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Questioning key conclusions of FAO publications 'Livestock's Long Shadow' (2006) appearing again in 'Tackling Climate Change Through Livestock' (2013)

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Abstract

The accusation by the United Nations Food and Agriculture Organisation (FAO) that domestic animals contribute 18% (Livestock's Long Shadow) or 14.5% (Tackling Climate Change Through Livestock), respectively, to anthropogenic greenhouse gas (GHG) emissions caused considerable damage to the reputation of animal husbandry in general, and in particular to the grassland-based production systems.
This rebuttal highlights the following:

- The publications mentioned ignore the uncertainties associated with the climate sensitivity of GHGs.
- Baseline scenarios over time and space for livestock-borne methane and nitrous oxide emissions are elided.
- There are deficits in the methodological treatment of emissions deriving from land use change (deforestation).
- It is not acknowledged that there is virtually no livestock signal discernible in global methane distribution and historical methane emission rates.
- The loss of energy through methane emissions by enteric fermentation in ruminants is considered as damaging to production. However, livestock-borne methane might be the price to be 'paid' for the effective transformation of high-fibre diets from crop residues and vast areas of grass- and rangelands marginal to agriculture into valuable food for humans (meat and milk).

Consequently, the mentioned publications highly overstate livestock contribution to climate change in its extent and impact.

Keywords: Green house gases; Livestock; FAO; Rangelands; Grasslands; Environment

The influential report 'Livestock's Long Shadow' was published by FAO in 2006 (Steinfeld et al. 2006). This report's main message (which claims that domestic animals contribute 18% to anthropogenic greenhouse gas (GHG) emissions) caused a major storm in the global media. The report has been cited nearly 1,200 times, according to Google Scholar. The concern about livestock's alleged contribution to climate change culminated with a hearing in the European Parliament 2009 on the topic 'Less Meat = Less Heat'. The United States Council on Foreign Relations marks the report as 'must read'. The USA Cattleman's Beef Board issued a rebuttal (2009). In summary, the above-mentioned report caused considerable damage to the reputation of animal husbandry in general, and in particular to the grassland-based production systems.

In a series of talks (almost two dozens), which I gave in the past seven years in Paraguay, Argentina and other countries at national and international congresses and seminars, I strongly criticized several basic assumptions and methodological approaches in the above-mentioned report. Meanwhile, however, I got the impression that

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the FAO had quietly abandoned its critique of domestic livestock promoting climate change, as it had become fairly quiet around this topic.

Unfortunately, I was mistaken: I was quite surprised when I recently discovered another report on the homepage of FAO 'Tackling Climate Change Through Livestock' (Gerber et al. 2013) (http://www.fao.org/ag/againfo/resources/en/publications/tackling_climate_change/index.htm). In this publication, the contribution of global domestic livestock to the anthropogenic GHG emissions has been somewhat reduced to 'only' 14.5% as compared to the above-mentioned previous report; however, it still

- contains the same methodological deficits,
- ignores the uncertainties associated with the climate sensitivity of so-called GHGs
- and ignores the inconsistencies between some of its conclusions and several empiric observations in the real world.

After seven years of intensive scientific examination of this topic, I feel obliged to challenge FAO with the following seven questions. I think the worldwide community of taxpayers, of which I form part too (in Paraguay and Germany) and which finances the FAO in order to comply with its mandate (to contribute sensibly to global food security), has the right to see the FAO rejecting well-founded doubts with its mandate compliance or, alternatively, heading to an institutional course correction.

It certainly cannot be the function of the FAO to discredit grazing systems in general and the beef sector in South America (the continent with the highest growth potential for food production) in particular, with unrealistically high emission values due to methodological inconsistencies and negligence and due to overstating the relevance of these emissions.

Being a cattle rancher in Paraguay, and a native of Germany, I also feel personally challenged, not to say threatened, by the FAO's journalistic activities.

Here are my questions:

1. Does FAO agree to the following statement? The assumption of noticeable climate sensitivity to anthropogenic GHG emissions (as defined as the mean increase of global temperature with a doubling of CO_2 equivalent (CO_2-equ.) in the atmosphere) is the basis for the hypothesis that livestock husbandry could eventually influence the climate (cause global warming).

2. Does FAO agree that considerable doubts with noticeable climate sensitivity to anthropogenic GHG emissions are justified, in the light of the following facts?

– Mean global temperatures were flat in the past 15 years, and did even slightly decrease in the past 10 years, in spite of steadily increasing CO_2 levels in the atmosphere which even caused a remarkable greening of some deserts in the past 30 years by fertilizing plants and making them more drought tolerant (CSIRO 2013). This is an empirical observation contradicting all the scenarios of projected temperatures published in the fourth IPCC assessment report and earlier reports. These scenarios are summarized in Figure TS 26 of the Technical Summary of AR4 (IPCC 2007).

– There is an overwhelming number of peer-reviewed papers, and among them various recently published ones, such as Alley (2000), Mangini et al. (2005), Mangini et al. (2007), Kobashi et al. (2011), Markonis and Koutsoyiannis (2012) and Esper et al. (2012) that acknowledge the existence of various warm periods during the Holocene (after the end of the latest ice age), which were warmer than or at least as warm as the present age (in spite of the pre-industrial atmospheric CO_2 levels at those times).

– In the AR4-IPCC report, 16 variables are identified as forcing agents of global warming/climate change and are used in the models. The level of understanding for 11 of them was specified by the IPCC as 'very low or low' (Table 2.11 in IPCC 2007). However, models made with uncertain variables require empirical validation. As far as the modelled temperature projections for a variety of emission scenarios published by the IPCC in the past four assessment reports can already be tested with observed temperature data, recent temperatures are located well outside the confidence intervals of all IPCC models, which therefore did not pass its validation exam as shown in Fig. 1.4. of the leaked second order draft of IPCC-AR5 (IPCC 2012, The Washington Times 2012). This Figure 1.4. is not shown in the Summary for Policy Makers (SPM) of AR5, released on Sept. 27, 2013. The 'observed reduction in surface warming trend over the period 1998-2012' is mentioned on page 10 of the SPM, hidden in the text body and provided with a number of excuses. I am not aware of any final version of the scientific-technical main report of AR5.

3. If the FAO report authors affirm questions 1 and 2, why did they not allude to the mentioned uncertainties, constraints and inconsistencies in the recent FAO report 'Tackling Climate Change' (Gerber et al. 2013)?

4. Comparing the global domestic livestock distribution (Steinfeld et al. 2006, map 20) and the geographical distribution of atmospheric methane concentrations determined with the satellite ENIVSAT (University of Bremen: http://www.iup.uni-bremen.de/sciamachy/NIR_NADIR_WFM_DOAS/xch4_v1_2003-2005.png), there is no consistent relationship to be found between both items. The historical evolution of the mean methane concentration in the atmosphere (including the decline of

the growth rate from about 1980 on) is determined by fossil fuel extraction and use, as well as the associated technological quality standards (Quirk 2010; Aydin et al. 2011).

As there is no livestock signal discernible, neither in the global methane distribution nor in the historical evolution of the atmospheric methane concentration, would FAO agree to the following statement? 'Domestic livestock is obviously irrelevant (or at least a minor player) for the global methane budget, as also suggested by IAEA (2008)'.

5. The only continent the FAO reports are blaming for CO_2 emissions from deforestation for pasture establishment is Latin America and the Caribbean. South America is charged with the very high 'emission intensity' of 100 kg CO_2-equ. per kg of carcass weight (CW) produced, of which 40 kg CO_2-equ. per kg CW is attributed to deforestation. This is justified in the FAO reports with the ascertainment that in other continents there have been no significant deforestations for pastureland expansion recently. However, in other continents, particularly Europe, extensive deforestations took place already centuries ago to establish permanent grasslands.

Mathematically, the term 'emission intensity' (used extensively in Tackling Climate Change 2013) describes the emission of a certain quantity of CO_2 equivalent necessary for producing 1 kg of a product (in this case carcass) under certain conditions (I prefer the term 'specific emission'). It is questionable to charge this mathematical term with emissions which are not related to the generation of this particular product. For example, while deforesting a specific area of land, the beef production is carried out on other pasturelands, already established earlier. In other words, the emission due to deforestation at one specific site has no immediate relationship to the ongoing production on already established grasslands. It is therefore methodologically illegitimate to allot the one-time CO_2 emission from deforestation to any accidentally chosen quantity of a product (e.g. yearly beef production in South America). The single emission from deforestation is generated (and tolerated) in order to produce beef on the new pastureland to be established for a very long period of time in the future (hundreds of years just like on European grasslands). But when the single 'carbon debt' from deforestation is spread over the accumulated production from the deforested area over centuries, the specific emission per kilogramme of product tends towards zero. And in case a certain grazing area is eventually abandoned, the carbon captured by encroaching secondary forests will offset the CO_2 released at the initial deforestation. Therefore, other continents such as Europe are treated correctly in the FAO report, by disregarding emissions from 'land use change (LUC)'. On the other hand, beef products from South America are charged with far too high values of 'emission intensities' (kg CO_2-equ. per kg CW), because of deforestation still being practiced which has, however, nothing to do with the current beef production within the continent (in the year of deforestation) but with future production on the cleared land.

With the term 'emission intensity', the FAO might want to quantify the emissions actually brought about by the total beef industry sector in a specific year within particular regions, continents or production systems. However, this approach is misleading when this number is referred to a certain quantity of product (e.g. kg of CW) without advising explicitly that the above-mentioned term contains casual emissions (from recent deforestations) which arose in the respective continent but did not contribute to the product generated in that particular year but will contribute instead to the products generated in the future. According to the FAO methodological approach, 500 years ago, when there was still ongoing deforestation in Europe, Europe once reached similar emission intensities as South America today, and in 10 or 20 years' time, when deforestation has come to a halt due to legal, environmental policy or physical limitations, emission intensities in South America will be similar to the ones in Europe today. But the FAO report did not tell readers this. Without an explicit footnote explaining this context, the FAO approach is scientifically dubious. In the tables and figures of the report, values are compared which are not comparable, because they need to be interpreted distinctly and some have (restricted) validity just for the moment. In that way, FAO loads (purposely?) unrealistically high emission values onto the South American beef industry and onto cattle grazing systems in general. Tropical deforestation reduces competitiveness in the agricultural sector of industrialized countries (http://assets.usw.org/our-union/pulp-paper-forestry/farms-here-forests-there-report-5-26-10.pdf). To castigate deforestation, particularly in the Amazon, is generally considered noble and highly ethical (presumed mitigation of climate change and loss of biodiversity) and increases therefore the chances for the FAO to raise funds from the rich donor countries.

It is not sufficient to offer values without the burden of emissions from deforestation, hidden in the text body, and to casually mention in a very general manner that the correct treatment of deforestation in the calculations is a very complex matter. Moreover, the fact that FAO is using the period from 1990 to 2006 to quantify deforestation, while thereafter deforestation dropped considerably in Brazil (Box 5, p. 95 in Gerber et al. 2013), can be interpreted as a deliberate discrimination of the beef production in South America by charging it with

emission burdens which were already much lower at the time of the publication of the 2013 FAO report.

An additional observation is that we could show that in the semiarid Chaco of Paraguay, deforestation for pasture establishment diversifies the habitats and therefore promotes species richness, provided the legal land use restrictions of preserving almost 50% of each farm's surface in pristine condition (in the form of a nature reserve, bush corridors and islands) are respected, as do >90% of the land owners. The additionally created habitats and resources are extensively used by wildlife too. These refer to the bush border effects over many kilometres, savannah-like landscapes, nutritious pastures and rainwater collection reservoirs (gráfico 1 in Glatzle 2009; Glatzle 2011).

6. The concealment of any baseline scenario over space and time most likely is the biggest fault of the latest publication by FAO on livestock and climate (Gerber et al. 2013). This new report interprets the direct and indirect emissions of methane and nitrous oxide by livestock at a 100% level as an *additional* anthropogenic emission of GHGs from animal sources. This is not the case, e.g. areas formerly populated by large herds of wildlife or areas comprising wetlands, drained later on, could emit less methane after a land use change towards pastoral land for livestock grazing than did the pristine ecosystem. In other words, livestock-borne GHG emissions need to be corrected by the emissions which would occur anyway in a (natural or pre-climate change) baseline scenario. This is particularly important for nitrous oxide. Grazing animals indeed somewhat accelerate nitrogen cycling; however, they do not increase the amount of nitrogen in circulation. Both the nitrogen quantity in circulation and the mean nitrogen turnover rate determine the nitrification and de-nitrification rates (besides, of course, the prevailing site characteristics such as waterlogging or temperature), which are crucial for the quantity of nitrous oxide produced as a leaking by-product. Therefore, nitrous oxide emitted from manure is by no means *additionally* released by livestock. Herbage and other plant biomass also produce considerable amounts of nitrous oxide (N is mineralized, nitrified and de-nitrified) even without passage through livestock's intestines. It could well be that N_2O emission rates from native forests (with often high N contents in the leaves) are even greater than from managed grasslands. In this case, the 23 kg of CO_2-equ. per kg CW (from N_2O) charged to the beef industry in South America should be reduced to zero or even adopt a negative value, when the grassland is situated at a formerly forested area. In any case, this number has to be corrected by the amount of N_2O, which would be released by the biomass anyway, even if it had not passed through the animal stomach. Only a nitrogen fertilization (which is rarely done on extensive grazing land because of economic constraints) considerably increases the amount of nitrogen in circulation and thereby the chance of N_2O emissions. This applies, however, to a far higher degree to (forage) cropping than to true pastoral systems.

Just like CO_2, methane and nitrous oxide are also part of natural cycles. Rather than considering the actual emissions, one ought to take into account the observed or theoretical difference of the atmospheric steady state equilibrium concentrations (between sources and sinks) *before* and *after* the creation of a new or additional source of emission. If at all, only this difference of concentration of a GHG could exert any influence on the climate.

The missing database or the high complexity of the matter (also due to the overlapping of various emission sources and sinks) does not excuse FAO from clearly displaying this complexity rather than omitting important baseline scenarios. It would rather be correct to desist from estimating specific emission values (or emission intensities, as the FAO report terms them) than to suppress weighty baseline scenarios, because they are complex and difficult to quantify. Moreover, certain pastoral ecosystems may represent a sink and not a source for methane (Gocher 2009, quoting Mark Adams, University of Sydney). This is another empirical observation which considerably reduces the utility of FAO's simplified bottom-up calculations.

What is FAO's response to this critique? Did FAO simply forget the baseline scenarios just like (almost?) all the authors of publications on 'life cycle assessments' (recent review: De Vries and De Boer 2010)? Even in its 'Guidelines for National Greenhouse Gas Inventories' (which most authors refer to), the IPCC (IPCC, Intergovernmental Panel on Climate Change 2006) proposes N_2O emission factors to calculate emissions of nitrous oxide from the total nitrogen deposited (as fertilizer, cured manure or fresh dung and urine) or mineralized from crop residues or soil organic matter in managed soils. I am not aware of any corrections for baseline emissions from pristine ecosystems (replaced by the respective agro-ecosystems) carried out by the IPCC. Baseline emissions are treated as if they had been inexistent. A tremendous overestimation of anthropogenic emissions is the obvious consequence.

7. The FAO 2013 report reckons that methane emissions by ruminants damage production as they constitute a waste of nutritional energy. Of course, methane emissions deliver energy to the environment, but do not spoil it, as methane is a (so far) unavoidable by-product of anaerobic degradation (by rumen cellulolytic bacteria) of the most widely spread substance in the biosphere, cellulose. Without methanogenesis, hydrogen (H_2) would

accumulate in the rumen and inhibit ongoing fermentation and digestion by negative feedback (Eckard et al. 2010). Thanks to the methane emissions, ruminants can make use of the high-fibre diet growing abundantly on the enormous terrestrial areas marginal to crop agriculture and convert it into precious food for humans (meat and milk), as well as skins, fibres and other useful products. As long as there are no effective and inexpensive technologies available to manipulate the rumen metabolism in order to cut back the methane emissions without hampering the digestibility of fibre-rich diets, methane emissions seem to be the price for the very important contribution of ruminants to food security and livelihood resources for humanity.

Has the omitted elucidation of this very important role of grazing ruminants been an oversight or was it done on purpose?

Conclusion

'Tackling Climate Change....' (Gerber et al. 2013) unjustifiably burdens grazing systems with ruminants, and in particular the beef industry of South America, with far too high emission values of GHG per kg CW. Due to gross negligence (omission of important baseline scenarios and of uncertainties in the appraisal of climate sensitivity to anthropogenic GHG emissions) and due to inconsistencies in the calculation and evaluation of specific emission values, this study will hardly be of a long lasting scientific merit. However, the good reputation of grazing systems in general and the South American beef industry in particular has already been damaged (by the FAO!!!). Therefore, the FAO should distance itself from this publication and withdraw it from its website.

My latest presentation on the website of the *Asociación Rural del Paraguay* given recently at the *4º Congreso Ganadero* in Asunción contains further explanations and illustrations on the topics touched upon herein (http://www.arp.org.py/index.php?option=com_content&view=article&id=841, http://www.arp.org.py/images/files/Ganaderia%20y%20clima%20DR_%20ALBRECHT%20GLATZLE.pdf).

Competing interests

The author declares he has no competing interests, apart from those mentioned in the text.

Author's information

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