

Communication

Emissions from Animal Agriculture—16.5% Is the New Minimum Figure

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Abstract: Knowledge production within the climate sciences is quickly taken up by multiple stakeholders, reproduced in scientific citation and the broader culture, even when it is no longer accurate. This article accomplishes two goals: firstly, it contributes to the clarification of the quantification of emissions from animal agriculture, and secondly, it considers why the dominant framing of the United Nations Food and Agricultural Organization (FAO) on this subject focuses on maximizing production efficiency. Specifically, analysing the FAO's own work on this topic shows that the often-used FAO estimate that emissions from animal agriculture amount to 14.5% of all greenhouse gas (GHG) emissions is now out of date. In returning to the FAO's own explanation of its data sources and its more recent analysis of emissions from animal agriculture, this article finds that the figure of minimum estimate should be updated to 16.5%. The tendency of the FAO to prioritize a technological approach focused on making animal production more "eco-efficient" is critically examined in light of many other evidence-based calls for reductions in animal consumption. An explanation for this FAO approach is offered in terms of a type of epistemological bias.

Keywords: animal agriculture; climate change; emissions; epistemological bias; FAO; GLEAM; sociology of science; United Nations



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1. Introduction

Two FAO reports, *Livestock's Long Shadow* (2006) [1] and *Tackling Climate Change Through Livestock* (2013) [2] have played a key role in the debate on GHG emissions from animal agriculture. They suggested the sector contributes overall 18% of emissions [1], then revised this down to 14.5% [2]. The two lead authors of each report are the same and neither reports advocated reductions in animal consumption, preferring to prioritize efficiency improvements and sustainable intensification as the best framing to tackle emissions from the sector. The 14.5% figure has subsequently been routinely cited in further research [3,4] and the media [5,6]. However, this figure is shown here to be incorrect by probing in more detail why the FAO revised 18% down to 14.5%. A better understanding of how such figures are calculated and become influential is important for a wide variety of stakeholders including climate scientists, climate social scientists, policy makers and civil society. Emissions related to agriculture are further important for producers and retailers in the food sector. Even small upward revisions in the percentage figure can be important for how the issue of emissions from animal agriculture comes to be socially and politically constructed. The main aim of this article is to examine the FAO 14.5% claim [2] by revisiting its methodology for arriving at that figure. A secondary aim is to critically reflect on the FAO reluctance to call for a downsizing of the animal production sector. This is an important issue for the aforementioned stakeholders because downsizing could have a more successful emissions reduction effect than the framing of trying to make animal production more efficient. Subsequent work such as the EAT-Lancet commission [7] calls for substantial reductions in meat consumption within a co-benefit framing of improving human health and achieving emissions reductions (as well as other concerns including biodiversity and water conservation). The commission argued that transitioning to more

sustainable diets is necessary to successfully meet the mitigation targets of the Paris Agreement and the United Nations' Sustainable Development Goals (SDGs). This asks questions of the FAO as to whether its own framing is in fact the best approach to achieve the goals created by its own parent organization. This article also contributes to the broader debate over the contribution of agriculture to overall emissions vis-à-vis fossil fuels [8,9], specifically to question the relative less attention given to agriculture in climate policy discourse.

2. Method

The method in this article is to re-examine the FAO data and their sources used. Both reports agreed that the Animal Agriculture–Greenhouse Gases (AA–GHGs) link is constituted by the following main emissions sources: land use changes for feed production and grazing, methane emissions mostly associated with the enteric fermentation of ruminant farmed animals, nitrous oxide emissions mostly associated with farmed animal manure, fossil fuel use during feed and farmed animal production, and fossil fuel use in the production and transport of processed and refrigerated animal products. However, the later report used a new methodological tool called GLEAM [10] (Global Livestock Environmental Assessment Model), a modelling framework developed within the Animal Production and Health Division of the FAO, which it asserted was more accurate. The Appendix to the second report [2] explains the differences between the two reports and gives some indication of why 18% became 14.5%. More specifically, the methodological approach of this article goes through several stages. For the two reports [1,2], year data reference points are compared both for emissions from animal agriculture and for total global emissions. Sources for total global emissions data are highlighted and it is examined whether the same source, or different sources, were used for the two reports. Furthermore, it is then investigated whether data remained stable over time, since data revisions by bodies involved in producing total global emissions data may impact upon FAO findings. The article then examines changes introduced by the FAO GLEAM tool for the second report, and then goes on to consider how FAO data on animal production and deforestation might have impacted emissions levels since 2010. FAO findings are compared with other relevant studies that have analysed the land use dimensions of animal agriculture. Finally, in the discussion section the FAO commitment to an efficiency framing as their preferred approach to tackling emissions from animal agriculture is examined.

3. Results

Despite its 2013 publication date, the second report used data that were relatively old: from 2004 (for total global emissions) and 2005 (for total emissions from animal agriculture). The first FAO report [1] used data from a 2000–2004 reference point (2000 for total global emissions and 2001–2004 for their animal agriculture emissions estimate). The second report estimated that “total GHG emissions from livestock supply chains are 7.1 gigatonnes (Gt) CO₂-eq per annum for the 2005 reference period” [2] (p. 15). It arrived at the 14.5% figure simply by expressing 7.1 as a proportion of the 2004 IPCC figure of total global GHG emissions of 49 Gt CO₂-eq found in the fourth assessment report of the IPCC in 2007 [11].

The report's authors made clear that their 7.1 figure was “in line with FAO's previous assessment, *Livestock's Long Shadow*, published in 2006” [2] (p. 15). However, the second report decided to use a different dataset for total global emissions. Whereas the first report used the total global emissions data of the World Resource Institute (WRI), the second report switched its data source to the IPCC. The WRI data are from their Climate Analysis Indicators Tool (CAIT) database [12], which includes all gases and sectors (referred to as WRI hereafter). This switch away from WRI to IPCC is significant because there is a consistent discrepancy between total global emissions data when the WRI and IPCC are compared. It is also significant because the second report used the IPCC fourth assessment data for 2004 published in 2007, but when the IPCC published their fifth assessment report

in 2014 [13], they had themselves revised down their total global emissions data for 2004. It is worthwhile examining these two points in further detail.

WRI data for total global emissions data are consistently lower than data of the IPCC. Whereas the second report uses an IPCC figure of 49 Gt CO₂-eq for 2004, WRI data do not reach the level of 49 Gt CO₂-eq until 2013 (their most recent data are 49.9 Gt CO₂-eq for 2017). In contrast to the IPCC, the WRI global emissions data for 2004 are 42.48 Gt CO₂-eq [12]. Had the FAO retained the WRI as their source of global emissions data for their second report they would have concluded that animal agriculture was responsible for 16.7% of emissions (not 14.5%), a figure far closer to the 18% of the first report [1]. The WRI data were available to the FAO but for reasons not specified they switched their data source to the IPCC, which had the effect of lowering the 18% figure of the first report. As mentioned, by the time they had published their fifth assessment report, the IPCC had revised down their global emissions data for 2004 from 49 to 45 Gt CO₂-eq [13]. Although these IPCC data were presumably not yet available to the FAO authors, this illustrates that even using their new preferred data source for global annual emissions the percentage contribution of animal agriculture to overall GHGs would not be 14.5% but 15.8% (see Table 1, note 3). Therefore, depending on whether IPCC or WRI data are used, a range of between 15.8 and 16.7% as a quantification of the AA–GHGs link is indicated.

Table 1. Estimates of the percentage contribution of animal agriculture to Total Global Emissions. Including two alternative expressed percentages based on FAO’s GLEAM 2.0 analysis using (A) IPCC AR5 and (B) WRI CAIT data for total global emissions (CO₂-eq Gt).

Analysis:	Livestock’s Long Shadow (FAO 2006)	Tackling Climate Change through Livestock (FAO 2013)	GLEAM 2.0 (FAO 2017)	A	B	Poore and Nemecek (2018)
Total estimated CO ₂ -eq emissions from animal agriculture (Gt)	7.1	7.1	8.1	8.1	8.1	14.7
Year(s) used	2001–2004	2005	2010	2010	2010	2010
Total Global CO ₂ -eq Emissions (Gt)	37.44	49 (45) ²	NR	49	46.64	52.3
Year used	2000	2004	NR	2010	2010	2010
Source	WRI CAIT	IPCC AR4	NR	IPCC AR5	WRI CAIT	EDGAR
Estimated contribution of animal agriculture to Total Global Emissions (%)	18 * (18.96) ¹	14.5 * (15.78) ³	NR	16.5	17.4	28.1

NR = Not Reported. * Widely cited figures. ¹ Recalculated based on reported WRI CAIT figure for 2000 of 37.44 Gt. ² Revised 2004 figure from IPCC AR5 (2014). ³ Recalculated based on figure of 45 Gt.

Yet there are further questions to ask. Firstly, is it credible that the figure of 7.1 Gt CO₂-eq remained static between the two reports? Secondly, were there any other methodological changes of relevance between the two reports that may have kept the figure at 7.1? Thirdly, and crucially, are there any more recent analyses of the 7.1 total? The Appendix of the second report [2] contains important information about the change in methodology and accounting performed in the second report. Specifically,

“The Livestock’s long shadow assessment includes GHG emissions related to the production of feed (including pasture) fed to all animal species (for a total of 2.7 gigatonnes CO₂-eq), whereas this report only accounts for feed materials fed to the studied species, i.e., poultry, cattle, pig, small ruminants and buffalo (for a total of 3.2 gigatonnes CO₂-eq including rice products). All manure emissions were accounted for in the Livestock’s long shadow assessment (for a total of ap-

prox. 2.2 gigatonnes CO₂-eq), but only emissions related to manure management and manure application on feed crops or pasture are accounted for in this report (for a total of 0.7 gigatonnes CO₂-eq and 1.1 gigatonnes CO₂-eq, respectively)" [2] (p. 106).

Although the second report covers the main farmed animal species, the extract implies that their figure related to the production of feed would have been marginally higher (and so also the overall figure of 7.1) had they, like in the first report, included all farmed animal species. Furthermore, it is not stated why the second report changed its accounting of manure emissions, which resulted in 0.4 Gt CO₂-eq less being included in the overall total. The decline in the percentage number between the two reports could be accounted for by (a) accounting for manure emissions differently, and (b) switching from WRI to IPCC data for total annual emissions. This analysis so far is sufficient to illustrate uncertainty over the construction of the 14.5% figure. At this stage we can confidently conclude that 14.5% was based upon an IPCC AR4 overestimate of total global emissions, which was later revised down by the IPCC AR5, and this has never been mentioned subsequently by the FAO authors.

Even more surprising though is that in 2017 the FAO issued on their website the results of GLEAM 2.0 with new data presented for animal agricultural emissions for 2010 [10]. However, this time there was no major FAO report and no media reporting of a new percentage figure. Looking at the new FAO data, total emissions from animal agriculture had increased by 1 Gt to 8.1 Gt in the period from 2005 to 2010 [10]. Most of this increase was accounted for by an increase in the proportion of emissions assigned to methane. Expressed as a proportion of total global emissions for 2010 for both the IPCC and WRI data sources (49 and 46.64 Gt, respectively) results in overall percentages of 16.5 and 17.4% (Table 1, columns A and B).

If the IPCC is the FAO's new favoured data source the conclusion is that between 2005 and 2010 the proportion of GHGs contributed by animal agriculture rose from 14.5% to 16.5%. For reasons unknown the FAO made no major announcement to say that their new GLEAM 2.0 data revealed the 14.5% figure to be dated. The new lowest figure ought to be 16.5%, even though this retains the problem of relying on data that are over 10 years old. The FAO achieved considerable media coverage for the first two reports [1,2] but there was no announcement for GLEAM 2.0. Furthermore, as recently as September 2018 (after the publication of GLEAM 2.0), two FAO authors from the second report were still using the 14.5% figure [14].

If the rate of animal agricultural emissions has grown faster than that of total global emissions since 2010, then the percentage proportion will now be higher than 16.5%. Using WRI data, total global emissions have grown from 46.64 Gt in 2010 to 49.95 Gt in 2017 [12], an increase of 7.1%. Whilst the FAO have not yet updated their analysis of 2010 data with a GLEAM 3.0, their own data show that farmed cattle production (the farming of which produces the highest amount of GHGs owing to land use changes and enteric fermentation) has grown globally from 1.411 billion live animals in 2010 to 1.477 billion live animals in 2017, a 4.7% increase [15]. Whilst some farmers may have attempted to instigate the efficiency recommendations of the two FAO reports, authors involved in these reports have since indicated that adoption rates are low, calling into question the rationality of their efficiency framing [16]. An increase of 66 million cattle may have increased the 8.1 Gt CO₂-eq reported for 2010 [10]. During the same period, the number of chickens farmed increased from 20.228 to 25.077 billion, a 24% increase [15], impacting land used for feed production. Furthermore, using the FAO's own data on deforestation, South America lost 2.6 million hectares of forest every year in the 2010–2020 period, and globally, 10 million hectares were lost annually in 2015–2020 [17]. Significant parts of that deforestation have been to cultivate animal feed, contributing to the AA–GHGs link.

These points highlight the land use dimension of the AA–GHGs link, analysed in more detail by recent studies [18–20]. These raise question marks over whether either FAO report fully accounted for land use changes related to animal agriculture. The second

report makes clear that “Both assessments include emissions related to land use change from deforestation for pasture and feed crops and limit the scope of the analysis to the Latin American region” [2] (p. 106) and that the two reports use different reference periods, spanning 1990–2010 in total [2]. The second report limited its analysis of feed crop expansion to soybean cultivation in Brazil and Argentina, whereas the first included all feed crop expansion in Brazil and Bolivia. This temporal, spatial and feed-crop type delimiting fails to account for the global scale of carbon sink loss via deforestation related to animal agriculture. Deforestation in other parts of the world is also linked to the economic expansion of animal agriculture. For example, in Australia beef production has been linked to 94% of all forest clearing in the Great Barrier Reef catchment areas between 2013 and 2018 with some of the remainder due to sheep production. A total of 1.6 million hectares were cleared in Queensland during the same time period [21]. One study [19] found that the FAO [2] had underestimated land use-related emissions from the dairy and beef sector.

These additional points question the accuracy of the new lowest figure presented here of 16.5% as the contribution of animal agriculture to all emissions. Although research on the AA–GHG link has expanded significantly, few studies offer estimates of percentage contribution of animal agriculture to overall emissions. As an exception, one study paid particular attention to the issue of land use change and the degree of mitigation that could be achieved via a global switch to plant-based diets. The authors calculated that “the land no longer required for food production could remove 8.1 billion metric tons of CO₂ from the atmosphere each year over 100 years as natural vegetation re-establishes and soil carbon re-accumulates” [20] (p. 991).

The authors later clarified that their “no animal products” scenario delivers a 28% reduction in global greenhouse gas emissions across all sectors of the economy relative to 2010 emissions [22]. This estimate of 28% makes a fuller attempt to calculate the mitigation potential of land carbon sinks than either FAO report, but it is worth noting that it uses a different data source, the Emissions Database for Global Atmospheric Research (EDGAR), for total global emissions data. It constitutes the largest (peer reviewed) percentage figure for the contribution of animal agriculture to total GHG emissions. In a broader context, a recent study [9] based on 2015 data found that 34% of global GHG emissions come from the food system as a whole, though with a range between 25 and 42%.

For emissions from animal agriculture, we have a potential range between 16.5 and 28.1% based on the FAO GLEAM 2.0 estimate [10] presented here and Poore and Nemecek [20,22] (Table 1). Given the shortcomings of the second FAO report [2], the number may not be as low as 16.5%, which should be seen as a new minimum. Critics of Poore and Nemecek [20] might argue that global transition to plant-based diets is politically highly challenging. This is clearly true, but it does not detract from the importance of producing more accurate estimates to inform research and policy. This analysis finds fault with the FAO in this regard.

4. Discussion

Total GHGs remain on an upward trajectory. Whether the proportion of animal agriculture-related emissions within it is also increasing awaits further data. However, such figures convey the conundrum for advocates of the sustainable intensification of animal agriculture. If efficiency is the policy—especially when adoption rates are low [16]—economic growth will outpace any emissions savings. The urgency of the climate crisis should logically demand the approach that can secure decreased emissions faster. It may be countered that both production efficiencies and reducing demand for consumption should be enacted, but the FAO have directed all of their attention to the first option. This places their work [1,2,10] in a difficult position because it has acted to embed the efficiency framing as the solution that should be favoured by the UN and national governments. This could appear as a form of protectionism. The FAO’s tendency to assume demand for animal products leaves it at odds with other UN agencies that have explored the potential

for reducing animal consumption [23,24]. What sort of explanation could be offered for this discrepancy?

The broad debate about emissions from animal agriculture is highly politically charged, as with other high emissions sectors. Different forms of bias can potentially be identified with various positions. The FAO work [1,2,10] is not peer reviewed in a conventional sense because it is not published in scientific journals. This should be remedied for future FAO emissions work, which should be peer reviewed by climate scientists external to the epistemological community of animal production scientists. Other non-peer reviewed work [25] has produced far larger estimates of the percentage contribution of emissions from animal emissions. When corporate interests seek out the lowest possible estimate and advocacy organizations are drawn to the highest, the debate is at risk of descending into a highly unsatisfactory fog of confirmation bias. The FAO work appears to be a concerted attempt to produce useful emissions estimates from what are multiple and complex datasets. However, its unexplained loyalty to an efficiency framing could be suggestive of a form of epistemological bias.

It is a basic insight from the sociology of science that scientific communities are not always distinct from commercial interests. As previous research has shown [26,27], this is certainly the case in the animal production sciences, which directly seek to improve the profitability of the sector, for example, via genomic or feed-related research. The FAO work on emissions has been carried out by the FAO division on Animal Production and Health, which consists of animal scientists who are exactly part of this epistemological community. Although the FAO has clearly played an important role in bringing to light the environmental costs of animal production with its two reports [1,2], the community of animal production sciences has an understandable commitment to a normative view of animal agriculture as a social good, which may impede its ability to be inclusive of policy advocating for the downsizing of the sector. Indeed, the Animal Production and Health division [28], as its name suggests, is explicitly mandated to “support countries to sustainably grow the livestock sector” and it supports “sustainable livestock production” in the service of the UN Sustainable Development Goals, also framing the sector as indispensable for food security in developing countries. Although the arguments around these claims are beyond the scope of this article, the enmeshment of the FAO Animal Production and Health division within this epistemological community does offer one explanation as to why this UN body (and only this UN body) continues to avoid recommending dietary transition as an important response to the climate, and other environmental, impacts of the sector. Further analyses [29,30] have been critical of the FAO division for allowing industry groups, such as the International Feed Industry Federation and the International Meat Secretariat, to influence their GLEAM methodology via the FAO’s formation of a partnership with private stakeholders, known as the Livestock Assessment and Performance Partnership (LEAP). Almiron [30] has been specifically critical of the FAO for allowing the two main lobbyists of the EU meat industry, the UECEV (European Livestock and Meat Trades Union) and CLITRAVI (Liaison Centre for the Meat Processing Industry), to become stakeholders within LEAP. These issues speak to important considerations of neutrality and raise the possibility that elements of the meat industry have been able to exert undue influence upon the formation of the environmental assessment tools for their own industry. The symbolic power of the UN and the political influence of the FAO on the issue of emissions from animal agriculture should not be underestimated.

5. Conclusions

This re-examination of FAO data alongside its juxtaposition with more recent work focused on the land use impacts of the global farmed animal sector serves to redefine the lowest percentage number and raises a question over why the FAO did not produce a new percentage figure based on their most recent analysis [10]. Some will contest the importance of a few percentage points. Yet even the difference between 14.5 and 16.5% is the difference between animal agriculture being responsible for close to one in seven, or one in six of all

emissions. Certainly, the findings presented here show that scientists, policy makers, civil society, and journalists should stop using the 14.5% figure. In what is a highly controversial and politically charged sector of climate science, an announcement of even a small increase would have had important social, political, and economic symbolism. Percentage numbers take on social and political importance, shaping policy, and are reminders of the significance of societal reflection upon the framings that emerge around them. That the authors of these FAO reports have been so clear to embed an efficiency framing contrasts sharply with the more transformative social and dietary change that others [31–35] argue is vital to address the contemporary urgency to reduce emissions.

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