Livestock and greenhouse gas emissions: the importance of getting the numbers right

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Abstract

Livestock are of significant importance to society. In the process of generating nourishment, income, employment and other benefits, they produce significant amounts of greenhouse gases. The estimated contribution of livestock to global greenhouse gas emissions ranges from 10 to 51% of the global emissions. This wide range suggests significant methodological differences and uncertainties in different studies. This commentary piece examines the main discrepancies between well known and documented studies such as FAO's Livestock Long Shadow report (FAO 2006) and more recent estimates. We advocate for better documentation of assumptions and methodologies for estimating emissions and the need for greater scientific debate, discussion and scrutiny in this area. This is essential to improve our understanding of livestock's contribution to GHG emissions and to design better climate change mitigation and adaptation strategies for the global livestock sector and those depending from it.

Keywords:

climate change, livestock, greenhouse gas emissions, mitigation, adaptation

Livestock farming plays a critical role in food production across the globe, and has formed part of local landscapes and ecosystems for millennia. The importance of livestock in providing human societies with food, incomes, employment, nutrients and risk insurance is widely recognized (Perry and Sones 2007, Herrero et al. 2009).

At the same time there is growing awareness within the research and policy communities that the rapid growth in global production and consumption of livestock products is contributing to a range of serious environmental problems, the most notable being the sector's substantial contribution to climate changing emissions.

In 2006, the FAO's Livestock's Long Shadow report (FAO, 2006), using well documented and rigorous life cycle analyses, estimated that global livestock contributes to 18% of global GHG emissions. According to the study the main contributors to GHG from livestock systems are land use change (carbon dioxide, CO_2), enteric fermentation from ruminants (methane, CH_4) and manure management (nitrous oxide, N_2O). A recent non-peer reviewed report published by the Worldwatch Institute (Goodland and Anhang 2009) contested these figures and argued that GHG emissions from livestock could be closer to 51% of global GHG emissions. In our view, this report has oversimplified the issue with respect to livestock production. It has emphasised the negative impacts without highlighting the positives and, in doing so, has used a methodological approach which we believe to be flawed. Even though Goodland and Anhang (2009) do not present detailed methodologies or clear scientific evidence to back their results, the differences between the studies center around the following areas:

Exclusion of carbon dioxide emissions from livestock respiration

According to Goodland and Anhang (2009), CO_2 from livestock respiration was an overlooked source of GHG from the FAO study[3]. Under 2006 Intergovermental Panel on Climate Change (IPCC) inventory guidelines (IPCC 2006) and under the Kyoto protocol, CO_2 from livestock is not considered a net source of CO_2 for the following reasons:

a) This CO_2 is considered to be part of a rapid biological system where the plant material consumed by the animals is created by photosynthesis (which sequesters CO_2 in the process). The amount of carbon in feed consumed and CO_2 emitted by livestock are considered to be roughly equivalent and part of a short-term carbon cycle. This short term cycle does not lead to a net increase in the concentration of atmospheric CO_2 within relevant time horizons.

b) It is true that in certain systems the balance between carbon consumed and CO_2 emitted is not perfectly equal, but these differences are small when overall global rangeland and forage productivity are considered as a carbon sink. There is also a significant body of evidence that suggests that grasslands and their growth more than offset CO_2 emissions from livestock (Fisher *et al.*, 1994, IPCC 2006). In any case, if respiration is accounted for, then CO_2 absorption related to the growth of forage and feed should also be considered in the overall carbon cycle analysis.

Emissions from land use and land use change

Goodland and Anhang (2009) claim that emissions from land use and land use change induced by the livestock sector have been grossly underestimated. While the estimates from FAO (FAO 2006) may be conservative in many aspects, the argument and analysis presented by the authors is flawed and overly simplistic on several fronts:

Firstly, in estimating the "unaccounted for emissions" from land use and land use change the authors utilize a different approach from that used in the FAO report (FAO 2006). The authors use a *consequential approach* that applies a "what-if scenario" in the estimation of emissions from land use and assess the potential emission reductions arising from the use of land for alternative practices. In other words, it quantifies the amount of carbon that would be sequestered if existing grazing lands were allowed to revert to forest, and then attributes the 'lost' opportunity for carbon sequestration to livestock. The FAO assessment (FAO 2006) on the other hand, bases its analysis on actual land use trends, thereby allocating carbon losses resulting from *current* changes in land use to livestock. While in a land constrained world it is important to consider different future possible uses for land so as to ensure food security, carbon storage and biological diversity, the approach adopted by Goodland and Anhang (2009) is methodologically inconsistent. The authors do not quantify the lost opportunity for carbon sequestration that results from other forms of land use, such as arable crop production for human consumption, or urban development. If they were to do this then overall anthropogenic GHG emissions would be higher, and livestock-related impacts would need to be seen as a percentage of this overall higher figure.

More importantly, the authors advocate that livestock products be replaced with alternative food sources, a strategy that would require a portion of the grazing land used for forage production to be converted to land for annual crop production either for food or for biofuel production. This practice would contribute to habitat destruction of native grasslands, an ecosystem that harbors a number of species at risk. Furthermore, the authors fail to provide any detailed analysis on what alternative protein sources would replace animal protein and what would be the likely implications in terms of land use, land use intensity, food security, human nutrition and livelihoods. In addition, it is erroneously assumed that biofuel production is GHG neutral (Searchinger *et al.*, 2007).

The proposed biofuel option is also misleading from a land use change perspective. In a hypothetical world without livestock, there could be many potential uses for land currently utilized for livestock with biofuel production being only one of these possibilities. This would depend significantly on alternative opportunity costs of land use, labour and transport costs as well as other factors. These have not been considered systematically in the Goodland and Anhang (2009) paper. At the same time, livestock in most cases occupy large areas of the world where other forms of agriculture are not possible, whether this would be for producing food, biofuels or other uses. This limits the scenario of growing biofuels in all areas occupied by livestock. Production of alternative biofuels may be limited to areas that are close to markets and that possess adequate infrastructure, but even these areas would have competing claims for the land and significant opportunity costs.

Removal of domesticated ruminants would also have implications with regard to the populations of wild ungulates, and what mixes of species would prevail in these environments. These counterfactuals point to the fact that estimating emissions from livestock systems is very complex and need to be analysed with solid conceptual models of global environmental, social and economic change.

The authors also omit to acknowledge that many key drivers of land use and land use change such as deforestation are outside of productive land uses and are instead driven by motivations and policies such as infrastructure development, land speculation, urbanization, and development of renewable energy. Many of these polices are driven by the present lack of economic incentive to conserve or maintain natural resources.

Global Warming Potential of Methane

Goodland and Anhang (2009) suggest using the 20-year global warming potential (GWP) for CH_4, which is 72. The debate on how much warming CH_4 causes is an ongoing one (Shindell *et al.*, 2009). Scientific advancements have indeed led to the corrections in CH_4 GWP values over the past decade. And while IPCC in its 4th Assessment Report (IPCC 2007) effectively revised the global warming potential (from 23 to 25) as indirect effects of CH_4 on ozone and stratospheric water vapor have been included - it should be noted that at the time of the writing of the FAO report (FAO, 2006) the GWP of 23 over a 100-year time horizon was considered valid and acceptable. CH_4 has an atmospheric lifetime of 12 years. In this first period CH_4 contributes more to the present global warming than the factor 25 suggests, but this effect decays almost completely after 20-30 years. CH_4 is therefore a very important gas to achieve short-term reduction of radiative forcing. However, the GWP is a measure to prioritize mitigation practices, for which the scale of a century is currently considered appropriate, even though this is under debate (Shindell *et al.*, 2009). IPCC has acknowledged the value of alternative metrics (e.g. the Global Temperature Potential) and indicated that further research is recommendable (Plattner *et al.*, 2009). Besides, selection of a time horizon is not only a scientific issue, but also a political one based on the relative weight that is given to short- versus long-lived greenhouse gases.

Attribution of greenhouse gases to livestock and others

Goodland and Anhang (2009) also identify a number of greenhouse gas sources currently excluded from GHG assessments from livestock.

Of particular importance are issues related to the complexity of attributing certain emissions to the livestock sector. For example cooking in open fires, waste management, use of toxic chemicals, packaging and use of cold chains, and chronic degenerative diseases amongst others, are aspects that not only relate to the production or consumption of livestock products. Methodologies for estimating and adequately attributing these kinds of emissions to specific sectors are still under development and have not been vetted by the international scientific community.

Goodland and Anhang (2009) point to the fact that FAO's 18 percent estimate presently lacks relevance and is outdated. The authors erroneously assume that a 12 percent increase in the global tonnage of livestock products directly translates into a proportionate increase in GHG emissions. This ignores the fact that production systems can become more efficient. For example, in Europe (EU-12) livestock production increased slightly between 1990 and 2002, while the emissions of CH_4 and N_2O decreased 8-9% over the same period (European Environmental Agency, EEA, 2009). Some European countries have seen even more dramatic improvements in efficiencies. Denmark thus reduced its emissions of CH_4 and N_2O by 23% over the period 1990 to 2002, while maintaining dairy production output and increasing pig production by 27% (Danish Environmental Protection Agency, 2005). This was due to a higher production per animal (and thus lower animal numbers) and a more efficient use of manures and nitrogen fertilizers.

The use of lower figures of animal numbers in the estimation of greenhouse gases and failure to use a correction factor are cited as one of the shortfalls of the FAO report (FAO 2006). Specific reference is made to the citation of the production of 33 million poultry worldwide. This however stems from a misinterpretation on the part of Goodland and Anhang (2009) who confound “poultry biomass” for production of poultry meat. It should also be mentioned that despite some shortcomings of the FAO statistics, FAO still remains the only globally recognized source of data on agriculture.

Goodland and Anhang (2009) correctly point out that the FAO assessment (FAO 2006) omits emissions related to the preparation of animal products and that estimates for land use change, transport and processing are deliberately conservative. These methodological decisions were constrained by data availability.

Concluding remarks

Livestock undoubtedly need to be a priority focus of attention as the global community seeks to address the challenge of climate change. The magnitude of the discrepancy between the Goodland and Anhang paper (2009) and widely recognized estimates of GHG from livestock (FAO, 2006), illustrates the need to provide the climate change community and policy makers with accurate emissions estimates and information about the link between agriculture and climate.

Improving the global estimates of GHG attributed to livestock systems is of paramount importance. This is not only because we need to define the magnitude of the impact of livestock on climate change, but also because we need to understand their contribution relative to other sources. Such information will enable effective mitigation options to be designed to reduce emissions and improve the sustainability of the livestock sector while continuing to provide livelihoods and food for a wide range of people, especially the poor. We need to understand where livestock can help and where they hinder the goals of resilient global ecosystems and a sustainable, equitable future for future generations.

We believe these efforts need to be part of an ongoing process, but one that is to be conducted through transparent, well established methodologies, rigorous science and open scientific debate. Only in this way will we be able to advance the debate on livestock and climate change and inform policy, climate change negotiations and public opinion more accurately.

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