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LETTER TO THE EDITOR

Reducing beef consumption might not reduce emissions: response to Phalan et al. (2016)

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Phalan *et al.* (2016) contest our findings (De Oliveira Silva *et al.*, 2016) (henceforth RdOS) on the relationship between livestock consumption and emissions. First, they doubt the likelihood of avoiding expansion of pastureland while increasing production and suggest that deforestation may still happen due to cropping area expansion, that is, 'net change (in deforestation) is not the same as gross change'. In response, we note that stable or reduced pasture area scenarios for Brazil have also been explored by others (de Gouvello *et al.*, 2011; Cohn *et al.*, 2014; Strassburg *et al.*, 2014). Phalan et al. (2016) suggest a difficulty in distinguishing pasture from native *Cerrado* vegetation using satellite data. We note that RdOS supported the likelihood of a decoupled (livestock–deforestation) scenario with historical data from agricultural census (IBGE, 2015) and FAO (2015), although satellite data (Beuchle *et al.*, 2015) would also corroborate RdOS when other land use expansion (LUE) is considered. Nongrassland LUE could cause native vegetation loss, but following FAO methodology (Opio *et al.*, 2013) means that emissions from conversion of native vegetation are allocated based on the LUE of each land use type. Alternative attributional criteria would be equally contestable. Note that the scope of our analysis is solely beef-related emissions (direct and indirect).

Phalan et al. (2016) suggest RdOS present no evidence supporting the observation that higher beef production would result higher soil carbon stocks (SCS), and propose evidence to the contrary referencing grazing intensity (GI) studies. The RdOS claim was supported by Maia *et al.* (2009) and Braz *et al.* (2013). Other authors (Neely *et al.*, 2009; Gerber *et al.*, 2013) also agree that tropical grasslands can be a strong CO_2 sink with magnitudes exceeding marginal emissions of higher stocking rates. We stress that pasture productivity recovery (PPR), as modeled by RdOS, involves specific measures to improve soil fertility, soil conservation, and pasture stand and imply greater change in net primary production (NPP) than GI alone. RdOS also did not use NPP as a surrogate of net biome productivity (NBP). Higher beef productivity resulted from PPR and supplementation, applying similar GI (constant residual mass) to all levels of productivity. SCS were dynamically estimated through a soil carbon model.

Phalan et al. (2016) further state that RdOS underestimate the mitigation through reduced consumption by overlooking the potential of land abandonment (LA) and secondary vegetation regeneration driven by falling prices. We suggest that the dynamic is much more subtle, with other nonprice factors demonstrably stopping abandonment. These include land ownership, speculation, agrarian reform, cattle held as reserve of value, and increasing rhetoric about payment for environmental services. All are in play and none has been convincingly modeled for the Brazilian *Cerrado*, although Bowman *et al.* (2012) provide evidence for the Amazon. By adopting current productivity as a lower bound of the projected scenarios, our analysis obviates abandonment as there is no reason to believe it will happen in future for equal or higher levels of productivity.

On the likely heterogeneity in rancher response to changing beef prices, we note that alternative 'optimization' behaviors can pertain but that altering the optimization assumptions does not alter our results significantly.

Finally, we agree on the range of alternative policy levers proposed by Phalan et al. (2016). But our point is that the increasing rhetoric on reduced consumption should be supported by further systematic modeling evidence and that the type of anomaly we observe warrants international attention.

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