

REVIEWERS COMMENTS AND RESPONSES OF THE AUTHORS

COMMENTS TO THE AUTHORS

Editor/Chief-Editor Landbauforschung

For your manuscript severe improvements are suggested by the reviewers making a complete reworking of the text necessary. They demand higher scientific quality of your argumentation. Also a clear consideration of the future role of ruminants in different economic and environmental surroundings and a more detailed comparison to other forms of land-use and other livestock production is demanded. Both reviewers feel that the arguments in your position paper are incomplete and also the vision is based on weak basis. They recommend major revisions or rejection. Therefore I have to reject the paper in its present form.

But the topic and range you have chosen for your submission is clearly important for future development of livestock and ruminant keeping, future land use and the related emissions. Also your position and the two reviews we gained are part of an interesting and ongoing debate. So in the light of the aim of position papers in Landbauforschung it might be of interest to share the reviewers comments with an updated and accepted manuscript with the readers.

So I would invite you to rework your position paper, clear up the mentioned weaknesses and add a more complete view of the topic as demanded and resubmit for further evaluation of the reviewers.

[Response: We thank the editor for summarizing the reviewers' comments, highlighting that our position paper fits the journal, and inviting us for re-submitting the paper. We address at the comments either in the revised position paper or in the reply to the reviewers below.](#)

[We had the impression that the referees were reviewing our manuscript as a research article rather than as a position paper. In some regards, we therefore did not take up the suggestions of the reviewers.](#)

Reviewer # 1:

Short summary of the aim of the paper, its main findings and conclusions

The paper argues that animal source food (ASF) in general and ruminant meat and milk in particular should become dramatically reduced in order not to exceed the planetary boundaries and to make both agriculture and food consumption sustainable. It focuses on the 3 overarching themes of Food and Nutrition Security, Development and Livelihoods and Biodiversity & Cultural landscapes and discusses alternatives approaches to ASF to achieve the goals.

The paper fits into the specific issue of Landbauforschung.

[Response: We thank the reviewer for finding our paper fitting for the scope of the special issue of the journal.](#)

General comments

The paper addresses a very important aspect, namely how the land is managed sustainably and how this affects human nutrition and the composition of the diet. Most of the conclusions are already well known and not very innovative.

Response: Many thanks for highlighting that our position paper addresses a very important aspect. Since this is a position paper instead of a research paper, we agree that most of our arguments are already known, and we could only synthesize the evidence of existing studies. However, innovative aspect of our position paper is that we link and bundle these arguments with the prevalent counter-narratives on need for reduction of animal source food consumption. Following the reviewer's suggestion, we highlight the innovative part of our position paper as follows:

“From an environmental perspective, reducing animal source foods, in particular ruminant sourced ones, are imperative globally and in most regions to meet emission reduction targets and other environmental concerns. However, as such calls become louder, they are also facing several prevalent counter-narratives. Here we bring a novel discussion on three of these narratives that relate to the social, economic, and environmental threats of animal source food reduction, including: i) food and nutrition security, ii) development and livelihoods, and iii) conservation of biodiversity and cultural landscapes. For each point, we highlight how the reduction of animal source foods, in particular ruminant sourced ones, can go hand-in-hand with concomitant improvements rather than threats.”

Unfortunately, the paper is very inconsistent. The title proclaims that ruminant systems should be replaced, while in the conclusion the rather prudent recommendation is made that instead of investing research and state support into improved and more efficient ruminant systems, plant production and especially vegetable production should become supported.

Response: Many thanks for the comment. We addressed the comment on inconsistency at several points in the manuscript and changed the title to “Improving ruminant systems is good, but low consumption of animal source foods is even better for the environment and public health”. Please also see below for details on further changes in the document.

A further inconsistency is the fact that the author talks about ASF but discusses mainly ruminant systems and ignores monogastric production.

Response: Our position paper mainly discusses ruminant systems because of two reasons: i) ruminant systems are a major contributor of greenhouse gas emissions and have a higher environmental impact than monogastric animals, and ii) the special issue of the journal is on ruminant systems. However, our arguments also hold for non-ruminant systems, and large parts of the manuscript actually talked about animal source foods (ASF) rather than ruminant products exclusively. We further highlight this as follows:

“Our discussion is focused on ruminant systems because ruminants emit higher amounts of greenhouse gases and have a higher environmental impact than monogastric animals, however, our arguments also hold for monogastric systems.”

In the paper, land use changes related to his suggestions are more or less ignored. How much land has to be converted into arable systems and how much carbon will become released consequently?

Response: We cannot follow the reviewers comment here. There is a broad literature (e.g. Weindl et al 2017, Stehfest et al 2009, Alexander et al 2016, Kastner et al 2012) stating that substituting ASF in diets would lead to a reduced land expansion or a net reduction, and not to an expansion of arable systems. We now mention these aspects in the manuscript as follows:

“On the other hand, multiple studies have shown that substitution of animal source foods by plant products in diets would reduce deforestation and the expansion of croplands due to reduced demand for feed crops (e.g. Weindl et al 2017, Stehfest et al 2009, Alexander et al 2016, Kastner et al 2012).”

If you only consider 100% pasture-fed ruminants, you may see a reduction of pasture and an increase of

cropland, but 100% pasture-fed animals are clearly the exception in all countries where we suggest a reduction of ASF (Herrero et al 2013). Moreover, horticulture has very high area productivity, such that even an expansion of horticulture replacing cereals and other feed crops would not lead to a conversion of pastures or natural forest, which we now point out as follows:

“Economic land productivities of the horticulture sector are often a multitude relative to cereals, offering potential for growth also to small-scale land-owners shifting from conventional cropping to the horticulture sector without conversion of pasture or natural forest (Weinberger and Lumkin 2005).”

It completely ignores that most of the permanent grassland is on marginal soils where arable, vegetable and fruit production is inappropriate.

Response: As stated above, feeding ruminants only on marginal pastures is clearly the exception (Herrero et al 2013). But we agree with the reviewer, that within the transition, the reduction of ASF should take part primarily in industrial systems. We now adopt this in our article as follows:

“Hence, a much reduced number of ruminants would be sufficient to maintain cultural landscapes across the world and can be guided by policies to preserve cultural and biodiverse pasture landscapes.”

We also acknowledge the comment and modified the statements as follows:

“Livestock contributes a lower share to income than cropping (Davis et al 2010), and a dietary transition from animal source foods towards healthier, more plant-based diets may create opportunities that could be more beneficial for smallholders than the foregone income from livestock farming. However, these opportunities mainly holds for regions where farmers have possibilities for alternative agricultural activities besides livestock farming.”

The author also underestimates the productivity of ruminant systems which is 36 million tons of protein compared to 38 million of monogastric systems (Mottet, A. et al. (2017) Livestock: On our plates or eating at our table. A new analysis of the feed/food debate. Global food security, Elsevier).

Response: We acknowledge the contribution of both ruminant and non-ruminant systems for the global protein supply. However, our position paper highlights the need of reducing animal source food for climate change mitigation and maintaining public health. For addressing the comment, we include the following statement comparing protein supply from ruminant systems and crops. We also included the provided reference in other part of the paper (see below).

“The global protein supply from ruminant systems is low as well, i.e., around 18% of per capita protein supply from ruminants in comparison to 60% from crops (FAO 2019).”

“Producing 1kg of boneless ruminant meat requires an average of 2.8 kg human-edible feed that varies between 0.1 to 9.4 kg human-edible feed depending on region and intensity of production (Mottet et al. 2017). However, despite the relatively large environmental impacts, ruminant systems produce a relatively modest 18% of the per capita protein supply, which compares to 60% from crops (FAO 2019).”

The author does also not describe the intensity of arable systems resulting from a strong reduction of ruminants and as he is obviously in favour of monogastric systems, he doesn't draw the conclusion that arable land use for feed stuff (for both monogastric animals and ruminants) should be mainly used for human nutrition (Schader et al., 2015; Muller A., Schader, C., El-Hage Scialabba, N., Hecht, J., Isensee, A., Erb, K.-H., Smith, P., Klocke, K., Leiber, F., Stolze, M. and Niggli, U., 2017, Strategies for feeding the world

more sustainably with organic agriculture, Nature Communications October/2017.).

Response: As mentioned in our response above, our position paper highlights the need of reducing animal source food rather than favouring monogastric systems. One however also has to consider some particular aspects of ruminant systems: Their particular GHG intensity, and that red meat is less healthy than white meat. Our position paper mainly discusses ruminant systems and ignores monogastric production because of two reasons: i) ruminant systems are a major contributor of greenhouse gas emissions and have a higher environmental impact than monogastric animals, and ii) the special issue of the journal is on ruminant systems. We also think that ruminant systems have some particularities that consider attention, such as the argument for preservation of cultural or biodiverse landscapes, which is less the case for monogastric animals. However, our arguments also hold for monogastric systems. We highlight these reasons as follows:

We changed the title to “Improving ruminant systems is good, but low consumption of animal source foods is even better for the environment and public health”, where we generalize to all ASF. As part of the special issue, we however also want to keep the link to the ruminant systems in the title.

“Our discussion is focused on ruminant systems because ruminants emit higher amounts of greenhouse gases and have a higher environmental impact than monogastric animals, however, our arguments also hold for monogastric systems.”

For addressing the comment on arable land use for producing livestock feed, we agree with the reviewer and included the following statement:

“Consumption of a low amount ASF also decrease demand of human-edible feed for livestock production (Muller et al. 2017), making conversion of conventional cropping to the horticulture sector a plausible option.”

Detailed comments by line

Line 11 and 12: This is trivial as it is true for any kind of agricultural production.

Response: We agree with the reviewers and revised the statement to be more specific, referring to the recent IPCC Special Report on Climate Change and Land.

“The technical potential for climate change mitigation of these options ranges 0.2-2.4 GtCO₂-eq yr⁻¹ in comparison to emissions of 4.1±1.2 Gt CO₂-eq yr⁻¹ from the livestock sector (Mbow et al. 2019). Therefore, even the best ruminant production systems cannot avoid putting pressure on the environment.”

Line 15: This is not quite correct. Please check Mottet et al. 2017)

Response: We modify the statement as follows:

“The global protein supply from ruminant systems is low as well, i.e., around 18% of per capita protein supply from ruminants in comparison to 60% from crops (FAO 2019).”

Lien 17/18: This is too simplified. Why not seriously discuss different ruminant systems which convert permanent grassland into protein without pushing yields with concentrates.

Response: Following the suggestion, we included ranges for ruminant systems based on the suggested literature.

“For producing 1kg of boneless ruminant meat requires an average of 2.8 kg human-edible feed that varies between 0.1 to 9.4 kg human-edible feed depending on region and intensity of production (Mottet et al. 2017). The demand for human-edible feed is higher for monogastric than ruminant systems (Mottet et al. 2017, Pradhan et al. 2013).”

Please consider that producing the current levels of meat using only ruminant systems fed by permanent grassland is not a viable or plausible option without a substantial reduction in the consumption of ASF.

Line 60 to 78: The aspect of the role of meat and milk in the human diet is discussed in a biased way.

Response: We disagree with that statement. Our arguments are based on the published literature on healthy diets. The associations of red and processed meat, and dairy are based on meta-analyses of cohort diets that clearly show increased disease risk for colorectal cancer and other non-communicable diseases for red and processed meat, and neutral health impacts, compared to an average unhealthy background diet, for dairy, which suggests that it would be advisable to consume more foods that are clearly associated with health benefits, such as fruits, vegetables, nuts, legumes, and whole grains.

Line 94 ff: Although the information is correct, it does not reflect the aspect of farmers living on marginal soils, Many hundred million farmers would lose their livelihood e.g. on obligatory grassland. The pastoralist people/farmers would disappear etc. All in all, 68% of the global agricultural land belong to that category (in Germany 28%). Cerrado soils e.g. which have become so unfertile that Savanna vegetation and low intensive ruminant systems is the most important utilization, are increasingly intensified with mineral fertilizers and GMO cropping systems.

Response: We acknowledge the comment and modified the statements as follows:

“Livestock contributes a lower share to income than cropping (Davis et al 2010), and a dietary transition from animal source foods towards healthier, more plant-based diets may create opportunities that could be more beneficial for smallholders than the foregone income from livestock farming. However, these opportunities mainly holds for regions where farmers have possibilities for alternative agricultural activities besides livestock farming.”

Line 134: This is only one aspect. The author does not calculation carbon losses caused by turning permanent grassland, nature conservation areas etc. into arable cropping systems.

Response: We agree with the reviewer that this is only one aspect. However, we have not provided any argument for turning permanent grassland, nature conservation areas etc. into arable cropping systems. In contrast, reducing the consumption of ASF would reduce or stop the current expansion of croplands because of a reduced amount of cropland-based feed, as several studies showed (e.g., Mueller et al. 2017). To avoid the confusion, we included the following statement:

“Economic land productivities of the horticulture sector are often a multitude relative to cereals, offering potential for growth also to small-scale land-owners shifting from conventional cropping to the horticulture sector without conversion of pasture or natural forest (Weinberger and Lumkin 2005). Additionally, Weindl et al (2017) showed that low consumption of animal source foods has a clear positive net-impacts on the carbon stocks accounting for the changes in soil organic carbon when pastures are converted into croplands.”

A thorough calculation of the consequences of dietary change on the carbon stocks has been provided by Weindl et al (2017), also accounting for the changes in soil organic carbon when pastures are converted into croplands. The study shows that the consequences of reduced animal products have clear

positive net-impacts, not even accounting for methane and NO2 emissions.

Are the conclusions justified and supported by the results?

The inconsistencies might lead to biased or even wrong conclusions. Mueller et al. (2017) concluded that a massive reduction of monogastric animals fed on arable land and a more or less stable ruminant livestock population fed on roughage only with less productivity would lead to sustainable nutrition of the human population by 2050, complemented by halving food wastes as proposed by FAO. This conclusion should be contrasted by the author at least.

Response: We do not see how the conclusions of Mueller et al (2017) stand in contrast to our conclusions, which also propose a strong reduction of ASFs. In addition, we see clear support why ruminant systems should be reduced along other ASFs, given that ruminant food supply chains emit roughly 10% of global GHG emissions. We make this clear by stating:

“The ruminant supply chains emit 5.7 gigatonnes CO₂-eq per year (FAO 2012) - roughly one tenth of global GHG emissions.”

Reviewer # 2:

General comments and recommendation

The authors are adding to a huge number of papers on the merits and demerits of animal source food. They draw attention to valid issues associated with ruminant production, but there is a distinct lack of evidence presented on the environmental costs of the alternative food sources that they promote.

Response: We agree with the reviewer and discuss this aspect at two points of the manuscript:

“However, the horticulture sector also need to expand sustainably with a focus on regional and seasonal products because environmental cost of horticulture products can be comparable with or even higher than ruminant sourced foods when they are produced in protected greenhouse systems and transported using air cargo (Lillywhite et al. 2007).”

“...multiple studies have shown that substitution of animal source foods by plant products in diets would reduce deforestation and the expansion of croplands due to a reduced demand for feed crops (e.g. Weindl et al 2017, Stehfest et al 2009, Alexander et al 2016, Kastner et al 2012).”

A title that suggests replacing ruminant systems has to provide evidence that the impacts of the replacements are less negative than the status quo to justify the position? The promise of the title is not therefore delivered. The language is also fairly “loose” in places - more appropriate for a newspaper than a peer-reviewed scientific journal. I therefore recommend its rejection or at least a complete reworking to use balanced scientific evidence.

Response: We agree that this piece is more opinionated and controversial than a usual research article. When reviewing the article, please consider that the article is not submitted as a research or review article, but as a “position paper”. The journal defines the scope of such articles as follows:

“**Position Papers** present science-based opinions on new, or possibly disruptive, developments in sustainable agricultural systems. Authors should use scientific references to validate and approve arguments for a position. These papers shall allow the reader to understand controversial positions and to find an own position.”

Beyond, we went over the paper again to avoid loose language.

Specifics

Loose wording: My issues start with the title “better” for what? It is a title written to be catchy rather than for a scientific journal. It lacks rigour. Plus the paper does not actually make the case for what would be the downsides of not having any ruminants for food production?

Response: Following the suggestion, we modify the title of the position paper as follows:

“Improving ruminant systems is good, but low consumption of animal source foods is even better for the environment and public health”

Sure ruminants “put pressure on the environment” (l 12) so do humans! So does horticulture, so does cereal production.....

Response: We agree with the reviewers and revised the statement to be more specific, referring to the recent IPCC Special Report on Climate Change and Land.

“The technical potential for climate change mitigation of these options ranges 0.2-2.4 GtCO₂-eq yr⁻¹ in comparison to emissions of 4.1±1.2 Gt CO₂-eq yr⁻¹ from the livestock sector (Mbow et al. 2019). Therefore, even the best ruminant production systems cannot avoid putting pressure on the environment. “

“The environmental footprint of diets containing livestock products is considerably higher than those of plant-based diets (Poore and Nemecek, 2018). The ruminant supply chains emit 5.7 gigatonnes CO₂-eq per year (FAO 2012) - roughly one tenth of global GHG emissions.”

On l 15 there is the statement : “The amount of food one gets out from ruminant systems is low as well” Intensive ruminant systems can be very productive – 600 million tonnes of milk each year global average over 2000l/cow. What exactly were the authors trying to say? This is poor quality scientific writing.

Response: We modify the statement as follows:

“Producing 1kg of boneless ruminant meat requires an average of 2.8 kg human-edible feed that varies between 0.1 to 9.4 kg human-edible feed depending on region and intensity of production (Mottet et al. 2017). However, despite the relatively large environmental impacts, ruminant systems produce a relatively modest 18% of the per capita protein supply, which compares to 60% from crops (FAO 2019).”

The discussion on efficiency rates ruminants in terms of efficiency, but that rating depends on the units you use for efficiency. Agreed that you don’t get as much energy or protein for human consumption from ruminants as you do from pigs and poultry if you compare vs total energy eaten but ruminants can turn human-inedible biomass into high quality food. None of that is mentioned. If you are going to talk about efficiency explain what units you have used.

Response: We acknowledge the comment. In this position paper, we use efficiency as produce more with less environmental impacts. To address the comment, we modify the statement as follows:

“There are many ways for efficient management of ruminant systems to provide more food with less environmental impact, such as improve feeding quality, avoid overgrazing, introduce silvopasture, control parasites or even feed specific ingredients that reduce the emissions of climate-heating methane (Lemaire et al. 2014, Schader et al. 2015).”

Our following statement addresses the comment regarding the use of feed for livestock production:

“For producing 1kg of boneless ruminant meat requires an average of 2.8 kg human-edible feed that varies between 0.1 to 9.4 kg human-edible feed depending on region and intensity of production (Mottet et al. 2017). The demand for human-edible feed is higher for monogastric than ruminant systems (Mottet et al. 2017, Pradhan et al. 2013).”

We also add the aspect, that some world areas have low production potential for other human-edible biomass:

“However, these opportunities mainly holds for regions where farmers have possibilities for alternative agricultural activities besides livestock farming.”

Food & Nutrition security: It is not legitimate to compare a source of nutrients with other mechanisms such as cash transfers, which obviously only bring food and nutrition benefits if they are used to purchase food and where is the food coming from? What are breast-feeding mothers eating?

Response: We disagree with the comment. This is because we need to have a systematic approach looking at food systems as a whole to ensure food security instead of concentrating on producing more only. However, we agree that the nature of “cash transfers” was not clear. Therefore, we modified the statement as follows:

“Other interventions, such as conditional cash transfers, have also shown effectiveness in some instances (Lagarde et al, 2009, Pega et al, 2015).”

Yes, you are right it matters what the mothers are eating. Thus, we also used “together with” instead of “and”. However, we also would like to highlight that sub-optimum breastfeeding is also a cause of child undernourishment (Bhutta et al, 2013).

“A comprehensive review (Bhutta et al, 2013) found that micronutrient supplementation programmes together with the promotion of breastfeeding are the most cost-effective options for improvement of maternal and child nutrition in low-income countries, but also that the broad category of complementary food supplementation has a role to play.”

Lumping red and processed meat together when the evidence is clear for processed meat (yet those studies were done in developed countries) but less clear for red meat (as the authors themselves acknowledge) is not good scientific writing? None of the arguments raised in this section are new and it is very developed country biased.

Response: We disagree with that statement. This is because our arguments are based on the published literature on healthy diets. The associations of red and processed meat, and dairy are based on meta-analyses of cohort diets that clearly show increased disease risk for colorectal cancer and other non-communicable diseases for red and processed meat, and neutral health impacts, compared to an average unhealthy background diet, for dairy, which suggests that it would be advisable to consume more foods that are clearly associated with health benefits, such as fruits, vegetables, nuts, legumes, and whole grains.

It seems that you are referring to the word “probably” in our statement. We used these wording because this is how IARC classified them. We made this explicit as follows.

“In 2015, the cancer agency of the World Health Organization, the International Agency for Research on Cancer (IARC), classified the consumption of red meat, which includes beef, lamb,

and pork, as “carcinogenic to humans” if eaten in processed form, and as “probably carcinogenic to humans” if eaten unprocessed (Bouvard et al, 2015).”

Regarding “developed country biased”, the study we are referring is based on more than 800 epidemiological studies for many countries, from several continents, with diverse ethnicities and diets. Additionally, looking at the dietary trends, many studies reported that developing countries are increasingly following dietary habits in developed countries with increase in consumption of animal source foods. Thus, these arguments are also valid for developing countries where the consumption of red and processed meat have increased, e.g. China.

Horticulture uses a lot of water – climate change is leading to increased frequency of droughts. Horticulture in some regions will be as negative as animal production. Promoting increased fruit and vegetable consumption without laying out the environmental consequences is irresponsible. There are also nutrition issues with home gardens – it is usually the women who do the work and the time they take to do that diminishes the time they have for cooking in some countries with negative impacts on their family’s nutrition.

Response: We carefully discussed the environmental issues raised in the comment as follows:

“However, the horticulture sector also need to expand sustainably with a focus on regional and seasonal products because environmental cost of horticulture products can be comparable with or even higher than ruminant sourced foods when they are produced in protected greenhouse systems and transported using air cargo (Lillywhite et al. 2007).”

We also mentioned the labor issue about the horticulture sector in our position paper as shown below.

“Additionally, labor intensity is much higher in this sector so that high employment effects can be expected, and horticulture production in urban and peri-urban areas may also benefit the urban poor (Weinberger and Lumkin 2005, Jaenicke and Virchow 2018).”

However, due to limited length of the paper we did not discuss gender issue raised by the reviewer. Nevertheless, there is plenty of literature showing positive association with home gardens and nutrition. Studies also associate the horticulture sector with women empowerment (e.g., Jaenicke and Virchow 2018).

Since you did not provide any specific literature regarding nutrition issues with home gardens, we are unable to highlight this aspect in our position. Nevertheless, we provided relevant literature for all our arguments.

The use of data in this section is also questionable - comparing ruminant meat production from 2010 with fruit and vegetables from a 2019 reference (although undoubtedly taken from earlier statistics) (Fig 1) is poor scientific practice.

Response: For the figure, we use data for the year 2010 both for pork & ruminant meat and fruits & vegetables from FAOSTAT (<http://www.fao.org/faostat/en/>), i.e., referred as FAO 2019. However, it was unclear in our figure caption. Thus, we made the year for which data was taken explicit in the caption as follows:

“Figure 1. (a) Intake of pork and ruminant meat (bovine meat, mutton, lamb) for 2010 across the world in comparison to the intake recommended by the EAT-Lancet report. (b) Intake of fruits and vegetables for 2010 across the world in comparison to the recommended intake (Willett et al. 2019). Circles indicate the food supply of the countries (FAO 2019). ISO codes of the top ten populated countries are also plotted with the circle. The light gray area represents the desirable

zone in terms of sustainable and healthy diets (Willet et al 2019).”

In summary – there are valid arguments here, but they are not made strongly enough (i.e. with a balanced approach) to attest what is already in the literature.

Response: Many thanks for the comment and acknowledging our valid argument. We believed that we made our argument strongly enough. Regarding a balanced approach, we would like to draw your attention that we are placing our position based on the available literature rather than providing a literature review or assessment.

Development and livelihoods: This is a poorly argued section. Use of a 2005 reference for land productivity and labour intensity is poor scientific practice for a sector that is undergoing rapid change. There are many recent references which should have been researched to make the case.

Response: We included an additional latest reference to supporting our argument as follows. However, we did not include more references to limit the number of references as this is a short position paper rather than a research article.

“Additionally, labor intensity is much higher in this sector so that high employment effects can be expected, and horticulture production in urban and peri-urban areas may also benefit the urban poor (Weinberger and Lumkin 2005, Jaenicke and Virchow 2018).”

The assumptions made about the potential of horticulture to change livelihoods shows a naivety about land capability in developing countries and the final section about relative funding while valid, also shows a naivety about the challenges of helping poor people out of poverty.

Response: For addressing the comment on land suitability, we added the following statement.

“In general, global agro-ecological zones show that arable land suitable for cereal productions are also suitable for horticulture (Fischer et al. 2015).”

Biodiversity and cultural landscapes: What do the authors understand by the term “cultural landscapes”?

Response: In our understanding, the landscapes that are shaped by a long tradition of grazing is known cultural landscapes. We also mentioned this in the position paper as follows:

“It is argued that ruminants play an important role in maintaining cultural landscapes of many parts of the world which are shaped by a long tradition of livestock grazing.”

This section is muddled between the biological viewpoint and what presumably is a social (cultural) viewpoint? Data are again restricted to the livestock sector with no data on the potential of rewilding? What would taking land out of production for rewilding do to food availability for example? The paper looks at each issue in parallel but actually they are interlinked and ignoring those interlinkages undermines the validity of the position taken.

Response: We thank review for this comment. For a holistic approach, we need to consider social, economic, and ecological viewpoint. Therefore, we present both biological and social viewpoints in this section. We include the data regarding the afforestation potential as suggested and its effect on food security.

“A recent study shows that 205 gigatonnes of carbon can be stored by afforesting areas that would naturally support forest growth (Bastin et al, 2019), , except current agriculture and urban areas. However, high level of reforestation, forest restoration and afforestation can have moderate negative impacts on food security (IPCC 2019).”

We also add an aspect on the effect dietary change would have on land requirements:

“..multiple studies have shown that substitution of ASF by plant products in diets would reduce deforestation and the expansion of croplands due to a reduced demand for feed crops (e.g. Weindl et al 2017, Stehfest et al 2009, Alexander et al 2016, Kastner et al 2012). “

Conclusions: This sentence: “The above counter-narratives do not provide pertinent arguments against a drastic reduction in ASF, in particular those from ruminants” is again loose wording. It would be better to say that the evidence presented shows that the counter-narratives presented for discussion do not provide..... Except that actually the evidence presented does not really do that. And “drastic reduction”? at what scale? In developed countries yes, but in developing countries with low ASF consumption a reduction let alone a drastic one is not appropriate. Mores precise wording would be more appropriate for a paper in a peer-reviewed journal and would have greater impact.

Response: We agree with the review that more precise wording would have greater impact. Thus, we change the wording as follows:

“The evidence presented shows that the counter-narratives presented for discussion do not provide pertinent arguments against a drastic reduction in ASF as recommended by Willett et al. (2019) for planetary and public health. Dietary changes towards plant based diets with limited amount of ASF present major opportunities for climate change mitigation and adaptation with human health co-benefits (IPCC 2019).”

The final paragraph of the paper is very valid and would make a good conclusion for a position paper, but the text before it does not substantiate it.

Response: Many thanks for finding the final paragraph very valid. We are confident that the revised version of the position paper substantiates it.

REVISED AND RESUBMITTED VERSION

Editor/Chief-Editor Landbauforschung

Both reviewers still suggest to sharpen your position and to include a vision and a dimension for a sustainable and appropriate grassland use with ruminants. I agree that including a deeper evaluation of this point would increase the significance of your position. Please check if some more details can be included. It would really help to approach the overarching view on ruminants and grassland we aimed at in our call for this issue. Also the below mentioned study on red meat consumption is worth to evaluate.

Response: We thank the editor to summarizing the comments of the reviewers. We carefully addressed the provided comments by you and the reviewers in our revised version. Mainly, we include some more details on sustainable grassland management and add our comment on the recent paper on health risks of meat consumption.

Please introduce the abbreviation 'Animal Source Food' (ASF) before using it further in the text.

Response: Many thanks. We use the full form "Animal Source Food" and avoid using "ASF".

The reference "Mottet et al. 2017" is missing.

Response: We include the reference. Unfortunately, we overlooked this.

Reviewer # 1:

Page 4: Please add and comment the reference of the latest publication on health risks of red meat: <<https://annals.org/aim/fullarticle/2752328/unprocessed-red-meat-processed-meat-consumption-dietary-guideline-recommendations-from>> Annals of Internal Medicine (Johnston et al., 2019). Their review paper might be more objective and less negative.

Response: Many thanks for the comment. We are aware about the paper. There are also many responses about this paper, which are summarized in the following link: <https://www.sciencemediacentre.org/expert-reaction-to-new-papers-looking-at-red-and-processed-meat-consumption-and-health/>. However, following your comment add and comment this reference in our paper as follows:

Although for a single individual, the health impacts of eating red and processed meat are only slightly negative, the potential public health impact of meat consumption cannot be ignored due to the wide prevalence of meat-eating across the world (Johnston et al. 2019). Many experts express similar opinion on non-ignorable health risks of meat consumption¹.

(1 <https://www.sciencemediacentre.org/expert-reaction-to-new-papers-looking-at-red-and-processed-meat-consumption-and-health/>)

I still do not find any information on how the agricultural land which is obligatory grassland (according to Mottet et al., 2017 1'945'000'000 hectares) can remain in the production of protein and energy. Under the chapter biodiversity & cultural landscape the author mentions: "The former can include large herbivores that are not necessarily used for food ...". Is this a real solution as any herbivores emit methane whether they produce food or not.

Response: We agree with your argument and sharpen our statement as follows:

There is a large potential to create different cultural landscapes through afforestation and to increase biodiversity through rewilding (Bakker and Svenning, 2018), providing additional climate benefits from sequestering carbon (Bastin et al, 2019).

We also mention sustainable grassland management as strategy so that current grassland may remain in the production of protein and energy, as follows:

Hence, a much reduced number of ruminants with sustainable grassland management would be

sufficient to maintain cultural landscapes across the world and can be guided by policies to preserve cultural and biodiverse pasture landscapes, at the meantime, producing animal source foods.

I think that ruminant livestock systems are presented only by negative points and not by the positive ones. Therefore, I'm still missing:

Response: Many thanks for highlighting the missing points. We included these points in our paper as explained below.

* Sustainable grassland management is completely missing. Grassland can be used without overgrazing and erosion. This is a matter of stocking density and not a principal problem.

Response: We mention about the sustainable grassland management in our paper. However, it was implicit. We make this explicit as follows:

However, on the one hand, such grasslands are rich in biodiversity when they are sustainably managed with low-input and appropriate stocking density. As soon as the grasslands are intensely fertilized, the number of species is strongly reduced (Hautier et al. 2009). Overgrazing will also have negative effects on biodiversity.

Hence, a much reduced number of ruminants with sustainable grassland management would be sufficient to maintain cultural landscapes across the world and can be guided by policies to preserve cultural and biodiverse pasture landscapes, at the meantime, producing animal source foods.

Sustainable grassland management is also implicitly mentioned in the first statement of our paper as follows:

There are many ways for efficient management of ruminant systems to provide more food with less environmental impact, such as to improve feeding quality, avoid overgrazing, introduce silvopasture, control parasites or even feed specific ingredients that reduce the emissions of climate-heating methane (Lemaire et al. 2014, Schader et al. 2015, Landholm et al. 2019).

* Ruminants can be kept with 100 % roughage. The author describe only the inefficient transformation of livestock systems with high cereal inputs.

Response: Following the suggestion, we make this aspect explicit as follows:

Producing 1kg of boneless ruminant meat requires an average of 2.8 kg human-edible feed that varies between 0.1 to 9.4 kg human-edible feed depending on region and intensity of production, e.g., ruminants in grazing and mixed systems mainly consume (about 90%) roughages (Mottet et al. 2017).

* Many pastoralists in Mongolia, Himalaya, Tibet, Ethiopia or in the European Alps have managed grassland for centuries in a sustainable way. Their living depends on pastoralism.+

Response: We include this aspect as follows:

However, these opportunities mainly may not hold for regions where farmers have limited possibilities for alternative agricultural activities besides livestock farming (e.g. pastoralism in Mongolia, Himalaya, the European Alps, etc).

* Ruminants do not only transform roughage into protein and energy, but also roughage into many bringing nitrogen and phosphorous from obligatory grassland into arable systems.

Response: Many thanks for this aspect of nutrient recycling/loop. We include this aspect as follows:

Next to income, animals often provide services like traction, asset formation or insurance and their manures can transfer nutrients from grassland into smallholder arable systems (Herrero et al 2013a).

Reviewer # 2:

I agree the paper is much improved. I have the following minor comments:

Response: We thank you very much for finding that the paper is much improved. Many thanks for the further comments to improve the paper. We address the comments as mentioned below.

Still some loose language e.g. l 40 what does “imperative globally” mean? It is ambiguous and while there is evidence supporting a global reduction there is not evidence suggesting that countries with very low current ASF production can safely decrease consumption without impacting child health. So the authors should clarify which they mean and if the latter make clear there may be risks.

Response: Many thanks for the comment. We made our argument more concrete as follows:

“From an environmental perspective, reducing animal source foods, in particular ruminant sourced ones, are imperative in most regions to meet emission reduction targets and other environmental concerns.”

On comparing options for food and nutrition security the authors’ response is valid.

Response: Many thanks for finding our response valid.

On the issue of meat and health – a recent sophisticated analysis disputed consumption of red meat per se being the cause of negative health and instead attributed increased risk to low fibre consumption. That analysis highlights the uncertainty around epidemiological studies. The authors of course can make their own choice as to which analysis to believe.

Response: Many thanks for the comment. Following your and Reviewer 1’s comments, we add and comment on the study you are inferring as follows:

Although for a single individual, the health impacts of eating red and processed meat are only slightly negative, the potential public health impact of meat consumption cannot be ignored due to the wide prevalence of meat-eating across the world (Johnston et al. 2019). Many experts express similar opinion on non-ignorable health risks of meat consumption¹.

On the issue of home gardens – agree that the literature is deficient.

Response: Many thanks for agreeing with our response.