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The beef with sustainability

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The US Beef Industry is a major contributor of greenhouse gases and is commonly regarded as unsustainable at current levels. Eshel* et al *model a system in which sustainability could be increased by subsistence on grass and agricultural by-products, prompting the question, 'what are the limits of sustainable livestock production in the US'?

Sustainability is a fraught issue. Discussions about the sustainability of different farming systems usually miss the point that they are typically limited in space. This could be because land may not be suitable, it may be better used for something else, or that the levels of environmental harm to other habitats may be unacceptable if the area becomes too great. Writing in *Nature Ecology & Evolution,* Eshel et al, pages XXX of this issue, suggest that the US can sustain beef production to around 45 % of present levels. They call this a "possible, non-unique" way of calculating sustainable levels of livestock production. But what are the alternatives, what scales and metrics are involved, and how can we decide which is the best approach?

Eshel et al's approach is to assume that beef should be raised only on existing pastureland in the US, supported by agricultural by-products such as grain that has been used for distilling. They roughly estimate how much energy would be available to the cattle and thus how many cattle could be supported: this could deliver approximately 45% of current production. They note that if the least productive areas of US pastureland, some 135 million hectares, were not used, the numbers of cattle would not be greatly affected, and about 43% of current production could be achieved. The authors then explore some of the impacts on resource use (fertiliser, irrigation water), environment (Greenhouse Gas emissions) and diet (availability of particular nutrients per capita) that the changes to land use would entail, as well as the crop production possibilities once the requirement to grow cattle feed is removed. They admit that their final estimations are based on heroic assumptions and preliminary data, but their logical, transparent framework permits calculations to be made at the national scale, and makes a real effort at re-imagining policy.

Moving to the global scale, priorities may be slightly different: agriculture needs to help the world stay within its safe and just operating space [1]. Safety is best assured by keeping Earth-system processes (including climate change, biodiversity levels, pollution and the use of natural resources) within their planetary boundaries, i.e. at levels that are under control and within any thresholds [2]. Justice can be interpreted as delivering the UN Sustainable Development Goals (SDGs), most obviously SDGs 1,2 and 3: No Poverty, Zero Hunger, and Good Health and Wellbeing, respectively.

Such global goals are very worthy, but are not always easy to achieve. The planetary boundary of land availability, the one considered by Eshel et al., is clearly within the control of individual territories. However, agreeing responsibility for those processes that cross boundaries is much harder, as we are currently seeing with the Paris Climate Agreement to control Greenhouse Gas (GHG) emissions. Earth-system processes are intertwined, and need to be addressed together. The evidence base to support such decisions is being assembled [3-5] .

By contrast, the SDGs have been agreed and are already reflected in national metrics. The challenge here is to see how changes to the Earth system actually help deliver the SDGs. In particular, we need to know who benefits from changes in agriculture. Esher et al. consider that a reduction in beef production and increase in plant-based alternatives would work their way through the US supply chain, resulting in a shift towards more healthy diets. But cause and effect is not always easy to see in our highly globalised food systems. One helpful method is Life Cycle Analysis, that traces the movement of food (and therefore embedded water and GHG emissions) through supply chains. Improvements to diet and health can therefore be related to the environmental footprint of food production, even in complex global value chains [6]. In practice, the SDGs are inter-related [7] and, just like the Earth system environmental processes, need to be managed together.

At the farm scale, there are many concepts of sustainability. The fundamental challenge is there are many ways of assessing farm performance, delivery of particular goods and ecosystem services, capacity to continue to deliver in the face of changing policies, demography, trading systems and, of course, climate. Five domains of farm-scale sustainability have been recognised, embracing productivity, economic sustainability, human wellbeing, environmental sustainability and social sustainability [8], but within these, there are many different views of what constitutes a sustainable farm. Thus a tenant farmer may be more concerned about short term profit than maintaining soil quality, while an international aid agency may wish to ensure resilience of smallholder production in the face of changing climate. Not all farms need to contribute to the delivery of all goods and services, as long as they are provided at appropriate levels across a landscape, catchment or region.

So there are many ways of asking what are the limits of sustainable livestock production in the US, depending on how sustainability is defined. But now that the concepts of a safe and just operating space are becoming more specific, and an evidence base is starting to appear, a scientific consensus about sustainable land use is possible. However, enacting such a consensus will be a huge challenge, given how the global market currently puts great pressure on farmers to produce cheap food with less regard to the other domains of sustainability.

1. **Raworth, K., *A safe and just operating space for humanity*, in *Oxfam Discussion Papers*2012, Oxfam.**
2. **Rockstrom, J., et al., *A safe operating space for humanity.* Nature, 2009. 461(7263): p. 472-475.**
3. **Dearing, J.A., et al., *Safe and just operating spaces for regional social-ecological systems.* Global Environmental Change-Human and Policy Dimensions, 2014. 28: p. 227-238.**
4. **Hayha, T., et al., *From Planetary Boundaries to national fair shares of the global safe operating space - How can the scales be bridged?* Global Environmental Change-Human and Policy Dimensions, 2016. 40: p. 60-72.**
5. **Muller, A., et al., *Strategies for feeding the world more sustainably with organic agriculture.* Nature Communications, 2017. 8(1): p. 1290.**
6. **Clark, M. and D. Tilman, *Comparative analysis of environmental impacts of agricultural production systems, agricultural input efficiency, and food choice.* Environmental Research Letters, 2017. 12(6).**
7. **Nilsson, M., D. Griggs, and M. Visbeck, *Map the interactions between Sustainable Development Goals.* Nature, 2016. 534(7607): p. 320-322.**
8. **Smith, A., et al., *Measuring sustainable intensification in smallholder agroecosystems: A review.* Global Food Security-Agriculture Policy Economics and Environment, 2017. 12: p. 127-138.**

Stock Photo - Livestock - Various breeds of beef cattle graze
Black Baldie / Montana

Livestock - Various breeds of beef cattle graze on a lush green pasture; Red Simmental, Black Angus and Black Baldie / Montana

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