



Livestock grazing systems: a problem or a solution for our planet?

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Abstract

Within the context of global change, livestock production is undergoing major restructuring. For several decades, demand for animal products has been rising sharply. This “livestock revolution”, together with expansion of land cultivated for food and feed, has exacerbated human pressure on land and natural resources. Ruminant livestock farming is one of the most heavily criticised sectors, notably for its significant contribution to greenhouse gas (GHG) emissions (12% of total emissions) and its role in degrading sensitive environments (desertification in the Sahel, deforestation in Amazonia). In addition to being a simple factor in reducing the environmental impact of food systems and, in particular, in adjusting GHG emissions, the productive purposes of livestock grazing systems and agro-pastoral systems are now being widely revisited. It is no longer just a question of ensuring food security, but of considering the many services provided by this activity, which is also heavily impacted by climate change. It is a complex question, and we need to go beyond simplistic visions and solutions. To contribute to the debate, we examine the major developments in the various types of livestock sector over the last few decades, particularly the ruminant sector, and their impacts on climate change. Then we propose to debate the controversies linked to the need to reduce emissions, which have made livestock farming a particularly problematic environmental and social issue. What are the options for sustainable grazing systems, combining adaptation to climate change with mitigation? What is the future of grazing livestock under the influence of intensifying and accelerating climate change? In order to facilitate transformation of the livestock sector, it is essential to reconsider the evaluation metrics used to assess the sector's impact on nature and its sources. This will enable a more comprehensive and detailed understanding of this sector, which will in turn inform its future development.

Introduction

According to a recent FAO (2023) assessment, livestock production accounts for 12% of anthropogenic greenhouse gas (GHG) emissions, or 40% of total emissions from the agrifood system. Critics point to its role in deforestation in the Amazon, desertification in the Sahel, competition between animal feed and human food, and concerns about the impact of meat consumption on human health and animal welfare. However, these generalisations fail to take into account the diversity of livestock farming systems, species, production methods and consumption patterns. Livestock farming fulfils important environmental, social and economic functions beyond its impact on GHGs, and it is therefore unwise to consider solely an emission reduction target. Effective assessment of livestock's contribution to climate change requires context-specific approaches, improved

evaluation methods and consideration of its multiple and interdependent agro-ecological and socio-economic dimensions, particularly in developing countries where data on livestock GHG emissions are limited. Given significant transformations in the sector in recent decades, this paper reviews briefly livestock's impact on climate change and explores options for sustainable systems. It also addresses controversies that make livestock farming a contentious societal and political issue. We hypothesise that appropriate assessment methods can help to better address the trade-offs between environmental, economic and social functions, towards sustainable livestock systems.

How does livestock farming contribute to climate change?

Global livestock production has grown faster than the human population (except for beef), intensifying its environmental impact (Gerber et al. 2013, FAO 2023). Over the past few decades, this growth has led to the expansion of land cultivated for food and feed, significantly increasing the ecological footprint of the livestock sector, which is now a major contributor to agricultural GHG emissions.

According to the FAO (2023), livestock systems account for 12% of anthropogenic emissions, with methane as the primary contributor (54%), followed by carbon dioxide (31%) and nitrous oxide (15%). GHG emissions vary widely across regions and are not strictly tied to production volumes. Ruminants contribute 70% of livestock emissions, but grass-fed livestock systems account for just 20% (Gerber et al. 2013). Regions like sub-Saharan Africa, with low productivity, and Latin America, where forests are converted to pastures and feed crops, exhibit the highest emissions per kilogram of carcass produced (70 kg eqCO₂/kg).

These figures are still the subject of debate within the scientific community. In particular, the contribution of livestock farming to emissions linked to land-use change and carbon sequestration has not yet been properly assessed. However, references on the specific contribution of livestock systems in southern countries to GHG emissions are insufficient and often based on data from developed countries. Besides in developed countries, livestock remains an important component of mitigation and adaptative strategies to climate changes through mobility, rangeland biodiversity preservation and source of income (see Alary et al. 2021).

What are the options for sustainable food systems?

Over the past 40 years, the rapid growth of livestock farming has certainly considerably increased GHG emissions. However, a more nuanced, context-specific approach (Blanfort et al. 2023) is essential to ensure that global solutions do not undermine rural communities and agro-pastoral systems, which often contribute to sustainable development. According to the United Nations, to feed nearly 10 billion people by 2050, livestock production should continue to grow, particularly in regions such as sub-Saharan Africa, India and South-East Asia, where populations are increasing rapidly and consumption of animal products remains low. To meet this demand, three options can be considered: i) increasing the number of livestock, ii) intensifying production or iii) importing animal products. These three options do not have the same impact on GHG emissions, respectively on: i) the increase in GHG emissions, ii) the reduction in GHG emissions per kg of product due to the increase in productivity but reduction in carbon storage in livestock farming systems, and iii) the carbon footprint linked to transport and imported deforestation (the direct or indirect deforestation caused by the production of raw materials or processed products outside the consumer's national territory).

Reconciling growth in the supply of animal products with global GHG emission reductions remains a major challenge. While alternatives advocate reducing meat and dairy consumption, particularly in the developed world, they often rely on industrialised models. A more viable approach, particularly in pastoral systems, is to minimise losses and waste throughout the animal product chain in pastoral systems: the circular bio-economy. This offers significant potential to reconcile sustainable economic development with global challenges such as food security, climate change and resource management (Vayssières 2011). Livestock systems that use grazed and harvested resources are also characterised by a capacity to store carbon in soils, which is highly effective in controlling

carbon fluxes According to Gerber et al. (2013), soil management offers the greatest potential for reducing agricultural emissions. This approach is becoming increasingly integrated into sustainable development plans for the livestock sector. However, the current metrics and methods of assessment may prove inadequate for evaluating grazed ecosystems, particularly in tropical regions, where the potential for carbon sequestration is significant due to the extensive land area involved.

Better assessment methods to address controversies in the livestock sector and facilitate its transition

In recent decades, livestock production has generated controversies over its role in meeting the world's demand for protein and its impact on the environment, particularly in relation to climate change. Addressing these challenges requires integrating both aspects to steer agriculture towards sustainable food systems.

The report 'Livestock's long shadow' (Steinfeld et al. 2006) highlighted the significant negative impacts of livestock on land use and climate. Meanwhile, livestock issues are increasingly central to climate negotiations, such as the methane pledge at the 26th Conference of Parties in the United Nations Framework Convention on Climate Change (UNFCCC COP26) in 2021, and broader mitigation. Soil organic carbon (SOC) now plays a key role in climate regulation, accounting for 47% of agriculture's mitigation potential (Bossio et al. 2020), with most SOC stored in forests (30%) and grasslands (30–35%, Lal et al. 2012). Maintaining or increasing these stocks is one of the few options identified by the Intergovernmental Panel on Climate Change (IPCC 2019) that can simultaneously mitigate climate change, combat land degradation and biodiversity loss, and improve food security. These synergies inspired the international initiative 4 for 1000: soil for food security and climate, launched at UNFCCC COP21 in 2015. The positions and narratives on livestock thus vary across political, scientific and social spheres, influencing each other. Understanding the actors behind these diverse narratives and metrics helps clarify the current view of livestock and its impact on policies.

Some metrics persist unchallenged, shaping pro- and anti-livestock discourse. Questioning these metrics (on their nature and sources) on today's agricultural trends should allow a more objective and nuanced view of the livestock sector. However, measuring the role of livestock farming in global change is complex and requires new, contextualised evaluation methods to accurately assess carbon flows. These assessments are crucial for designing mitigation actions: i) reducing GHG emissions and ii) promoting carbon transfer and storage from the atmosphere to terrestrial compartments. Several cases of field research on livestock grazing systems in emblematic tropical areas reveal effective mechanisms for soil carbon sequestration and methane emission reduction by cattle. In Amazonia, in areas where farmers have stopped deforestation, research is supporting a low-carbon development path. The renewable resources in these regions (solar radiation, rainfall, soil) can efficiently support productive grazing systems that store carbon in the soil (Blanfort 2023), as shown by research in the French Amazon (Stahl et al. 2016, 2017). In Senegal, despite livestock's reputation for high GHG emissions per unit of product, research shows that pastoral areas can be carbon neutral by using an ecosystem assessment method that considers the entire use of the territory (Blanfort et al. 2023).

Conclusion

Livestock farming plays a complex role in climate change and food security, with its environmental impact varying across regions and production systems. While livestock contributes significantly to global GHG emissions, particularly methane, the environmental footprint is not uniform. A nuanced approach to evaluating these impacts is needed, considering diverse farming practices and the socio-economic functions of livestock.

Therefore, future research should focus on developing more refined and regionally tailored assessment methods to better understand the full scope of livestock's environmental impacts. In particular, it is necessary to produce more integrative measures and evaluation methods to better grasp the complex interactions between livestock farming and environmental factors, while integrating the multifunctional dimensions of livestock farming.

The aim is to contribute to science-based policies, right up to the international governance levels of the COPS of the UNFCCC and the United Nations Convention to Combat Desertification (UNCCD). The challenge for the future is to develop policies that support livestock farmers in the face of climate challenges, while guaranteeing food security and sustainable resource management.

The International Year of Rangelands and Pastoralists (IYRP), to be held in 2026, offers a tremendous opportunity to work towards these goals, to effectively integrate these issues into international commitments and climate financing. This will help to better integrate the role of pastoral systems in mitigation, adaptation and sustainable land management – aspects often underestimated in climate negotiations.

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