Fire, deforestation, and livestock: When the smoke clears

Rafael De Oliveira Silva[a,*], Luis G. Barioni[b], Dominic Moran[a]

[a] *Global Academy of Agriculture and Food Security, The University of Edinburgh, Easter Bush Campus, Midlothian, EH25 9RG, Edinburgh, UK*
[b] *Embrapa Agriculture Informatics, CEP 13083-886, Campinas, SP, Brazil*

ARTICLE INFO

ABSTRACT

Recent Amazon fires fuelled a media narrative combining politics with an already emotive story linking deforestation to extensive cattle ranching and global meat consumption. Scrutiny of the reasons for the 2019 fires suggests that the perceived link between deforestation and extensive land use for beef production is not as clear as commonly supposed. Indeed, land sparing through sustainable intensification of predominant livestock pastures may be acting as a significant buffer between meat demand and livestock production and consequent land use change and deforestation. Well-intentioned beef boycotts potentially weaken the incentive to invest in pasture restoration and may lead to a counterfactual of extensive land use, and increased greenhouse gas emissions. The possibility suggests the need for more nuanced debate about the regional-specificity of land use for sustainable livestock production, and the role of dietary change.

The 2019 Amazon fires sparked global outrage, a diplomatic spat between Brazil and France, and calls for an international boycott of Brazilian beef (Independent, 2019). The episode was subsequently linked to a drastic increase in official estimates of the rate of Amazon deforestation (INPE, 2019a).

Fuelled by several high profile deforestation studies (Fearnside, 2015; Nepstad et al., 2014), a plethora of reports advocating dietary change (Searchinger et al., 2019; Willett et al., 2019), and an Inter-governmental Panel on Climate Change (IPCC) report on climate change and land (IPCC, 2019), which incriminated meat consumption, the annual fires fed a perfect media storm with livestock production at its centre. Linking ruminant production and consumption to land clearance, greenhouse gas emissions (GHGs) and biodiversity loss is as plausible sell for international campaigners and global media eager for a simple narrative on culpability. Unpicking the true picture on deforestation drivers is more complex, and while meat production has a role, it is important to consider the contested evidence on its significance. Livestock has typically been the predominant use of cleared land following deforestation. However, evidence suggests that the relationship between demand of livestock products and land conversion is now far from clear.

After peaking in 2004, Amazon deforestation fell to its lowest level in 2012, and was apparently under control until 2014, largely due to the implementation of the Action Plan to Prevent and Control Deforestation in the Amazon (PPCDA) in 2004 (Arima et al., 2014; Negra et al., 2015)

The PPCDA included several planning activities for sustainable production, coordinated satellite and in-field monitoring, law enforcement, expansion of protected areas, and restrictions on some rural credit involving production in deforested areas. Deforestation was also influenced by market interventions, e.g. soya and beef moratoria, in which major traders committed to avoiding purchases of commodities linked to deforestation (Arima et al., 2014).

These factors have helped to stabilize pasture area at around 180 million hectares since 2006, while livestock production has continued to grow. Another reason is that extensive beef systems are simply less profitable than more intensive and export-oriented farms. The recent growth in production is increasingly attributable to gains in productivity via improvement of existing pastures, better animal performance measures, feed supplementation on-pasture and in feedlots, and improved animal genetics (Lobato et al., 2014). The picture is one of increased productive and emissions efficiency per unit product while minimizing competition with land used for food and feed, plus avoided biodiversity loss. These are arguably the essential elements of sustainable intensification of agriculture (SI) (Garnett et al., 2013).

Fig. 1 illustrates the SI and the apparent decoupling of the link between beef production and deforestation in Brazil. An increase of around 5% in beef production over the period 1986–1988 correlated with a 3% increase in pasture area. From 2006, positive variations in production caused no pasture expansion. Increased production is instead explained by gains in productivity (Fig. 2).

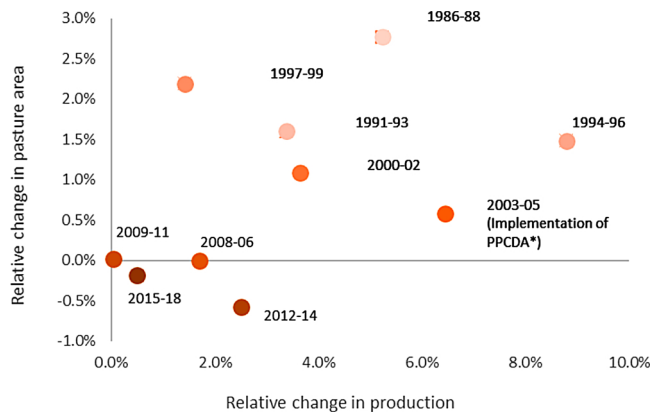Furthermore, and contrary to popular belief, the increased share of

---

Fig. 1. Relative changes in pasture as a function of relative changes in beef production. We use data from Mapbiomas (2019) for pasture area, while beef production is based on FAO (2015).

export-oriented beef might have contributed to weakening the beef cattle-deforestation link in Brazil. Fig. 2 shows that pasture area stabilization coincided with a steep increase in Brazilian exports since the 2001 mad cow disease outbreak in Europe. The episode gave Brazilian product a competitive advantage, as pasture-fed animals were not as susceptible to the disease and subject to stricter international environmental regulations.

Political economy is also a significant factor in the beef-deforestation link. Large export-oriented agribusiness, the so-called "rural coalition", wields significant power in the Brazilian National Congress, and has lobbied for increasing amounts of rural credit for producers, which has facilitated extensive investment in SI (Lapola et al., 2014).

Between 2012 and 2014, an average of 1.5 million tonnes of carcass weight equivalent was exported to around 90 countries (FAO, 2020), while pasture area reduced by around 1 million ha over the same period (Fig. 2). A similar exported quantity in the period 2015–2017 was linked with a pasture area contraction of 0.44 M ha (FAO, 2020). This reinforces the point that policy and market interventions rather than beef demand have significant influence on the livestock-deforestation link (Silva et al., 2017).

A narrative incriminating soybean production in the livestock-land use narrative is also tenuous. In fact, pasture expansion is also negatively correlated with soybean production (**See supplementary file**). Around half of soybean production is exported, mostly to China, while most domestic consumption is for pig and poultry production, which are concentrated in the south of Brazil (EMBRAPA, 2020). Brazilian beef cattle is predominately grass-fed, i.e., pastures account for more than 95 % of feed demand, as only 5 million animals out of a herd of

200 million are confined for 2–3 months (ANUALPEC, 2017). Other studies have emphasised the on-going roles of clearance and fencing for speculation and tenure security as drivers of land conversation (Bowman et al., 2012; Arima et al., 2014), which in turn frequently lead to high levels of land abandonment of deforested areas (c.a. 50 % in 2004–2014) to secondary vegetation growth (Carvalho et al., 2019; Mapbiomas, 2019).

This suggests a subtle land use dynamic in which grazing animals are used to facilitate conversion and signal ownership, rather than being the primary driver as often assumed. Nevertheless, this does imply that SI alone is sufficient without regulatory reform for land access and tenure securitization. We suggest that the latter is a key determinant of land availability and an important driver of SI investment.

Political instability since 2015, particularly a rightward shift in 2018, has heightened fears that monitoring and enforcement capacity could be undermined, leading to possible recrudescence of land conversion. This was confirmed in 2019 when preliminary data from the INPE near real time fire warning system (DETER) reported an 84 % increase in fire warnings between January-August, compared to the same period in 2018 (INPE, 2019b). The increase was then correlated with the highest annual deforestation rate over the last decade, amounting to 1.03 Mha of natural vegetation (INPE, 2019a). Recent preliminary data on fire alarms covering the first quarter of 2020 confirms this concern (INPE, 2019b).

Official data do therefore indicate cause for concern about the Amazon's long-term trajectory, with some commentators arguing the biome may reach a tipping point within a few years (Lovejoy and Nobre, 2018). This should be the basis for an informed debate about all deforestation drivers, including the perceived link to meat demand, and by extension, with cattle ranching practices. It should also scrutinise other legal and regulatory drivers still in force around land tenure.

In addition to avoided deforestation, GHG emissions intensity (EI) of livestock products can vary significantly in more or less efficient farms, with even a possibility of negative emissions when carbon sequestration from deep rooted grass pastures are included in the calculations (de Oliveira Silva et al., 2016; Stanley et al., 2018). One eventuality of reduced demand might actually be increased emissions in some circumstances, where reduced market demand removes incentives for grassland intensification and continued improvement of animal productivity. Ultimately, reduced demand may incentivise more extensive land use.

The Brazilian fires have refocussed international attention on the fate of a global public good but there is a tendency to simplify the complexity of land use dynamics, demonising livestock producers and the role of market demand. There are good arguments to moderate meat consumption in several regions of the world, but we should also
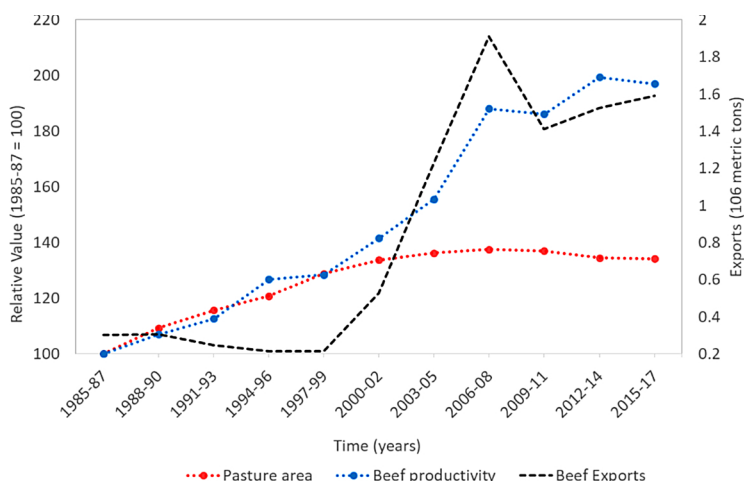

Fig. 2. Relative pasture area and beef productity (FAO, 2020) in relation to 1985-87 average, as a function of time periods (primary y-axis) and beef exports (secondary y-axis). Beef productity is calculated as kg of beef in carcass weight equivalent per heactare per year. See calculation details and statistical analysis in the **Supplementary file**.

make room for evidence on systematic links to guide a more nuanced conversation about concentrating residual production on more efficient systems and regions, while reducing production in others. Part of this conversation is a realistic appraisal of the market for transacting value attached to both market and non-market goods. Dietary change is only one part of the story and the potential unintended impact of diet shifts and information on implicit EIs provides some evidence to rebalance the current rhetoric around reduced meat consumption. The latter may not yield the anticipated outcome in terms of less extensive land use.

CRediT authorship contribution statement

Acknowledgements

Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:https://doi.org/10.1016/j.landusepol.2020.104949.

References

ANUALPEC, 2017. Anuário Da Pecuária Brasileira. FNP Consultoria/Agros Comunicaçãohttps://doi.org/10.1145/2505515.2507827.

Arima, E.Y., Barreto, P., Araújo, E., Soares-Filho, B., 2014. Public policies can reduce tropical deforestation: lessons and challenges from Brazil. Land Use Policy 41, 465–473. https://doi.org/10.1016/j.landusepol.2014.06.026.

Bowman, M.S., Soares-Filho, B.S., Merry, F.D., Nepstad, D.C., Rodrigues, H., Almeida, O.T., 2012. Persistence of cattle ranching in the Brazilian Amazon: a spatial analysis of the rationale for beef production. Land Use Policy 29, 558–568. https://doi.org/10.1016/j.landusepol.2011.09.009.

Carvalho, R., Adami, M., Amaral, S., Bezerra, F.G., de Aguiar, A.P.D., 2019. Changes in secondary vegetation dynamics in a context of decreasing deforestation rates in Pará, Brazilian Amazon. Appl. Geogr. 106, 40–49. https://doi.org/10.1016/j.apgeog.2019.03.001.

de Oliveira Silva, R., Barioni, L.G., Hall, J.A.J., Folegatti Matsuura, M., Zanett Albertini, T., Fernandes, F.A., Moran, D., 2016. Increasing beef production could lower greenhouse gas emissions in Brazil if decoupled from deforestation. Nat. Clim. Chang. 6, 3–8. https://doi.org/10.1038/nclimate2916.

EMBRAPA, 2020. EMBRAPA Swine and Poultry Data. [WWW Document]. URL. https://www.embrapa.br/en/suinos-e-aves/cias/mapas.

FAO, 2020. The Statistics Division of the FAO (Food and Agriculture Organization of the Uninited Nations). [WWW Document]. URL http://faostat.fao.org/ (Accessed 9.7.20). .

Fearnside, P.M., 2015. Deforestation soars in the Amazon. Nature 521https://doi.org/10.1038/521423b. 423–423.

Garnett, T., Appleby, M.C., Balmford, A., Bateman, I.J., Benton, T.G., Bloomer, P., Burlingame, B., Dawkins, M., Dolan, L., Fraser, D., Herrero, M., Hoffmann, I., Smith, P., Thornton, P.K., Toulmin, C., Vermeulen, S.J., Godfray, H.C.J., 2013. Sustainable intensification in agriculture: premises and policies. Agriculture. Science 80- (341), 33–34. https://doi.org/10.1126/science.1234485.

Independent, 2019. Every Meat-eater on the Planet Is Helping to Fuel the Amazon Forest Fires – Here's How. [WWW Document]. URL https://www.independent.co.uk/voices/amazon-forest-fire-brazil-beef-meat-vegan-vegetarian-brazil-a9076236.html (Accessed 10.12.19). .

INPE, 2019a. Annual Deforestation Rates in the Brazilian Amazon - PRODES Project. [WWW Document]. URL. http://terrabrasilis.dpi.inpe.br/app/dashboard/deforestation/biomes/legal_amazon/rates.

INPE, 2019b. Fires Monitoring Program. [WWW Document]. URL. http://queimadas.dgi.inpe.br/queimadas/portal-static/situacao-atual/.

IPCC, 2019. Climate Change and Land: an IPCC Special Report on Climate Change, Desertification, Land Degradation, Sustainable Land Management, Food Security, and Greenhouse Gas Fluxes in Terrestrial Ecosystems. [WWW Document]. URL. . https://www.ipcc.ch/report/srccl/.

Lapola, D.M., Martinelli, L.A., Peres, C.A., Ometto, J.P.H.B., Ferreira, M.E., Nobre, C.A., Aguiar, A.P.D., Bustamante, M.M.C., Cardoso, M.F., Costa, M.H., Joly, C.A., Leite, C.C., Moutinho, P., Sampaio, G., Strassburg, B.B.N., Vieira, I.C.G., 2014. Pervasive transition of the Brazilian land-use system. Nat. Clim. Chang. 4, 27–35.

Lobato, J.F.P., Freitas, A.K., Devincenzi, T., Cardoso, L.L., Tarouco, J.U., Vieira, R.M., Dillenburg, D.R., Castro, I., 2014. Brazilian beef produced on pastures: sustainable and healthy. Meat Sci. 98, 336–345. https://doi.org/10.1016/j.meatsci.2014.06.022.

Lovejoy, T.E., Nobre, C., 2018. Amazon tipping point. Sci. Adv. 4https://doi.org/10.1126/sciadv.aat2340. eaat2340.

Mapbiomas, 2019. MAPBIOMAS - the Brazilian Annual Land Use and Land Cover Mapping Project. [WWW Document]. URL http://mapbiomas.org/. .

Negra, C., Vermeulen, S., Barioni, L.G., Mamo, T., Melville, P., Tadesse, M., 2015. Brazil, Ethiopia, and New Zealand lead the way on climate-smart agriculture. Agric. Food Secur. 4 (15 December 2014). https://doi.org/10.1186/s40066-014-0019-8.

Nepstad, D., McGrath, D., Stickler, C., Alencar, A., Azevedo, A., Swette, B., Bezerra, T., DiGiano, M., Shimada, J., Seroa da Motta, R., Armijo, E., Castello, L., Brando, P., Hansen, M.C., McGrath-Horn, M., Carvalho, O., Hess, L., 2014. Slowing Amazon deforestation through public policy and interventions in beef and soy supply chains. Science 344, 1118–1123. https://doi.org/10.1126/science.1248525.

Searchinger, T., Waite, R., Hanson, C., Ranganathan, J., Ranganathan, E., 2019. Creating a Sustainable Food Future - a Menu of Solutions to Feed Nearly 10 Billion People by 2050 (Final Report). WRI.

Silva, J.Gda, Ruviaro, C.F., Ferreira Filho, J.B.de S., 2017. Livestock intensification as a climate policy: lessons from the Brazilian case. Land Use Policy 62, 232–245. https://doi.org/10.1016/j.landusepol.2016.12.025.

Stanley, P.L., Rowntree, J.E., Beede, D.K., DeLonge, M.S., Hamm, M.W., 2018. Impacts of soil carbon sequestration on life cycle greenhouse gas emissions in Midwestern USA beef finishing systems. Agric. Syst. 162, 249–258. https://doi.org/10.1016/j.agsy.2018.02.003.

Willett, W., Rockström, J., Loken, B., Springmann, M., Lang, T., Vermeulen, S., Garnett, T., Tilman, D., DeClerck, F., Wood, A., Jonell, M., Clark, M., Gordon, L.J., Fanzo, J., Hawkes, C., Zurayk, R., Rivera, J.A., De Vries, W., Majele Sibanda, L., Afshin, A., Chaudhary, A., Herrero, M., Agustina, R., Branca, F., Lartey, A., Fan, S., Crona, B., Fox, E., Bignet, V., Troell, M., Lindahl, T., Singh, S., Cornell, S.E., Srinath Reddy, K., Narain, S., Nishtar, S., Murray, C.J.L., 2019. Food in the Anthropocene: the EAT–lancet Commission on healthy diets from sustainable food systems. Lancet. https://doi.org/10.1016/S0140-6736(18)31788-4.