essential nutrients and increasing the proportion of concentrate feeding.
2.	Improved genetic selection to produce low methane producing animals.
3.	Diet modification through ammonia and molasses feeding to reduce methane.
4.	Oil and ionophore supplementation e.g., monensin and tannin.
5.	Defaunation and rumen microbial intervention.
6.	Ensuring proper health care through upgraded veterinary practices.
7.	Reducing the manufacture of livestock production.
8.	Employing advance technology for reducing methane production.
9.	Reduce livestock population.
10.	Improving grassland management.

Source: Sejian *et al*. (2010).

Different strategies for mitigating methane emissions from livestock

I) Dietary manipulation

A simplistic and pragmatic approach among various nutritional strategies of methane mitigation that can reduce methane emissions by 40-75 % is dietary manipulation (Mosier AR, Freney JR, 2000).

Forage quality

Young plants are rich sources of easily digestible carbohydrates and should be preferred because they reduce methane production by altering the fermentation pathways (Beever and Dhanoa,1986). In contrast, mature forages due to high C: N ratio decrease digestibility and produce more amounts of methane. Leguminous forages have lower methane yield due to presence of tannins, a low fibre content, a high dry matter intake and a fast passage rate (Beauchemin and McAllister, 2008).

Forage processing

Methane production can be decreased by 20-40% per unit of feed intake by grinding and pelleting of forages (Johnson and Johnson, 1996). The reduction in methane production associated with ground and pelleted forages is attributed to reduced particle size, reduction in fibre digestibility and a faster rate of passage (LeLiboux and Peyraud, 1999). Fine grinding of forages has proven to be uneconomical due to the greater incidence of acidosis associated with deficient effective neutral detergent fibre and low milk fat concentration (Boadi *et al*., 2004).

Forage preservation

Partially fermented ensiled forages have lower power of methanogenesis (Boadi *et al.*, 2004).Maize or whole grain silage can reduce methane production in rumen by increasing dry matter intake, reducing residence time of ingesta in rumen, enhance propionate production and improve animal performance which lowers methane emission per unit product (Murphy et al., 1982).

Concentrates

Feeding forages at maintenance plain of nutrition lead to 6-7% loss of gross energy intake (GEI) and when high grain concentrates are offered ad libitum, the energy loss reduces to 2-3% of GEI (Johnson *et al* (1995).Concentrate feeds are composed of two components; structural (cellulose and hemicellulose) and non-structural (starch and sugar). Among all the carbohydrate sources, starch contributes least to methane production in rumen (Tamminga *et al*., 2007). Besides maintaining propionate dominating VFA environment in rumen, starch feeding decreases methane emission by; creating an alternative hydrogen sink (Murphy *etal*.,1982), lowering rumen pH, reducing growth of methanogens (Russel *et al*, 1996), decreasing rumen protozoa number and limiting the interspecies hydrogen transfer between methanogens and protozoa. Sugar being water soluble carbohydrate is more methanogenic than starch because former is rapidly and completely degraded in rumen leading to enhanced butyrate production at the expense of propionate production.

Genetic Improvement in Forages
High levels of water soluble carbohydrates are present in tropical grass cultivars. Breeding such forages to increase animal performance as a consequence reduce methane emission per unit of product. This has been shown with ryegrass genotypes in U.K. (Lovett *et al.*, 2006).

Feed Additives
Dietary fats
In ruminant ration, fats and oils may be added to feed at a concentration below 7% to reduce methane production, a higher concentration may inhibit carbohydrate breakdown altogether (Hegarty, 1999). Dietary fats are effective dietary alternatives for reducing methane production compared to concentrate diets as former depresses ruminal methanogenesis without decreasing ruminal pH(Sejian*et al.*, 2011). A reduction of 55.8% in grams of methane per day has been observed by feeding linseed oil (5% of dry matter intake) to lactating dairy cows (Martin *et al.*, 2008). Coconut oil is the most popular oil for methane abatement experiments and has been found to reduce methanogenesis by 13-73% depending up on the inclusion level, diet and ruminant species used for experiment (Machmuller *et al.*, 2000). Beauchemin *et al.* (2008) reported that in beef cattle, dairy cows and lambs, for every 1% (DMI basis) increase in dietary fat, methane (g/kg DMI) was reduced by 5.6%.Fats and oilscan supress methane production indirectly as well as directly, indirectly by reducing organic matter fermentation and fibre digestibilityand directly by inhibition of methanogens in the rumen via bio-hydrogenation of unsaturated fatty acids (Johnson and Johnson, 1995). Medium chain (C8:C14) fatty acids are most effective in methane mitigation. Furthermore, fats are not metabolised in rumen (Jenkis *et al.* 1993) and therefore do not contribute to methanogenesis (Johnson and Johnson, 1995).

Bacteriocins
Bacteriocins are the peptides or proteins produced by bacteria. They increase population of cellulolytic bacteria and increase cellulose degradation (Kalmokoff and Teather, 1997).Bacteriocins produced by Streptococcus bovis act as potential feed additives by inhibiting growth of indigenous ruminal Streptococcus bovis and prevent rumen acidosis caused by them (Manrovani *et al.*, 2002). Bovicin HC5 is a bacteriocincapable of inhibiting most Gram-positive ruminal organisms and reduces approximately 50% of methane production when added to mixed ruminal cultures as semi-purified preparations (Lee *et al.*, 2002). Nisin obtained from Lactobacillus lactis ssp. lactis, is another bacteriocin capable of reducing methane production by 36% in-vitro (Callaway *et al.*, 1997).

Organic acids
Organic acids (intermediates of carbohydrate metabolism) when added to rumen act as hydrogen sink and enhance propionic acid production (Boadi *et al.*, 2004). In batch cultures, fumarate and acrylate produce the most consistent reductions in methane production however, fumarate is more effective than acrylatein artificial rumen (McAllister *et al.*, 2008)) and reduces methane output by 38% in continuous fermenters using forage as a substrate (Kolver, 2004).

Ionophores
Ionophores are chemical agents with selective effect on rumen microorganisms. Antibiotics, such as monensin, are antibiotics that are customarily used in beef and dairy cattle production to improve feed efficiency, harmonize feed intake and improve animal productivity (McGuffey *et al.*, 2001). Monensin by increasing reducing equivalents of propionate production build up acetate: propionate ratio in rumen (Beauchemin *et al.* 2008). Ionophores reduce methane yield by shifting the bacterial population from Gram-positive to Gram -negative with a consequent change in the fermentation from acetate to propionate (Patra *et al.*, 2012). Ionophores reduce the number of rumen protozoa that shelter methanogensand hence help to reduce methane production (Tokura *et al.*, 1999). Feeding monensin @ 33mg/kg reduce methane yield by 30% (Guan *et al.* 2006).

Probiotics
The use of probiotics for methane mitigation has newly been described (Moss *et al.*, 2000). Probiotics, such as, lactic acid producers (Lactobacillus plantarum, L. casei, L. acidophilus and Enterococcus faecium), acetate and propionate producers (Selenomonas ruminatium and Megasphaeraelsdenii) and yeast (Saccharomyces cerevisiae and Aspergillusoryzae) are widely used (McAllister *et al.*, 1999). There is advancement in feed intake, rumen fermentation and milk yield by using probiotics obtained from Saccharomyces cerevisae (Beauchemin *et al.*, 2008). Methane reducing probiotics are promising agents for methane mitigation due to their modest price and wide use in ruminant production.

Plant Secondary Metabolites
There has been a paradigm shift for the use of plant secondary metabolites (PSM) as natural, safe and alternative feed additives for inhibiting enteric methane emissions (Patra and Saxena, 2010). Some plant extracts with high concentration of bioactive agents like saponins, tannins and essential oils (EO), appear to have potential to inhibit methane production in the rumen (Kobayashi, 2010). The methane supressing effect of PSM is mainly associated with antimicrobial effect that kill the bacteria (Bodas *et al.* 2012), protozoa (Hristov *et al.* 2003) and fungi (Patra *et al.* 2009) in the rumen.

Saponinsinhibit rumenbacterial and fungal species (Patra *et al*., 2009) and limit the H2 availability for methanogens in the rumen, thereby reducing methane production (Bodas *et al*., 2012). Methane reduction of upto 50% has been reported with the addition of saponins (Patra *et al*., 2009).Condensed Tannins (CT) have been shown to reduce methane production by 13-16%, mainly through a direct toxic effect on methanogens(Goel and Makkar, 2012). They show their effect either by their bactericidal and bacteriostatic activities or/and by inactivating ruminal enzymes (Faixova and Faix, 2005). Methane production was reduced up to 55% when ruminants were fed tannin-rich diet, such as lucerne,sulla, red clover and lotus (Barry *et al*., 2005).The side effects of tannin feeding as an anti-nutritional factor, depends up on tannin concentration in the plant, animal species, physiological status of the animal, and diet composition (Yanez Ruiz *et al*., 2004).

Exogenous Enzymes

Enzymes such as cellulase and hemicellulase are currently being used in ruminant diets. When properly formulated, enzymes can improve fibre digestibility, animal productivity (Beauchemin *et al*. 2003) and lower acetate: propionate ratio in the rumen, ultimately reducing methane production (Beauchemin *et al*., 2007).

Alternative H_2Sink

Nitrates and sulphates in small amounts in the basic diets of animals act as alternative electron acceptors and hence can help to reduce methane emissions. A 32% methane reduction was reported for nitrate, 16% for sulphate and 47% for a combination of nitrate and sulphate fed to lambs (Newbold *et al*., 2010). However, nitrate supplementation has not been established in many countries (e.g. Denmark) due to its toxic effects that could lead to animal death. A lower amount of nitrate in the diet is safe for the animal (Bruning *et al*., 1993).

Genetic Basis of Methane Mitigation

Opportunities for nutritional and microbial manipulation to reduce enteric methane emissions from livestock have been extensively researched and reviewed (Beauchemin *et al*., 2008; McAllister and Newbold, 2008), but there is a little information on opportunities for mitigation via animal genetics. If livestock GHG emissions are included into local and global carbon economies, mitigation of enteric methane emissions may shift to private breeding objective from current public breeding objective (Wall *et al*., 2010). Recently the focus has been on livestock genetic improvement, but little about the correct breeding objectives (Jones 2008; Hegarty 2009; Arthur *et al.,* 2009). Possible objectives include reduction in total emissions from the sector, farm or individual animal, or reduction in emission intensity (emissions/unit animal product) or methane yield (g/kg fed). The direct costs of GHG explicit should be included in the economically based breeding objective. Similarly, the GHG emissions metric should be expressed on a basis that is independent of other traits to aid breeder interpretation (Blaxter and Clapperton, 1965). In order to attain breeding objectives, heritability and repeatability of methane traits and feed intake are required. Assuming a direct positive correlation between methane emissions and production traits, there is a little selection pressure for methane relative to that for production traits due to low economic value of methane at current carbon values as a result of which methane emissions go unchecked. Genetic improvement in cattle is a cost-effective technology, producing permanent and cumulative changes in performance. Wall *et al*.(2010)reviewed three routes through which genetic improvement can help to reduce methane emissions per kilogram of product include improving productivity and efficiency, reducing wastage in the farming system and directly selecting on emissions.

Animal selection

Selection of animals with high genetic merit is an important tool for genetic improvement of animals. However, if proper economic values are given to methane yield per animal, selection can be used as an effective tool for mitigating methane emissions. Bentley *et al*. (2008) in his studies compared methane production on the basis of weaned weight of two cattle breeds. He estimated that changing from Shorthorn cows in 1981 (mean cow live weight of 422kg) to Composite breed cattle in 2006 (mean cow live weight of 507kg) reduced methane emission/tonne weaned weight by 31%. This was largely on account of the higher weaning weight rate achieved by Composite breed females. Modelling of the effects of prolificacy in sheep by Alcock (2009) and Cruickshank *et al*. (2009) showed 4% improvement in emissions /live weight sold per 10% increase in lambing rate. Animals can be selected on the basis of methane-specific trait. There are a number of mechanisms by which host animal genetics may affect Daily Methane Production (DMP) including;

Diet Selection

Ingestion of forages of differing digestibility will alter methane yield between ruminant species as well as within the species (Blaxter and Clapperton 1965, Warren *et al*., 1984). Thus, the animals to be selected should be provided with similar diets so as to exploit their genetic potential regarding methane production/unit product.

Eating Rate

Animals with faster rate of eating show lower DMP because faster rate of eating is associated with shorter mean retention time in gut (Forbes *et al.*, 1972). Thus, selecting animals on the basis of faster eating behaviour can lower methane emissions.

Digesta Kinetics

The retention time of digesta fluid has a strong association with methane yield, both in continuous culture studies and in ruminants (Pinares *et al*., 2003). Rumen retention time explained 57% between sheep variation in methane emissions (Pinares *et al* 2003).

Based upon differences in feed retention time in rumen, Waghorn *et al.* (2006) reported that at the same stage of lactation and same diet, Holstein cows from the Northern Hemisphere produced 15% less methane/kg DMI than cows of New Zealand.

Long Retention in the Herd or Flock

The highest producing animals are identified and maintained in the herd or flock while replacing less productive animals earlier in their life. An increase in average female age, reduce the need for replacement females hence reduce methane emission intensity. Delaying culling of ewe by 1 year could reduce emission intensity by 6.4% (Cruickshank *et al*., 2009). Increasing retention in the milking herd reduced cow number required to produce milk to the quota and reduced methane emissions approximately by 4% (Wall *et al.*, 2010).

Residual feed intake (RFI)

RFI= measured feed intake- predicted feed intake. Animals with negative RFI are efficient than animals with positive RFI. Few results have shown that RFI is correlated ($r=0.44$, $P\leq0.05$) with daily methane production and energy lost in cattle (Nkrumah *et al*., 2006). In another study Hegarty*et al*. (2007) also reported a significant ($p\leq0.01$)positive relationship between methane production and residual feed in take in Angus steers. Thus, selecting animals with negative RFI can help to mitigate methane production.

Phenotypic Selection for Reduced Enteric Emissions

No difference was found between emission rates of sheep breeds, Bos Taurus and Bos indicus (Hungate *et al*., 1960). Indigenous sheep (Pinares*et al.*, 2003) and cattle (Goopy *et al.*, 2006) are expected to produce more or less than expected, but these phenotypic differences have not been always maintained across diets. One of the critical challenges to breeding for low emissions is the lack of an accurate measurement technology to phenotype large number of pedigree progeny to establish genetic parameters for a methane trait. However, enclosure of sheep in respiration booths for 1-2 hours was found to be the most useful of a suite of predictors of DMP studied (Goopy*et al.*, 2009). A standardised pre-measurement protocol and recommended multistage selection (Robinsonm, 2009) was used to measure emissions from over 700 sheep. This study identified significant sire differences in methane production and a heritability of 0.13 for methane production. The short term enclosure method of Goopy could be the first stage selection tool as preclude to calorimetry in identifying animals of extreme methane phenotype.

Grassland Management

Permanent pastures and meadows cover about 3.3 billion hectors, one quarter of the earth's land area and 68% of the global agricultural area. Since age's people have been rearing animals for their capacity to turn marginal resources into high value food, produce manure for fertilization, provide supplementary income to farmers and so on. Increase in livestock sector and poor grazing management increased grazing pressure as a result of which 20% of grasslands around the world are degraded. The solutions to restore the quality of pastures and increase soil carbon include adjusting grazing pressure by balancing spatial and temporal presence of livestock, fertilization and nutrient management, introduction of nutritious grass species like legumes, improved mobility of animals in pastoral and agro pastoral systems, integration of trees and pastures (silvopastoralism) and rotational or deferred grazing (FAO, 2007).

Changing Rumen Environment-Defaunation

The removal of protozoa from rumen is known as defaunation and it has been used to investigate the role of protozoa in rumen function and methanogenesis. It has been reported that ruminal methanogens remain attached to protozoan species indicating an interspecies hydrogen transfer (McAllister and Newbold, 2008). 9-37% of methane in the rumen has been found to be produced by ciliated protozoa (McAllister and Newbold, 2008). Removal of protozoa from the rumen has been associated with decrease in methane production (Patra and YU, 2013). Plant bioactive agents and chemical agents can be used for defaunation. In vitro studies in India using ethanol extracts of *Sapindus mukorossi* (a seed rich in saponins) showed a 52% reduction in protozoa population and 96% reduction in methane emissions in buffalo (Agarwal*et al*., 2009). Depending upon diet, defaunation can decrease methane production by 50% (Hegarty *et al*., 1999). Different techniques have been tested experimentally for removal of protozoans from the rumen but none is used routinely, because of toxicity problems, either to the rest of the rumen micro flora or to the host animal (Gworgwor *et al.*, 2006).

Vaccine

In order to overcome the disputes and security issues related to the use of chemical feed additives, a novel artificial immunity technique has been developed to reduce methane emissions (Buddle *et al.*, 2011). By injecting the vaccine to the animal an immunity response is set up that leads to production of antibodies against methanogens (Clark, 2013). Two vaccine strains were developed by Wright *et al.* (2004) namely VF3 (based on three methanogen strains) and VF7 (based on seven methanogen strains). They reduced methane production by 7.7% per DMI. The strains of bacteria, Methanobrevibacter were used for the study.The development of alternative methanogens after immunisation is a possible reason for the failure of vaccination approach.

Judicious use of antibiotics

Since ages antibiotics have been in use for promoting growth and treating and preventing livestock diseases (Mellon, 2001). Besides being a source of nutrients, organic matter and microbes to pasture ecosystems (Eghbal, 2002), livestock dung can also act as a source of pathogens (Mawdeslay *et al*., 1995) and emit significant quantities of greenhouse gases, including methane (Jarvis SC *et al*., 1995). However, these effects of dung can be modified by the diverse communities that interact, inhabit and consume dung e.g. dung beetles (Manning P *et al*., 2016). These beetles while feeding on dung draw tunnels and create aerobic conditions for dung decomposition thus, reduce methane emissions. Veterinary pharmaceuticals can harm beetles and other downstream consumers of livestock dung, which may depress dung decomposition and reduce the diversity of dung-based communities. Antibiotics administered to cattle alter microflora of their gut as well as dung beetle microbiota and, as a consequence, there is increase in methane emissions from such animals, dung and dung beetles. Antibiotic treated cows produce 80% more methane in dung than untreated cows (Tobin J Hammer, 2016).

CONCLUSION

Methane emissions from livestock industry are very significant contributors to anthropogenic emissions of GHGs. Different strategies and techniques with different profiles of feasibility, cost and possible uptake by the end users can be employed to reduce emissions of different greenhouse gases. However, the prime objective should be focussed on the most cost-effective measure and mitigating methane emissions from livestock industry is one such option to reduce the negative impacts of these emissions on global environment. Although different feed resources and supplements are now available for feeding animals for reduced emissions but the cost of production is also to be given firm consideration. Rumen altering agents are the most promising measures but further research in the field is required. Genetic variations are already being used to reduce emission intensity through traits like live body weight gain, milk production or feed efficiency. The fruition of the method can be achieved by including GH emissions in selection indexes. The usefulness of pursuing low methane animals will depend up on the heritability of the trait, its correlation with productivity traits and ultimately its economic value. Proper enrichment and management of the available grasslands is to be done in order to increase their nutritive value and prevent their degradation. Furthermore, majority of the producers are notaware about the greenhouse gas emissions of the livestock species and their direct impact on the near and far future of generations of generations with respect to climate change and its effects. Thus, filling the gap between lab and land is the need of hour.

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