3 March 2016
Issue 449

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Source: Henderson, B., Falcucci, A., Mottet, A., Early, L., Werner, B., Steinfeld, H. & Gerber, P. (2015). Marginal costs of abating greenhouse gases in the global ruminant livestock sector. *Mitigation and Adaption Strategies for Global Change*. DOI: 10.1007/s11027-015-9673-9

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1.AnimalChange is supported by the European Commission under the Seventh Framework Programme. See: http://www.animalchange.eu/

European Commission

Science for Environment Policy

Reducing greenhouse gas emissions from livestock: what are the costs?

The livestock sector is estimated to contribute 14.5% of all global anthropogenic greenhouse gas (GHG) emissions. This study estimated the costs of reducing emissions from ruminant livestock using five different practices. The findings will help policymakers to understand the cost effectiveness of different interventions in the sector, and the contribution that different policies could make to addressing climate change.

Globally, there is the potential to reduce GHG emissions from the livestock sector by as much as 2.4 metric gigatonnes of CO_2 equivalent emissions every year ($GtCO_2$-eq yr^{-1}). The vast majority of this potential is associated with ruminant species, such as cattle (*Bos taurus* and *Bos indicus*), sheep (*Ovis aries*) and goats (*Capra hircus*).

In spite of this potential, few studies have assessed the costs and benefits of different GHG mitigation practices. Those that have suggest that between 0.2 and 0.6 $GtCO_2$-eq yr^{-1} of this potential is available at a price (the amount that polluters must pay for their emissions, or be paid to polluters to reduce their emissions) of $50 per tonne of CO_2 equivalent emissions (tCO_2-eq yr^{-1}). This is significantly lower than the total abatement potential, which suggests much of the total potential is not attainable in a cost-effective manner.

To investigate this further, this study set out to estimate the costs of reducing GHG emissions from the global livestock sector. The researchers, who were part funded by the EU's AnimalChange[1] project, calculated the *marginal* costs rather than the more commonly reported *average* costs of abatement. This approach incorporates variability in the effectiveness, costs and benefits of practices in different regions and production systems.

The authors used a five-step analytical approach, beginning with selecting production systems. They focused on ruminant production systems, which account for over 90% of all direct GHG emissions from livestock globally. Next, they selected abatement practices according to their reliability and effectiveness in reducing emissions. They selected practices that target enteric methane and soil carbon sequestration, as they are the largest sources of abatement for ruminant production systems — accounting for 98% of the global livestock sector's total abatement potential. Five practices were identified, three of which target methane emissions: feeding of dietary oils, feeding of nitrates (applied to fattening and milking animals in the form of calcium-, potassium- or sodium-nitrate) and urea treatment of crop straws fed to animals; and two which increase carbon sequestration: improved grazing management and legume sowing.

Data was analysed using the Global Livestock Environmental Assessment Model (GLEAM). Using this tool, the authors created marginal abatement cost (MAC) curves, which show how costs increase with each additional unit of emissions that is reduced. MAC curves are useful for policymakers, as they show the emission reductions that can be expected in response to different policies.

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European Commission

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The practices differed in affordability. For example, around half of the global abatement potential of improved grazing management was found to be achievable at no cost. Costs then increase sharply as the affordable opportunities for sequestering soil carbon are exhausted. Legume sowing was also shown to be affordable. Although it has high upfront costs, these are offset by the returns associated with increased forage production and animal productivity. Eighty five percent of its total abatement potential is achievable at a carbon price of \$10 tCO_2 eq^{-1}.

However, the costs of dietary oils and nitrates are high at all levels of abatement due to the expense of oilseeds and lack of associated improvement in animal productivity. The urea treatment of straws was also shown to be unprofitable, which is in line with its modest uptake. Past studies have shown that most farmers stop using the treatment after trials end due to the very high upfront costs. Thus, proposals to reduce GHG emissions that present a high cost may prevent farmers from using them without funding.

Combined, the abatement options were estimated to save a total of 379 metric megatonnes of CO_2 equivalent emissions every year ($MtCO_2$-eq yr^{-1}): 11% of annual ruminant GHG emissions globally. Importantly, a large chunk of this potential is affordable. In fact, two thirds can be abated at a rate of \$20 tCO_2 eq^{-1} (a level seen in markets compliant with the Kyoto Protocol).

The study offers guidance for targeting abatement efforts to have the highest impacts at the lowest cost. In Western Europe, legume sowing was the most efficient practice and, overall, abatement practices were found to be most effective for dairy cattle. The authors argue that around half of the abatement potential for improved grazing management and legume sowing could be achieved with extension and capacity building programmes (policy options that encourage the uptake of practices that are profitable). For the costlier abatement options though stronger policy options would be required, such as a carbon tax or emission quotas.

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