

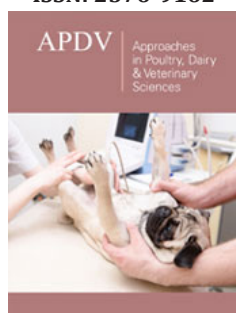
Emerging Trends and Future Directions in Methane Mitigation from Livestock Sector

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Background

Methane emissions from livestock are a significant concern to global warming due to their substantial impact on climate change. According to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change, methane emissions from anthropogenic activities contribute to 0.5 °C to observed Global Warming (IPCC, 2021). Additionally, agri-food systems mainly enteric fermentation of ruminant livestock and the anaerobic digestion of animal manure hold the greater part in this emission (FAO, 2023). The emission from enteric fermentation accounts for 70% of global agricultural methane emissions followed by 7% from manure management [1]. Nevertheless, the regional differences report cases of contribution of manure management and enteric fermentation reflecting that manure management is also central to the 1.5 °C target. The livestock sector is the most significant, and the demand for milk, meat and other livestock-derived products is increasing day by day. The pressing concern about the global greenhouse effects of methane from enteric fermentation mainly ruminants has changed the focus to methane mitigation strategies that are beneficial economically as well as environmentally [2]. The challenge of developing sustainable technical approaches for emission reduction without compromising productive performances is a huge hurdle to tackle [3]. Current research trends are increasingly focusing on innovative strategies to mitigate these emissions effectively. As we look towards the future, understanding the development of these mitigation techniques becomes crucial. This opinion paper examines the current trends in methane mitigation research within the livestock sector that could positively support SDG-13 representing climate action.

Major Interventions to Reduce Enteric Methane Emission

It has already been identified that one of the most promising avenues for reducing enteric methane emissions involves dietary modifications. Researchers are experimenting with feed additives such as seaweed, 3-Nitrooxypropanol (3-NOP), essential oils, probiotics etc. which have shown the potential to reduce methane production by altering the gut microbiota of ruminants [4]. Methane production (g) per kg of Dry Matter Intake was 38% and 30% decreased by using 3-NOP and chloroform respectively compared to the control [5]. Another approach gaining traction is the use of genetic selection to breed ruminants having lower methane emissions traits. Besides these individual variations in enteric methane emissions observed in the same feeding and management conditions suggest the possibility of breeding low-emission cattle and sheep. Identifying individuals that produce less methane and selecting them for breeding, by using indirect selection traits as indicators.

Further, this helps in choosing animals that are naturally low in methane emissions for breeding purposes. Variability due to external factors in methane emission also needed to

be considered. As technology advances today genetic markers can decipher entire genomic information at a reasonable cost. The research has given the idea of individual variability in methane production due to polygenic nature, quantitative trait loci, and single nucleotide polymorphism [6]. This strategy not only reduces methane but also improves feed efficiency, aligning economic benefits to farmers with environmental sustainability [7]. Methane vaccines against rumen methanogens are again a research area in the developmental phase. Antibodies can be created in animals, and they have been shown to subdue in vitro cultures of methanogen. Nevertheless, availability in markets and adoption is a concern as many cost-effective animal vaccines are not even adopted till date [8]. Red Seaweed *Asparagopsis taxiformis* was added and fed as a feed ingredient in the high grain diet in beef cattle. Further, methane emission reduced as the seaweed inclusion increased and the levels were 9%, 38% and 98 % as the inclusion increased from low to high.

Further, the study denoted that, the average daily weight gain compared to the control has been increased due to the inclusion of seaweed. The strategy has a high potential to have a significant effect on mitigating methane production [9].

An evaluation of the potential for mitigating methane by substituting traditional pasture species with those exhibiting anti-methanogenic properties revealed significant benefits. Specifically, replacing a pasture composed of ryegrass and subterranean clover with *Lotus corniculatus* led to a reduction in enteric methane (CH₄) emissions by up to 19%. Additionally, the intensity of emissions was decreased by 5–20% in lamb production, correlating with varied simulated dietary intakes of *L. corniculatus* (comprising 20%, 30%, and 40% of the diet) [10,11]. Legume and Herbs species like *Biserrula* (*Biserrula pelecinus*) showed great potential to reduce enteric CH₄ emissions similar to subterranean clover (*Trifolium subterraneum*) and higher than Lucerne (*Medicago sativa*) in a case study conducted in lamb in Australia. A comparative study was conducted in the tropics of Mexico for cows in Monoculture Systems (MS) and Intensive Silvopastoral Systems (ISPS) to assess the efficiency of grazing systems in relation to productivity and ecological sustainability. As per the study, the dairy milk yield was higher in Monoculture systems than in ISPS. However, enteric methane production was observed 18% less in Intensive Silvopastoral Systems than in Monoculture Systems. The results state that Silvopastoral Systems show better indicators of sustainability than monoculture systems [7]. In addition, the work on Plasma-based nitrogen enrichment of cow manure inhibiting methanogenesis is a novel approach in this regard.

Way Forward

Future scenarios predict a more integrated approach combining technological, genetic, and nutritional strategies to achieve substantial reductions in methane emissions. The adoption of circular economy principles, where waste products are repurposed as bioenergy or feedstocks, could also reduce the environmental footprint of livestock production. Furthermore, policy frameworks and global cooperation will be instrumental in implementing these mitigation strategies effectively, ensuring compliance and widespread adoption across different regions and scales.

References

1. Nyvold M, Dörsch P (2024) Complete elimination of methane formation in stored livestock manure using plasma technology. *Frontiers in Sustainable Food Systems* 8: 1370542.
2. Patra, Amlan K (2012) Enteric methane mitigation technologies for ruminant livestock: A synthesis of current research and future directions. *Environ Monit Assess* 184(4): 1929-1952.
3. Kumari S, Fagodiya RK, Hiloidhari M, Dahiya RP, Kumar A (2020) Methane production and estimation from livestock husbandry: A mechanistic understanding and emerging mitigation options. *Science of the Total Environment* 709: 136135.
4. Badgery W, Guangdi Li, Aaron S, Jennifer W, Smith R, et al. (2023) Reducing enteric methane of ruminants in Australian grazing systems- A review of the role for temperate legumes and herbs. *Crop and Pasture Science* 74(7-8): 661-679.
5. Martinez FG, Duval S, Kindermann M, Schirra HJ, Denman SE (2018) 3-NOP vs. Halogenated Compound: Methane production, ruminal fermentation and microbial community response in forage fed cattle. *Front Microbiol* 9: 1582.
6. Simon R, Gonzalo MF, Yuliaxis RC, Milka P, Stuart D, et al. (2024) Recent advances in enteric methane mitigation and the long road to sustainable ruminant production. *Annual Review of Animal Biosciences* 12(1): 321-343.
7. Flores CG, Juan H, Hernández M, Juan Ku V, Francisco JS, et al. (2023) Intensive Silvopastoral Systems mitigate enteric methane emissions from cattle. *Atmosphere* 14(5): 863.
8. Reisinger A, Harry Clark, Annette LC, Jeremy EB, Carlos GF, et al. (2021) How necessary and feasible are reductions of methane emissions from livestock to support stringent temperature goals? *Philosophical Transactions of the Royal Society A* 379(2210): 20200452.
9. Kinley RD, Gonzalo MF, Melissa KM, Rocky de Nys, Marie M, et al. (2020) Mitigating the carbon footprint and improving productivity of ruminant livestock agriculture using a red seaweed. *Journal of Cleaner production* 259: 120836.
10. <https://www.fao.org/3/cc7607en/cc7607en.pdf>
11. Muir SK, Kennedy AJ, Kearney G, Hutton P, Thompson AN, et al. (2020) Offering subterranean clover can reduce methane emissions compared with perennial ryegrass pastures during late spring and summer in sheep. *Animal Production Science* 60(11): 1449-1458.