POSITION PAPER

Reducing ruminant numbers and consumption of animal source foods are aligned with environmental and public health demands

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1 The environmental burden of ruminants

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). The technical potential for climate change mitigation of these options ranges from 0.2 to 2.4 Gt $CO_{2\text{-eq}}$ yr^{-1} in comparison to the current emissions of 4.1±1.2 Gt $CO_{2\text{-eq}}$ yr^{-1} from the livestock sector (Mbow et al., 2019). Therefore, even the best ruminant production systems cannot avoid putting pressure on the environment. Ruminants inevitably produce methane in their rumens, require land for their feed, and their excretion leads to emissions of ammonia, nitrate, and nitrous oxide, responsible for air pollution, water pollution, and global warming (Steinfeld et al., 2006). Producing 1 kg 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 roughages (about 90 %; Mottet et al., 2017). However, despite the relatively large environmental impact, ruminant systems produce a relatively modest 18 % of the per capita protein supply in comparison to 60 % from crops (FAO, 2019).

The dimension of the global ruminant livestock production system further amplifies its already high per-product impact. The global ruminant livestock population of around 4 billion in 2017, consisting of 38 % cattle, 31 % sheep, 26 % goats, and 5 % buffaloes (FAO, 2019), has a bodyweight that is more than 10 times the bodyweight of all wild mammals (Bar-On et al., 2018). Their feed requirements and nutrient excretion are exceeding the absorption capacity of natural systems, even when fed sustainably. The environmental footprint of diets containing livestock products is considerably higher than those of plant-based diets (Poore and Nemecek, 2018). The ruminant supply chain emit 5.7 Gt $CO_{2\text{-eq}}$ yr^{-1} (Opio et al., 2013), which is roughly one-tenth of global greenhouse gas emissions. Even if the most efficient and currently available management practices were adopted in the entire agricultural sector, a food system with high levels of animal source foods in general, and ruminant meat and milk in particular, would risk to exceed key planetary boundaries (Springmann et al., 2018a). These include those for climate change, land use, freshwater extraction, nitrogen and

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phosphorus. Model-based analyses showed that the food system has a chance of staying within planetary boundaries only when efficient management practices were combined with dietary changes towards less animal source foods and less food waste (Springmann et al., 2018a).

From an environmental perspective, reducing animal source foods, in particular ruminant-source ones, is imperative 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 provide a novel discussion on three of these narratives that relate to the social, economic, and environmental threats of reducing animal source foods, 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-source ones, can go hand-in-hand with concomitant improvements rather than threats. Our discussion is focused on ruminant systems because ruminants emit higher amounts of greenhouse gases and often have a higher environmental impact than monogastric animals; however, our arguments also hold for monogastric systems.

2 Food and nutrition security

Globally, 821 million people are facing hunger and undernourishment (FAO et al., 2019). Animal source foods can provide protein and micronutrients in food-insecure countries and help diversify mainly starch-based diets (Willett et al., 2019). In large parts of Sub-Saharan Africa, an increase in animal source foods could contribute to improving nutritional status and reduce stunting, in particular for children (Neumann et al., 2002; Bwibo and Neumann, 2003). However, this can also be achieved by environmentally sustainable options that do not include livestock. Bhutta et al. (2013) showed in a comprehensive review that micronutrient supplementation programmes together with the promotion of breastfeeding are the most cost-effective options for improving maternal and child nutrition in low-income countries. But also the broad category of complementary food supplementation has a role to play. Among food-based interventions, the role of home gardening, optionally expanded by some backyard animal husbandry or fish ponds, has been widely discussed as a promising option for improving dietary diversity and strengthening the women's role in the household (Darnton-Hill, 2014). Other interventions, such as conditional cash transfers, have also shown effectiveness in some instances (Lagarde et al., 2009; Pega et al., 2015). Thus, a wide range of options exist for improving maternal and child health, many of which can be considered less environmentally intensive than the promotion of ruminant-source foods.

An additional benefit of promoting more holistic food system options is for long-term health. In 2015, the International Agency for Research on Cancer (IARC), the cancer agency of the World Health Organisation, 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). In addition to being linked with cancer, the consumption of red and processed meat has also been associated with increased rates of coronary heart disease (Micha et al., 2010), stroke (Chen et al., 2013), type 2 diabetes mellitus (Feskens et al., 2013), and overall mortality (Sinha et al., 2010; Larsson and Orsini, 2014). Although some researchers have questioned the need for recommending reductions in red and processed meat consumption (Johnston et al, 2019), such opinions are not shared by the public health and nutrition community[1], nor by the available epidemiological evidence[2]. At a population level, the public health impacts of red and processed meat consumption are large (GBD 2017 Dietary Collaborators, 2019) and carry a substantial cost burden, in particular in countries with high consumption (Springmann et al, 2018b).

The consumption of red and processed meat exceeds recommended levels in most high and middle-income countries and increasingly in several low-income countries (*Figure 1a*). By 2030, the average consumption of red meat in low-income countries is projected to exceed values recommended on health grounds by the EAT-Lancet Commission on Healthy Diets from Sustainable Food Systems (Springmann et al., 2018c). Conversely, the consumption of fruits and vegetables, which is consistently associated with reduction in chronic disease mortality (Aune et al., 2017), is often too low in low-income countries (*Figure 1b*). Thus, also from a health perspective, a focus on promoting nutritious plant-based foods, such as fruits, vegetables, legumes, and nuts, has arguably greater prospects for contributing to food and nutrition security in the medium- and long-term than the promotion of ruminant-source foods.

3 Development and livelihoods

Livestock creates income and livelihoods for the poorest of the world, with about two-thirds of households in developing countries receiving part of their income from livestock farming, and with almost two thirds of poor livestock keepers being rural women (Davis et al., 2010; Herrero et al., 2013a). In addition to income, animals are often used to provide traction, for asset formation, or as insurance, and their manure can transfer nutrients from grassland into smallholder arable systems (Herrero et al., 2013a). However, such statistics deserve to be put into perspective. Livestock contributes a lower share of 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 may not hold for regions where farmers have limited possibilities for alternative agricultural activities besides livestock farming (e.g. pastoralism in Mongolia, Himalaya,

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

2 https://www.hsph.harvard.edu/nutritionsource/2019/09/30/flawed-guidelines-red-processed-meat/

the European Alps, etc.). Horticultural production of fruits, vegetables, legumes, and nuts often accounts for higher net farm income than conventional cropping (Weinberger and Lumpkin, 2005). In 2014, livestock contributed 35 % to the global value of agriculture production of 2.55 trillion international dollars, while cropping systems contributed the remaining 65 %, which included 23 % from fruits and vegetables (FAO, 2019). Increasing the production of fruits and vegetables in line with recommendations would require a massive upscaling of the horticultural sector (see *Figure 1b*) that could be of benefit for livelihoods. Economic land productivities of horticulture are often larger than that of cereals. This offers potential for income growth also to small-scale land-owners shifting from conventional cropping to the horticulture sector without the need to convert pastures or natural forests (Weinberger and Lumpkin, 2005). In general, global agro-ecological zones show that arable land suitable for cereal productions is also suitable for horticulture (IIASA/FAO, 2012). Reducing the consumption of animal source food also decreases the demand for human-edible feed for livestock production (Muller et al., 2017), making conversion of staple cropping for food and feed to the horticulture sector a plausible option. Additionally, labour intensity is much higher in this sector that could trigger high employment effects; moreover, horticultural production in urban and peri-urban areas may also benefit the urban poor (Weinberger and Lumpkin, 2005; Jaenicke and Virchow, 2018). However, the horticultural sector also needs to expand sustainably by avoiding environmentally intensive production and distribution systems, such as heated greenhouses and transport using air cargo (Clark and Tilman, 2017).

Given that most of the growth in the livestock sector occurs in industrialised systems, which not only show poor environmental performance but also low contribution to poor livelihoods (Herrero et al., 2013a), a shift in development aid and research priorities is appropriate (USAID, 2005). Instead of trying only to improve the environmental performance of the industrial livestock sector by subsidies and development aid, which consolidate and promote the livestock sector as such, priority should rather be given to supporting horticultural systems and their value chains. Horticulture currently receives only a minor share of both development aid and research funding (USAID, 2005), despite its critical importance to healthy and sustainable diets.

4 Biodiversity and cultural landscapes

It is argued that ruminants play an important role in maintaining cultural landscapes in many parts of the world, which are shaped by a long tradition of livestock grazing. In comparison to natural land, these semi-natural grasslands can have a higher diversity of plant species (Dahlström et al., 2006; Yuan et al., 2016). 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 fertilised, the number of species is strongly reduced (Hautier et al., 2009). Overgrazing also has negative effects on biodiversity. Globally, grassland systems

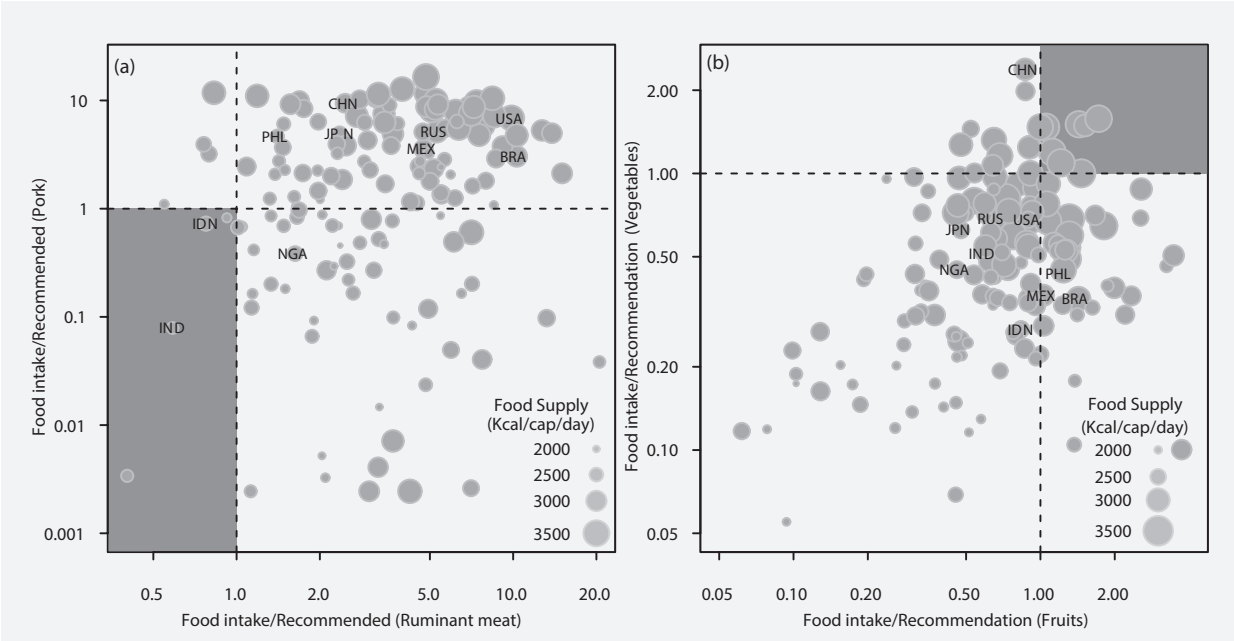

FIGURE 1

(a) Intake of pork and ruminant meat (bovine meat, mutton, lamb) for 2010 across the world in comparison to the maximum intake of 1 serving per week as recommended by the EAT-Lancet report

(b) Intake of fruits and vegetables for 2010 across the world in comparison to the recommended minimum intake (Willett et al., 2019). Circles indicate the food supply of the countries (FAO, 2019). ISO codes of the ten world's most populous countries are displayed on the respective circles. The dark grey areas represent the zone within which the consumption of the respective food is desirable for sustainable and healthy diets (Willett et al., 2019)

produce relatively low amounts of animal source foods in comparison to other systems. Mixed crop-livestock systems are the most important ruminant production systems in both developed and developing countries, producing 69 % of milk and 61 % of ruminant meat globally (Herrero et al., 2013b). Interestingly, the industrial livestock system or overgrazing often dominates in those regions that argue for the need of livestock for maintaining their cultural landscapes (Herrero et al., 2013b). Hence, a much-reduced number of ruminants with sustainable grassland management would be sufficient to maintain cultural landscapes across the world. Such landscape maintenance can be guided by policies to preserve cultural and biodiverse pasture landscapes, producing animal source foods in the meantime.

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 a reduced demand for feed crops (e.g. Weindl et al., 2017; Stehfest et al., 2009; Alexander et al., 2016; Kastner et al., 2012). Additionally, Weindl et al. (2017) showed that low consumption of animal source foods has clear positive net-impact on the carbon stocks by avoiding land use changes from forests to pasture and from pasture to cropland for livestock feeding. There is a vast potential to create different cultural landscapes through afforestation and to increase biodiversity through rewilding (Bakker and Svenning, 2018), which would provide additional climate benefits through carbon sequestering (Bastin et al., 2019). A recent study shows that 205 gigatonnes of carbon can be stored by afforesting areas that would naturally support forest growth, except current agricultural and urban areas (Bastin et al., 2019). However, high level of reforestation, forest restoration, and afforestation can have moderate negative impacts on food security (IPCC, 2019). Nevertheless, the current expansion of ruminant systems is a major driver of deforestation worldwide (Gibbs et al., 2010; Curtis et al., 2018), being responsible for around 70 % of deforestation in South America in 2017 (De Sy et al., 2015). This deforestation is widely associated with negative impacts on climate, biodiversity, and ecosystem services, rather than with the appraisal of new cultural landscapes.

5 Conclusion

The evidence provided shows that the counter-narratives presented for discussion do not offer pertinent arguments against a drastic reduction in animal source foods, in particular from ruminants, as recommended for planetary and public health (Willett et al., 2019). Instead, dietary change towards plant-based diets with a limited amount of animal source foods presents major opportunities for climate change mitigation and adaptation with human health co-benefits (IPCC, 2019). While a world without any livestock production could indeed have negative trade-offs, the current scale of livestock production and consumption of animal source foods in the large majority of world regions exceeds the amounts appropriate for good health food security, development, biodiversity, and cultural landscapes.

Public perception may be misled by world views dating back several decades, when obesity and diabetes was not yet an issue in developing countries, the world population was smaller, environmental pollution from livestock farming was not so pervasive, and ruminants in developed countries were mostly grassland-based. These world views have to be updated, future situations have to be anticipated, and the inertia of the system has to be considered. Today's world population of almost eight billion people cannot sustainably feed four billion ruminant animals. Encouraging intensive livestock systems in many countries may not be farsighted when considering the high growth rates of animal source foods that are already inherent.

Importantly, we do not argue that ruminants and grassland systems cannot be made more productive and sustainable. The innovation here is indeed needed. But we argue that priority should be given to a shift from animal source foods to more healthy and sustainable plant-based foods. Such a shift in priorities implies, for example, that sustainable ruminant systems are incentivised by taxes rather than by subsidies, and that development cooperation, is realigned from supporting the ruminant industry towards promoting horticulture, in line with the shift from undernutrition to overconsumption.

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