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Policy Article

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From stable to sustainable: tackling livestock carbon footprints

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Abstract

Sustainable livestock production is crucial for meeting current animal product demands while ensuring environmental, societal, and animal well-being. Practices like feed optimization and efficient manure handling mitigate greenhouse gas emissions, as quantified by the carbon footprint concept, emphasizing the role of methane emissions. Mitigation strategies, including diet modifications and holistic management approaches, are vital for reducing livestock-related greenhouse gas emissions. Government initiatives play a pivotal role in fostering sustainable practices, aiming to strike a balance between ecological responsibility and agricultural productivity.

Introduction

Sustainable livestock production will play a central role in the years to come for achieving the nutritional and livelihood security of the country while ensuring long-term environmental, societal, and animal well-being. Key practices include climate-smart agriculture techniques such as optimizing feed, managing enteric fermentation, and efficient manure handling to reduce greenhouse gas emissions. Prioritizing sustainability is crucial for optimizing resource utilization, promoting food security, and mitigating climate change impacts. Embracing climate-smart farming methods is necessary to adapt to changing climates. Addressing carbon emissions in agriculture, particularly in livestock farming, is vital for mitigating climate change effects, preserving ecosystems, enhancing resource efficiency, and meeting consumer preferences for environmentally friendly products. Ultimately, reducing carbon emissions in livestock farming is pivotal for cultivating a resilient and environmentally responsible agricultural system.

Understanding the concept of Carbon Footprint

Carbon footprint is the total amount of greenhouse gas emissions, specifically carbon dioxide (CO_2) and its equivalents, associated with the entire lifecycle of livestock products. This includes emissions generated from various stages such as feed production, animal digestion, manure management, transportation, and processing.

The term 'carbon footprint (CF),' now a ubiquitous and globally recognized concept, is defined as "a measurement of the total greenhouse gas (GHG) emissions directly or indirectly caused by an individual, an organization, or even a product, expressed in terms of carbon dioxide equivalent (CO_2e)." Consequently, CF is quantified in units of kilograms or mega grams of carbon per person or activity. Livestock contributes to the carbon footprint primarily through the release of methane (CH_4) during digestion. This potent greenhouse gas has a higher warming potential than carbon dioxide over a shorter timeframe. Additionally, emissions may arise from the energy-intensive processes involved in feed production, livestock and feed transportation, and animal waste management.

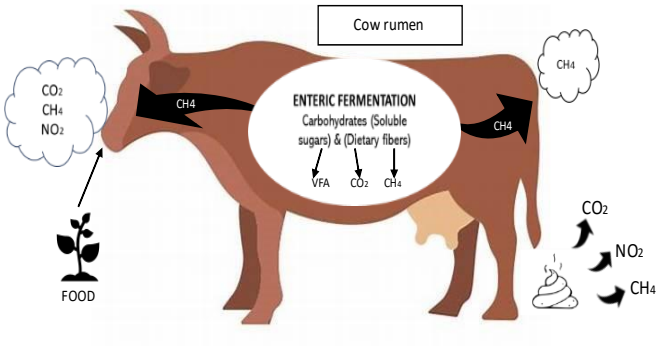

Figure 1: Ruminants generate methane in two main ways: through their digestion and through their waste.
CO_2 = Carbon dioxide, NO = Nitrous oxide, CH_4 = Methane, VFA= Volatile fatty acid.

Livestock and Climate Change: What We Need to Know

The escalating atmospheric concentrations of greenhouse gases (GHGs), driving climate change, result mainly from fossil fuel combustion, nitrogen fertilizer use in agriculture, and large ruminant rearing. In agricultural production, carbon dioxide, methane, and nitrous oxide are the primary GHGs released, with ruminants contributing significantly through anaerobic digestion and manure processes. Despite livestock generating approximately 12.5% of global GHG emissions, it constitutes 80% of the agriculture sector's total emissions. In India, livestock, particularly ruminants, play a substantial role in GHG emissions, with methane accounting for 91% of total emissions. Notably, despite the considerable methane output, India's per capita emission rate remains relatively low at 24.23 kilograms per animal per year. The imperative lies in addressing livestock-related emissions to achieve sustainable agricultural practices and mitigate climate change impacts.

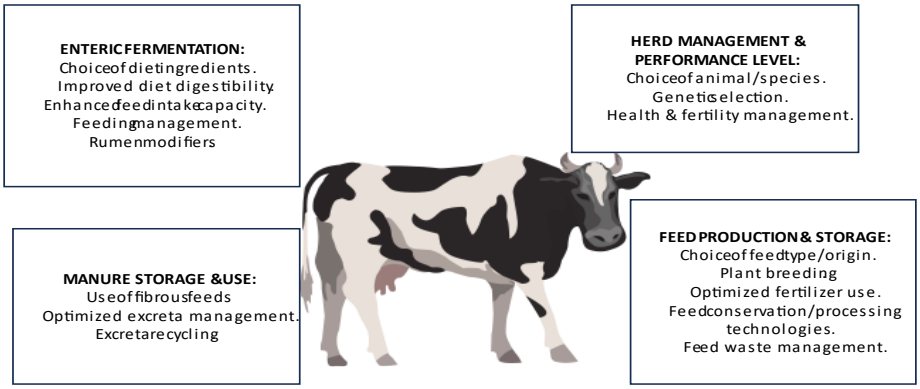

Figure 2: Sources of GHG emissions during livestock production.

Carbon Footprint Index and its Measurement-

The carbon footprint index for livestock production is a vital tool that quantifies and evaluates the environmental impact of various activities in the sector. It systematically measures greenhouse gas emissions, including carbon dioxide, methane, and nitrous oxide, throughout the lifecycle of livestock products. Expressing the results in terms of carbon dioxide equivalents (CO2e), the index provides a comprehensive measurement of greenhouse gas emissions at key stages such as feed production, digestion, manure management, transportation, and processing. The tool offers a comprehensive view of the industry's carbon footprint. The CF is expressed as the total GWP (Global Warming Potential) from all GHGs released. The total GWP or CF is calculated as: Carbon footprint or GWP tot (kg CO2e) = Amount of CO_2 * 1 + Amount of CH_4 * GWPCH4 + Amount of N_2O * $GWPN_2O$

(Where $GWPCH_4$ is the characterization factor for CH_4 and $GWPN_2O$ is the characterization factor for N_2O).

Mitigation Strategies for Carbon Footprint Reduction:

1**. Enteric Emission Reduction Strategies:** Mitigation approaches include diet modification, vaccinations, and genetic selection to reduce enteric methane production. Techniques like increased concentrate feeding and nutritional adjustments, such as high cereal diets, show effectiveness. Research explores vaccinations and selective breeding for methane reduction while altering microbial communities with lipid or fatty acid additions proves beneficial. Agro-by-products like cottonseed and brewer's grains contribute to lowering enteric fermentation.

2**. Manure Emission Reduction Strategies:** Proper storage and application of livestock manure are crucial to mitigate emissions. Aeration, composting and plastic film covering of manure stockpiles effectively lower methane emissions. Urea inhibitors in manure slow down or stop N_2O production. Anaerobic digestion of manure, while increasing direct N_2O emissions, reduces NH_3 emissions, resulting in an overall net neutral effect on air emissions. Implementing these strategies is essential for sustainable livestock farming and reducing the overall carbon footprint.

3. **Sustainable Feed and Fertilizer Practices:** Optimizing feed production and refining fertilizer application, particularly through careful nitrogen management, are pivotal strategies for reducing the carbon footprint in livestock production. Avoiding wet seasons and significant rainfall during application enhances biomass production and minimizes nitrous oxide emissions from the soil.

4. **Holistic Animal and Grazing Management:** Intensive rotational grazing, featuring subdivided paddocks, proves beneficial in controlling nitrogen excreta distribution, promoting vegetation re-

growth, and reducing nitrous oxide emissions through controlled grazing practices. Animal management, focusing on genetic improvement for efficiency, fertility, and health considerations, plays a crucial role in lowering greenhouse gas emissions in livestock production. Balancing improved fertility for emission reduction with potential health risks is essential for a sustainable and eco-friendly livestock management system.

Proper and scientific Implementation of state of art mitigation strategies at the farmstead or supply chain will help not only to reduce the greenhouse gas emissions but also enhances the efficiency of livestock production. This will further results in supply of more carbon neutral livestock produce ultimately helps to reach the target of sustainable production.

Table: Greenhouse gases incidence of enteric fermentation and manure storage by animal type, expressed as Gigatonnes of carbon dioxide equivalents

	ENTERIC METHANE	**MANURE METHANE**	**MANURE NITROUS OXIDE**	**CO_2 EQUIVALENTS in (Giga tonnes)**
BEEF CATTLE	91%	3%	6%	1.8 (45%)
DAIRY CATTLE	85%	8%	7%	1 (26%)
BUFFALOES	91%	2%	7%	0.5 (12%)
PIGS	11%	69%	20%	0.3 (7%)
SHEEP	93%	3%	4%	0.2 (4.5%)
GOATS	93%	4%	3%	0.2 (4%)
CHICKEN	0%	34%	66%	0.1 (1.5%)

***(Source**: Grossi, Giampiero; Goglio, Pietro; Vitali, Andrea; Williams, Adrian G (2019). Livestock and climate change: impact of livestock on climate and mitigation strategies)*

Government Initiatives for Sustainable Livestock Production-

Government policies play a pivotal role in fostering sustainable livestock production through regulatory frameworks and incentives. These initiatives encompass subsidies for eco-friendly technologies, tax incentives, and regulations for responsible waste management. The focus is on promoting sustainable practices like efficient feed and fertilizer use, improved animal management, and the adoption of renewable energy sources. Educational programs further raise awareness among farmers, aiming to strike a balance between ecological responsibility and agricultural productivity for a more sustainable livestock industry.

Conclusion

In conclusion, tackling carbon emissions in agriculture, particularly livestock farming, is vital for climate change mitigation. Livestock's significant greenhouse gas contributions demand sustainable practices to ensure food security and environmental responsibility. The carbon footprint index quantifies emissions, emphasizing the need for mitigation. Strategies, from enteric and manure emission reduction to sustainable feed practices, are crucial. Holistic animal and grazing management, coupled with supportive government initiatives, contribute to a resilient and eco-friendly livestock industry. The integration of these approaches not only reduces emissions but enhances resource efficiency, aligns with global commitments, and meets consumer demands for sustainable products. This comprehensive strategy is essential for fostering a resilient, eco-friendly, and economically viable future in livestock production.

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