FCRN summary and comments on

Havlík et al, *(2014),* Climate change mitigation through livestock system transitions

Full Citation

Havlík P, Valin H, Herrero M, Obersteiner M, Schmid E, Rufino MC, Mosnier A, Thornton P, Boettcher, H, Conant RT, Frank S, Fritz S, Fuss S, Kraxner, F, Notenbaert, A. (2014). Climate change mitigation through livestock system transitions, *Proceedings of the National Academy of Sciences*

Since this is a complex but very interesting paper, we've put together a more detailed summary and explanation of the paper's approach and findings, together with some comments in this document here. Our summary and commentary draws upon some very helpful insights from Professor Pete Smith at the University of Aberdeen and includes some useful commentary from Dr Marco Springmann at the University of Oxford – thanks to both.

SUMMARY

This paper looks at the growth in ruminant production worldwide and at the emissions arising from that growth, under a range of different scenarios. It does not look at monogastric systems (pigs and poultry).

Under all scenarios livestock emissions grow – the scenarios therefore model the *reductions in growth* potentially achievable (ie. a reduced overall level of growth). The most 'pessimistic' scenario (FIX) assumes that the structure of the ruminant sector remains the same as it is today, but that it increases in output in line with the FAO's projected increases in demand.

An alternative scenario (DYN) also assumes the same projected increase in output but assumes that market forces work to improve the efficiency production. Hence emissions are 9% lower than under the FIX scenario (although they are still greater than they are today).

Third, it models five scenarios.

Four scenarios are focused on the supply side and in these cases an emissons price is introduced ($10 tonne/carbon and $100 tonne carbon). One scenario targets just livestock non-CO_2 emissions (CH_4 and N_2O); one targets all agricultural non CO_2 emissions; a third targets CO_2 from land use change and the fourth targets *all* emissions, from *all* agricultural sources. These scenarios find the following:

- That scenario that targets all gases from all sources delivers higher reductions than those that just target non CO_2 gases, or just land use change CO_2 – although targetting land use change CO_2 is more effective than just targeting the non CO_2 gases.
- Under all scenarios the bulk of the emissions reduction (note – the reduction in *overall increase* in emissions) comes from land use change avoidance (ie from land sparing and avoided CO_2 release) even when the non CO_2 gases are targeted (since these focus on livestock and lead to changes in systems of livestock production).

- Trade plays an important role in the mitigation story – the assumption is that the introduction of a carbon price will relocate production to areas where livestock can be reared more efficiency. An increase in the feeding of grains rather than a reliance on pasture fed only is also an important element.
- Under all scenarios, these supply side measures have an effect on the growth in demand. This effect is greater and actually quite significant when just the non CO_2 gases are targeted since they have such an impact on livestock. Note – that under these scenarios consumption is not *specifically* targeted but is a consequence of the carbon price that is targeted at producers.

This figure illustrates these points.

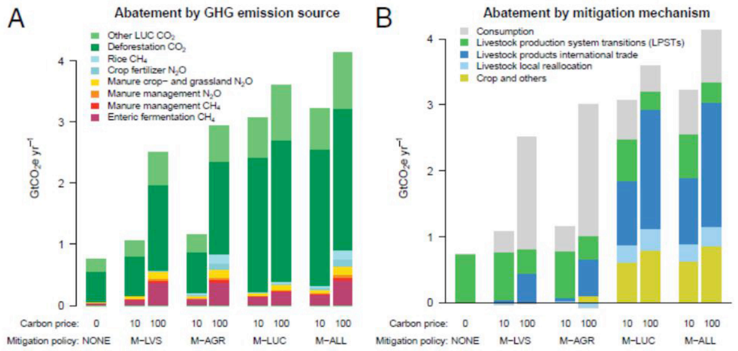

Fig. 3. GHG emission abatement decomposed by (*A*) emission source and (*B*) mitigation mechanism for different carbon price scenarios applied in the dynamic livestock sector scenario, DYN. The values are calculated as the difference in annual average emissions under the mitigation scenario and the reference scenario, FIX, over the period 2010–2030. "NONE" corresponds to the autonomous mitigation without a climate policy. Two levels of carbon price are displayed: US$10 and US$100 per tCO2e. Mitigation policies are implemented alternatively to livestock non-CO_2 emissions (M-LVS), to total agricultural non-CO_2 emissions (M-AGR), to land-use change CO_2 emissions (M-LUC), and to all agricultural and land-use change emissions (M-ALL).

A fifth scenario targets consumption. It assumes an intervention aimed at carbon price that impacts on consumers rather than producers, that has an effect of moderating livestock consumption. Consumption is moderated but there is no impact on production side efficiencies (more later).

The paper then looks at all five scenarios and assesses their mitigation effect in relation to the effect they have on overall per capita calorie availability. In other words it looks at what the calorie 'cost' of these mitigation scenarios might be, arguing that this is critical given the prevalence of malnutrition worldwide.

It finds the following:

- The higher the carbon price, the greater the mitigation potential but also the higher the calorie cost.
- Targeting just land use change emissions achieves more mitigation per unit of calorie cost than targeting the non CO_2 emissions. However, from a food security point of view, targeting the non CO_2 gases (ie. largely the livestock sector) may be more efficient since livestock constitute a smaller overall share of calories than other foods – in other words, it doesn't hit the non livestock food groups so badly
- However – and this is the point that has been highlighted in all the media publicity surrounding this paper – *measures that address consumption and demand directly (rather than supply) deliver less mitigation potential at higher calorie cost*.
- The paper therefore concludes that a focus on consumption is inefficient and less effective than addressing the production side.

COMMENTS

If one were looking at the short term global warming impacts of the different gases (ie. between now and 2030), then the GWP of methane might arguably be greater than used here (ie. 78 rather than 21). This would increase the significance of targeting the non CO_2 gases and would also suggest a significantly greater role for reducing livestock consumption (NB – a reduction in the growth of livestock consumption). This said the paper follows IPCC protocol in this respect.

Arguably, if you really wanted to maintain projected livestock output while reducing the rate of growth in emissions then an additional scenario that might have been modelled would be a switch out of ruminant production and over to intensive pig, poultry and aquaculture production. This is likely to be a bad idea for all sorts of reasons but in terms of its land sparing and GHG mitigation potential such a scenario is in a sense a logical conclusion of what the paper is modelling.

The demand side scenario is perhaps the least developed aspect of the paper. This is what the paper says: "Under an exogenously prescribed consumption reduction scenario of 40 kcal per capita per day without carbon prices, the emission reduction is predicted to be only 1,948 MtCO2e· y−1, and the resulting unit calorie cost would increase to 21 kcal per capita per day per GtCO2e· y−1." Note that adopts this scenario since it is equivalent, in terms of daily calorie cost to the scenario in which a $10 /tonne carbon price targeting the production side is modelled, and in which the unit cost (impact per unit of mitigation) is only 12 calories/day.

However, the appendix (available here) in fact makes the following point:

"Our demand function has the virtue of being easy to linearize which allows us to solve GLOBIOM as a linear program. This is currently necessary because of the size of the model and the current performance of non-linear solvers. However, this demand function has although some limitations which need to be kept in mind when considering the results obtained with respect to climate change mitigation and food availability. One of them is that we do not consider direct substitution effects on the consumer side which could be captured through cross price demand elasticities. Such a demand representation could lead to increased consumption of some products like legumes or cereals when prices of GHG intensive products like rice or beef would go up as a consequence of a carbon price targeting emissions for the agricultural sector. Neglecting the direct substitution effects may lead to an overestimation of the negative impact of such mitigation policies on total food consumption. However, the effect on emissions would be only of second order, because consumption would increase for commodities the least affected by the carbon price, and hence the least emission intensive. Although we do not represent the direct substitution effects on the demand side, substitution can still occur due to changes in prices on the supply side and can in some caseslead to a partial compensation of the decreased demand for commodities affected the most by a mitigation policy. This phenomenon can be observed in our results for mitigation policies targeting the livestock sector only (Fig. 4. In the main text)."

In other words, it raises the possibility that the negative impacts on food security of moderating consumption are overplayed (under all scenarios) .

Significantly, the paper focuses on food security and defines the problem as one of hunger and malnutrition. It does not acknowledge the rising burden of overconsumption and associated chronic diseases in developing and low in come countries (see for example this report from the Overseas Development Institute).

Finally, the way the paper's findings have been represented in the press (and to a certain extent in the paper itself) might lead one to suppose that there is no role for consumption side measures. However this would be misleading for the following reasons:

- Given the nature of the climate and environmental problems we face, we do not have the luxury of adopting an either-or position. Most commentators who highlight the need to address consumption *also emphasise the need for production side* approaches (eg. see the paper by Hedenus et al)
- Following on from this, rather than have a polarised discussion about the merits of production versus consumption side approaches, a more interesting approach might be to examine how policies might be more effectively targeted at optimising and synergising production and consumption changes so as to deliver environmental (not just climate) improvements while also enhancing nutritional outcomes (including over as well as under consumption related issues). Approaches here will need to go beyond simplistically considering 'the meat question' to look at the role, both positive and negative, of other foods as well.
- Under all scenarios (those focusing on the supply side as well as the specifically consumption side scenario) consumption is moderated. In other words, even in the supply side scenarios, the mitigation achieved is not just a consequence of production efficiencies.
- As noted, the paper's demand side scenario is perhaps least investigated and articulated in this paper – so there is a great deal more work to do here.
- To emphasise, the paper does not consider obesity and overconsumption related dimension of the food security challenge
- On a very minor point, it states at the beginning that livestock contribute to 12% of global emissions when the latest FAO estimate puts the figure at 14.5% - although all estimates are subject to major uncertainties.
- In the conclusions it touches upon some of the practical policy challenges inherent in any of the scenarios. And it notes, somewhat in passing, these points: "there are considerable challenges associated with the intensification of livestock production, such as sanitary issues and animal well-being concerns, as well as social impacts related to the role of smallholders in livestock production and to the various cobenefits of livestock in rural areas, such as draft power and subsistence income."

Here are some additional comments provided by **Marco Springmann**:

Havlik et al construct an "exogenously prescribed consumption scenario" that results in the same GHG emissions reduction as the supply-side flexibilities analysed in their main scenarios. On the basis of comparing the consumption scenario with the associated supply-side scenario, they conclude that demand-side measures are less efficient than supply-side ones (assessed in terms of abatement costs and food availability). While portrayed as indicating that dietary changes are unnecessary, it is well known in economics that regulating the source of emissions is more efficient than regulating final demand. The idea behind this is that putting a price on GHG emissions at the source internalizes the environmental externalities of those emissions throughout the whole production chain, whilst demand-side measures do not lead to the same kind of structural changes.

I think extending this basic argument to criticize papers focussing on dietary changes (as in the passage referred to above) is somewhat short-sighted. Either dietary changes occur as an endogenous development, such as the food transition to more meat-based diets, or they are induced by policies, such as dedicated taxes. In the first case, dietary shifts are part of future projections against which scenarios and potential savings can be assessed - fair enough. In the second case, dietary changes can be brought about by supply-side policies. Thus, equating dietary changes or the associated policies with demand-side measures is somewhat misleading. The results of Havlik et al's supply-side scenarios actually show a big effect on consumption, which is exactly what one would be after when designing policies that are meant to affect the demand side. So what their analysis really shows is that supply-side measures change diets and the associated GHGs efficiently (and that dietary changes are inefficient in changing the whole supply side and the associated emissions). Their analysis does not show that it is not important to change diets to address GHG emissions, rather it shows that diets will indeed change.

Now to the main part of the paper. The set-up of the paper is fairly simple: the authors compare two livestock trajectories with each other, one which keeps the relative distribution of (ruminant) animals across livestock-production systems fixed at base-year values, the other one doesn't. Both scenarios are unrealistic in the sense that the first one is too constraining (pessimistic in some sense) and the other one is too dynamic (or optimistic). However, the scenarios are well suited to span a wide state space in which actual developments may take place in the future. Thus, the contribution of this paper is a sensitivity analysis of different livestock-system responses (to prices and environmental constraints) and their implications for GHG emissions. This part of the paper, I think, is very well done, and the authors deserve credit for their model developments.

What I find again a bit misleading though is how the results are communicated. The authors frequently state that LPSTs (livestock production system transition, i.e., dynamic responses to the constraints mentioned above) lead to GHG emissions reductions, a decrease in grass consumption, and so on. Then, somewhere in the paragraph that follows, we learn that croplands still expand globally (main text) and that absolute GHG emissions are higher in the LPST scenario than in the base year (appendix). So what the LPST scenario is compared to in the beginning of each paragraph is the fixed scenario without LPST, but not the conditions in the base year. That by itself is totally fine, but I would wish it would have been stressed explicitly. The omission of what the outcome of the LPST scenario is compared to makes one believe that the livestock sector constitutes no problem at all (and indeed might be beneficial) if it can just respond dynamically to price signals. However, I think it would be fair to say that the livestock sector still carries a long (and actually longer) shadow when looking at the absolute numbers in 2030 even after all those dynamic responses have taken place

I end by noting that the paper utterly ignores the health implications of diets high in livestock products. The authors focus on caloric availability and highlight the danger of undernutrition (which they wrongly equate with malnutrition). Livestock products, according to this reasoning, are beneficial because they are more calorie-dense than, e.g., plant-based products. The problem of overconsumption is mentioned, but only as a problem for developed countries. I have to say that I find the authors' disregard for a broader and more balanced view of nutrition quite alarming. Although undernutrition is still a big problem which deserves attention, almost any developing country nowadays faces a double burden of undernutrition in terms of calories and micronutrients on the one hand, and of overnutrition, in particular in terms of livestock products, on the other hand. The latter is associated with (and in many cases thought to be causally linked to) a broad range of non-communicable diseases, such as heart diseases, stroke, cancers, etc, which cause more deaths and disabilities worldwide than undernutrition does. The failure to at least mention this broader dimension that is directly associated with the livestock sector is what I find most disconcerting with the paper. Indeed, I think the economic and health community could have easily agreed that it is important to consider both, technological improvements in the livestock sector, and dietary changes. Although the paper broadens the detail with which the livestock sector is represented in economic models, its conclusions also show why we need to continue working on more comprehensively integrated models of environmental sustainability, economic development, and health."