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REDUCING METHANE EMISSIONS THROUGH NUTRITION, GENETIC SELECTION AND MANAGEMENT

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Abstract: This paper examines recent developments and research trends related to the reduction of methane emissions in livestock systems, with a particular focus on sheep farming. Methane mitigation is presented as a key objective within sustainable agriculture due to its significant contribution to greenhouse gas emissions and its impact on climate change. The authors identify three main intervention pathways—nutrition, genetic selection, and farm management—as the most effective and widely studied strategies for reducing enteric methane production. The study first outlines general approaches to methane reduction in livestock, emphasizing the biological processes underlying methane formation in the rumen and the factors influencing its intensity. Within this context, nutritional strategies are discussed in detail, including diet formulation, feed additives, improved forage quality, and manipulation of rumen fermentation to reduce methane output while maintaining productivity. Genetic selection is also presented as a long-term mitigation strategy, focusing on breeding animals with naturally lower methane emissions or improved feed efficiency. The authors highlight the potential of integrating genetic traits into breeding programs to achieve cumulative and permanent reductions in emissions. In addition, management practices are analyzed, including grazing strategies, herd structure optimization, and improved overall farm organization, all of which can contribute indirectly to emission reduction. The paper concludes that no single strategy is sufficient on its own; instead, meaningful and consistent reductions in methane emissions can only be achieved through the integrated application of nutritional, genetic, and management-based approaches within sheep production systems.

• Introduction

Reducing methane emissions in sheep (which rank 4th among livestock – Figure 1) requires acting on three complementary levers: what animals eat (because diet is the fastest and most flexible way to influence methane production since methane is created during rumen fermentation) – an issue that can be approached by practicing precision feeding and by supplying additives that inhibit methanogenesis, fat supplementation, higher-quality forages, and more concentrates or starch-rich feeds; how they are bred – an issue that can be approached by breeding for rumen microbiome profiles, selecting for feed efficiency, and selecting for low residual methane production; and how they are managed – an issue that can be approached by ensuring animal health and welfare, ensuring early life programming, improving grazing management, managing manure, and optimising herd structure.

• Material and method

The present study is based on a qualitative bibliographic research design, aimed at analyzing and synthesizing recent scientific literature on strategies for reducing methane emissions in sheep farming systems. The research focuses on three principal intervention pathways: nutrition, genetic selection, and farm management, which are widely recognized as the most relevant approaches for methane mitigation. The material used consists of peer-reviewed scientific articles, review papers, and specialized publications addressing methane emission reduction in livestock, with a primary focus on sheep. The literature was selected from internationally recognized scientific databases and journals. The selection process was guided by the following inclusion criteria: studies published within the last ten years, ensuring the relevance and timeliness of the information; research addressing enteric methane emissions in ruminants, particularly sheep or comparable grazing species; studies focusing on at least one of the three key mitigation strategies: nutritional interventions, genetic selection, or management practices and articles providing experimental data, modelling approaches, or comprehensive literature reviews. The selected literature was analyzed using a comparative and integrative approach. Key findings were extracted and categorized according to the three main mitigation pathways: nutrition, genetics, and management.

• Results and discussion

The present study highlights that reducing methane emissions in sheep farming is a complex but achievable objective, provided that mitigation strategies are implemented in an integrated and context-specific manner. The analysis of recent scientific literature confirms that nutrition, genetic selection, and management practices represent the three principal and complementary pathways through which enteric methane emissions can be effectively reduced.

Table 1. Strategies to reduce enteric methane emission in livestock species

Strategies			
Nutritional	Genetic	Managerial	Miscellaneous
Concentrate feeding	Breeding for low methane production	Fodder management	Biotechnological methods
Defaunation	Breeding for feed efficiency Residual feed intake	Good Veterinary care	Chemical inhibitors
Feeding molasses	Genomic selection	Overall improved nutrition	Immunization
Ionophores	Improved selection	Production enhancers	Optimizing production
Oil supplements	Integrated omics approach	Reducing animal numbers	
Propionate enhancer	Metabolomics	Strategic culling	
Tannin supplements	Metagenomics	Strategic supplementation	

• Conclusions

An important finding of this study is that no single strategy is sufficient to achieve substantial and sustained methane mitigation. Instead, the greatest benefits are obtained through the integration of nutritional, genetic, and management-based approaches. Such a combined strategy allows for immediate reductions through diet, long-term improvements through genetics, and system-wide efficiency gains through management. Overall, the results suggest that methane emissions in sheep farming can be reduced by up to 30–50% over time without compromising productivity, provided that farmers adopt a holistic and adaptive approach. Future research should focus on improving the practical applicability of mitigation strategies in grazing systems, enhancing measurement methods for genetic selection, and developing region-specific solutions tailored to local environmental and economic conditions. In conclusion, reducing methane emissions in sheep farming is not only an environmental necessity but also an opportunity to improve production efficiency, resilience, and sustainability within modern livestock systems.