Vol. 4 Issue- 2, October 2023 (e-ISSN: 2582-8223)

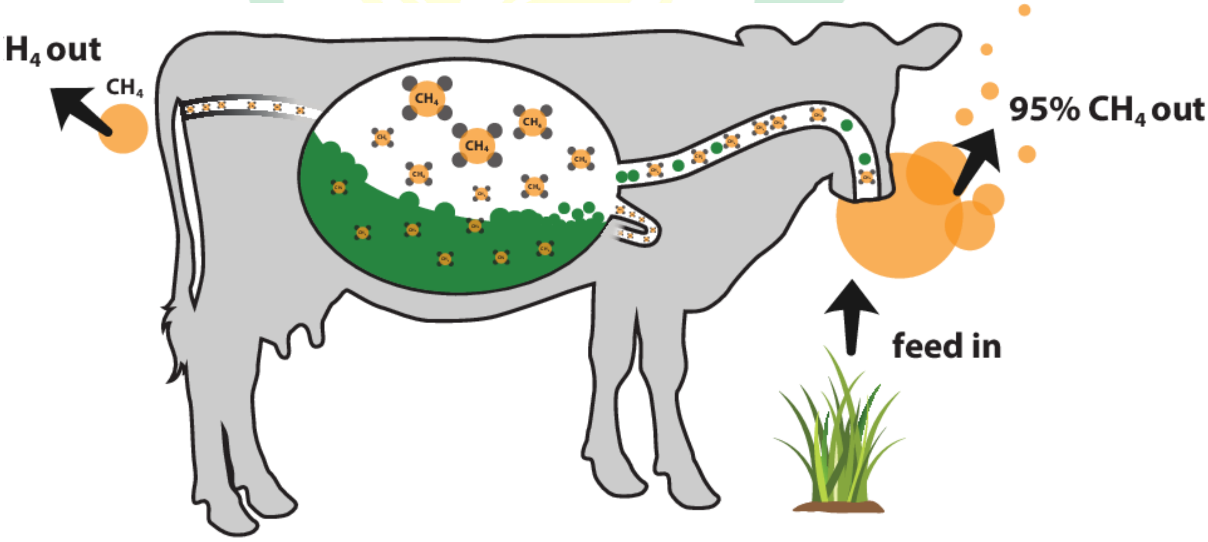
Methane Emission from Dairy Cattle and Its Mitigation

Priyanka A. Dahiwale, Abasaheb K. Parade and Pranjali B. Meshram
Ph.D Scholar, Department of Animal Husbandry and Dairy Science, Mahatma Phule Krishi Vidyapeeth Rahuri-413722, Ahmednagar (MH).

ARTICLE ID: 42

Strategies

Greenhouse gases (GHGs) like carbon di-oxide (CO2), methane (CH4) and nitrous oxide (N2O) in the atmosphere are responsible for global warming. Methane is one of the GHG produced from the ruminants due to the fermentation of nutrients by methanogenic bacteria and expelled to the environment through eructation. Methane (CH4) is a colourless and odourless gas that is released into the atmosphere from many sources, including the digestive tract of ruminant animals (mammals that have a stomach with four compartments that ferment food as a major part of the digestion process). Ruminant animals include cattle, sheep, and goats. Enteric methane is the methane resulting from the fermentation process within ruminant animals' digestive tracts, which allows them to obtain nutrients from feed resources high in fiber and thus not edible by humans.



The global warming potential of methane is 21 times greater than that of CO2. Ruminants contribute about 20-30% of the world total methane production. So ruminants are the major anthropogenic source of methane and minimizing the methane emission from ruminants is a vital role in the present scenario to reduce global warming and enhancing animal productivity. There are various strategies are suggested for reducing methane emission from ruminants are discussed in detail below.

Physical Methods to Reduce Methane Emission

- **Supplemental strategy: -** In India most of the livestock are fed with low quality crop residues and they are tends to produce more methane because of high cell wall contents and low digestibility. Fermentation of cell wall carbohydrates produce more methane than fermentation of starch and leads to greater loss of feed energy. High concentrate-based diets are associated with higher rate of fermentation and low production of methane. Supplementation of concentrate along with crop residues improves the fibre digestion and reduces methane emission from ruminants.
- **Frequency of feeding: -** Low frequency feeding tends to reduce methanogens and protozoal population in the rumen which leads to low methane generation and more propionate production. Low frequency feeding increases fluctuations in rumen pH that can be inhibitory to methanogens. Feeding of ruminates twice a day can help in reducing methane emission.
- **Level of feed intake: -** High feed intake increased the passage rate and decreased the microbial access to the dry matter which in turn reduces the rate and extent of fermentation and ultimately reduces the methane production.
- **Forage species and stage of maturity: -** Methane emission in ruminants tends to increase with high maturity forage crops fed because of high cell wall contents. Methane production from the ruminal fermentation of legume forages is generally lower than non-legume forages, which is due to the fact that lower cell wall content of legumes and faster rate of passage in the rumen. So harvesting at optimum stage and selection of suitable crops for feeding to the ruminants is a vital role in reducing methane emission.
- **Forage processing: -** Grinding and pelleting of forages to enhance the efficiency of nutrient utilization tends to decrease methane emission from the rumen by about 20-40%. This effect is due to lowered fibre digestibility, decreased ruminal available organic matter and faster rate of passage. However fine grinding of forages is not beneficial to dairy animals because of incidence of acidosis and low milk fat syndrome.

- **Ensiling of forage crops: -** Ensiled forage tends to produce lower methane production than dried forages in the rumen. This is due to decreased digestion with ensiled forages in the rumen because of extensive fermentation that occurs during silage making. Addition of enzymes during ensiling of forages is another alternate for reducing enteric methane emission from ruminants.

Increasing the amount of green fodder: - The nutrient requirement of low milk producers can be met through combined feeding of green fodders and straws. Feeding of straws along with green fodders reduces methane emission by about 11-27% through changing the ruminal fermentation pattern.

Chemical Feeding Strategies to Mitigate Methane Emission

Antibiotics

Ionophore antibiotics such as monensin, lasalocid, lysocellin, narasin, salinomycin and laidomycin are added in the diets of ruminants to enhance the efficiency of production and have been shown to decrease methane production. These antibiotics tend to depress fibre degradation and inhibit protozoal growth so it has to be used judiciously.

Defaunation

Elimination of rumen protozoa using chemicals or dietary agents reduce methane production by about 20-50% depending upon the diet composition. Protozoa is responsible for production of more hydrogen in the rumen and more closely associated with methanogens. The chemicals used for defaunation includes copper sulphate, sodium lauryl sulphate, dioctyl sodium sulphosuccinate. However,many defaunating agents are toxic to the animals and practical method of defaunation to reduce methane production is yet to be developed.

Addition of fat

Fats are added in the dairy cattle ration to increase the energy density and to modify the milk fat composition. It was found that addition of medium chain (C8-C16) fatty acids cause greatest reduction in ruminal methane emission and they are less toxic to the ruminal microbes. Unsaturated fatty acids (USFA) also reduces methane production by acting as electron acceptor during biohydrogenation, however, they are toxic to the rumen microbes. Excessive addition of fat in the feed is not recommended because it may suppress the fibre degradation in the rumen hence, dietary lipids are not viable option forsuppressing methanogenesis in ruminants.

Bacteriocins

Bacteiocins are bacteriocidal compounds produced by bacteria and they are peptide or protein in nature. They can be used to reduce methanogenesis in ruminants. Nisin is the well-studied bacteirocin produced by Lactococcus lactis. It has similar actions to monensin and reduced methanogenesis by 36% in vitro. In another study it was found that bacteriocin from Streptococcus bovisreduced methanogenesis as much as 50%.

Inhibition of methanogens using chemicals

Bromoethane sulphonate (BES) is a potent inhibitor of methanogenesis because it is a structural analogue of co-factor mercapto-ethane sulphonic acid (coenzyme M) used by the methanogens. In vitro studies revealed that BES inhibited methanogenesis by about 71% and this is attributed to the toxic effect of BES on methanogenic bacteria. However, in vivo studies in sheep showed that BES effectively reduced methane production only for 3 days which is due to the adaptation of methanogens to these chemicals. Chlorinated methane analogues such as chloroform, carbon tetrachloride and methylene chloride and related compounds such as trichloro ethyl adipate and pyrolmellitic diimide have been reported to inhibit methanogenesis. So it can be concluded that the use of chemicals to reduce methanogenesis may not be a commercially viable method and presence of these chemicals in the animal products needs to be addressed.

Propionate enhancers

Due to the development of resistance by the methanogens to various antibiotics and chemicals agents, there is a need to find alternate to these compounds as growth promoter. Dicarboxylic acids such as fumaric and malic acids have been studied in vitro as feed additive to enhance the efficiency of animal production and to reduce methane emission. These acids act as hydrogen acceptor in the rumen and thereby they make hydrogen unavailable to the methanogens for methanogenesis. Fodder crops rich in these acids can be used for feeding ruminants to reduce methane emission.

Sulphate supplementation

It is observed that sulphate supplementation helps in increasing the production of fibre degrading enzymes and fibre degradation in the rumen. As sulphate / sulphite have high affinity

JUST AGRICULTURE multidisciplinary e-Newsletter

for utilization of hydrogen for its reduction to sulphide, therefore, a fibre diet, as prevalent in Indian livestock, sulphate / sulphite supplementation can be a good mode of rumen amelioration for improving fibre degradability and inhibiting methanogensis, but a proper dose will have to be optimized, keeping in view the toxic levels of sulphide generated on sulphate reduction.

Biological Methods to Mitigate Methane Emission

Enhancing reductive acetogenesis in the rumen in the gut of termites and rodents, acetogenic bacteria convert excess hydrogen to acetic acid. Exogenous inoculation of these acetogens in to the rumen for competing against methanogens may be an option to reduce methane emission from ruminants.

Probiotics

The effect of probiotic cultures on the methane production is minimal and very little information is available on these aspects. Aspergillus oryzae was found to reduce methane emission by about 50% through inhibiting the growth of protozoa. Addition of Sacchromyces cerevisiae reduced methane production by 10% in vitro. The exact mechanism of probiotics on methane reduction was not known.