

1 ***Letter to the Editors***

2 **Increasing beef production won't reduce emissions**

3 Ben Phalan<sup>1\*</sup>, William J. Ripple<sup>1</sup>, Pete Smith<sup>2</sup>

4

5 <sup>1</sup> *Department of Forest Ecosystems and Society, Oregon State University, Corvallis, OR*  
6 *97331, USA.*

7 <sup>2</sup> *Institute of Biological & Environmental Sciences, University of Aberdeen, 23 St Machar*  
8 *Drive, Aberdeen, AB24 3UU, UK.*

9 *\*benphalan@gmail.com*

10

11 De Oliveira Silva et al. (2016) model beef production in the Brazilian *Cerrado*, and conclude  
12 that – if accompanied by tight deforestation control – increasing production could lower  
13 emissions by incentivising better pasture management. While their analysis is valuable in  
14 identifying the conditions under which increasing meat consumption could be compatible  
15 with reducing greenhouse gas emissions, we believe that there is little chance of such  
16 conditions occurring in practice. Overall, increasing beef consumption and production is  
17 unlikely to be an effective lever for reducing emissions, and is more likely to exacerbate  
18 deforestation.

19

20 The analysis by de Oliveira Silva et al. shows that reduced emissions are only possible if  
21 clearance of savannas and forests is halted almost completely. However, even if the Forest  
22 Code is implemented perfectly, ~40 million hectares of native vegetation remain legally  
23 available for conversion to pasture in the *Cerrado* (Soares-Filho et al. 2014). Halting  
24 deforestation on these lands would require a degree of political determination, legislative  
25 change and effective enforcement beyond even that achieved in the Amazon. Even in the 9%

26 of the *Cerrado* with formal protection, deforestation has only been reduced, not eliminated  
27 (Carranza et al. 2014). According to de Oliveira Silva et al., there was zero net deforestation  
28 for pasture between 2006 and 2015 (Supplementary Table 3). However, there are two reasons  
29 to be skeptical that pasture has not replaced native vegetation during that time. First, it is  
30 difficult to distinguish pasture from native *Cerrado* vegetation using satellite data (Spera et  
31 al. 2016). Second, net change is not the same as gross change. Cropland area in the *Cerrado*  
32 has doubled since 2003, at the expense of both pasture and native vegetation (Spera et al.  
33 2016). Considering both cropland expansion and the goal of ending deforestation, net  
34 reductions in pasture area are needed to avoid further displacement of pasture into native  
35 vegetation.

36

37 De Oliveira Silva et al. present no evidence to support their assumption that higher beef  
38 production would result in more carbon captured in pastures. While higher profits might  
39 allow investment in pasture restoration, higher stocking rates can instead result in reduced  
40 soil organic carbon stocks (Navarette et al. 2016). Improved pasture management, if  
41 implemented, could increase grassland productivity, but this increased productivity will only  
42 translate into increased carbon storage if it outpaces the higher amount of carbon removed in  
43 the form of beef. Grazing strongly reduces the share of net primary production (NPP) that can  
44 accumulate in an ecosystem (Soussana et al. 2007), with up to 60% of above-ground dry  
45 matter ingested by livestock in intensive grazing systems (Lemaire & Chapman 1996). For  
46 this reason, increased NPP is not a good surrogate for increased carbon storage (net biome  
47 productivity; NBP). Pasture productivity can also be increased on a shrinking pasture area  
48 without any increase in beef production. Furthermore, by treating the *Cerrado* as one large  
49 farm, de Oliveira Silva et al. omit important heterogeneity in how ranchers respond to beef  
50 price changes. When beef prices fall, marginally profitable farms may take land out of

51 production or go out of business. Abandoned pasture could then revert to secondary  
52 vegetation, storing carbon in the process (Chazdon et al. 2016). This outcome is not  
53 considered, meaning the potential for reduced beef demand to promote carbon sequestration  
54 is underestimated.

55

56 The study underlines the importance of controlling deforestation for reducing emissions from  
57 the agricultural sector, but other policy levers appear more promising than increasing beef  
58 production. Such levers include making access to agricultural credit conditional on achieving  
59 habitat conservation targets (Nepstad et al. 2014), incentives for forest restoration (Latawiec  
60 et al. 2015) and programmes of support to ranchers to improve pasture management  
61 (Strassburg et al. 2014). A shift away from meat-rich diets would reduce the amount of land  
62 needed for food production, leaving more scope for conserving native vegetation (Erb et al.  
63 2016). More emissions could be captured if cattle herds are reduced, and if land-sparing  
64 policies are developed to promote improved pasture management on a smaller area, coupled  
65 with protection and restoration of native vegetation (Cohn et al. 2014, Lamb et al. 2016).

66 Taking action to reduce beef demand and cattle herds would not only help to reduce  
67 emissions, but also to safeguard the soils, water and biodiversity of the *Cerrado*.

68

### 69 **Acknowledgments**

70 BP is supported by a grant from CAPES (Coordenação de Aperfeiçoamento de Pessoal de  
71 Nível Superior) through the Brazilian Science without Borders programme (number  
72 88881.068115/2014-01). He thanks Luciana Leite de Araújo for suggesting the topic of this  
73 letter.

74

### 75 **References**

76

77 Carranza, T., Balmford, A., Kapos, V. & Manica, A. Protected area effectiveness in reducing  
78 conversion in a rapidly vanishing ecosystem: the Brazilian Cerrado. *Conserv. Letters* **7**, 216–  
79 223 (2014).

80

81 Chazdon, R. L. *et al.* Carbon sequestration potential of second-growth forest regeneration in  
82 the Latin American tropics. *Science Advances* **2**, e1501639 (2016).

83

84 Cohn, A. S. *et al.* Cattle ranching intensification in Brazil can reduce global greenhouse gas  
85 emissions by sparing land from deforestation. *PNAS* **111**, 7236–7241 (2014).

86

87 de Oliveira Silva, R. *et al.* Increasing beef production could lower greenhouse gas emissions  
88 in Brazil if decoupled from deforestation. *Nature Clim. Change* **6**, 493–497 (2016).

89

90 Erb, K.-H. *et al.* Exploring the biophysical option space for feeding the world without  
91 deforestation. *Nature Commun.* **7**, 11382 (2016).

92

93 Lamb, A. *et al.* The potential for land sparing to offset greenhouse gas emissions from  
94 agriculture. *Nature Clim. Change* **6**, 488–492 (2016).

95

96 Latawiec, A. E., Strassburg, B. B., Brancalion, P. H., Rodrigues, R. R. & Gardner, T.  
97 Creating space for large-scale restoration in tropical agricultural landscapes. *Frontiers Ecol.*  
98 *Environ.* **13**, 211–218 (2015).

99

- 100 Lemaire, G., Chapman, D., Tissue flows in grazed plant communities. In: Hodgson, J., Illius,  
101 A.W. (Eds.), *The Ecology and Management of Grazing Systems*. CABI, Wallingford, UK  
102 (1996).
- 103
- 104 Navarrete, D., Sitch, S., Aragão, L. E. O. C. & Pedroni, L. Conversion from forests to  
105 pastures in the Colombian Amazon leads to contrasting soil carbon dynamics depending on  
106 land management practices. *Glob. Change Biol.* (2016). doi:10.1111/gcb.13266
- 107
- 108 Nepstad, D. *et al.* Slowing Amazon deforestation through public policy and interventions in  
109 beef and soy supply chains. *Science* **344**, 1118–1123 (2014).
- 110
- 111 Soares-Filho, B. *et al.* Cracking Brazil's Forest Code. *Science* **344**, 363–364 (2014).
- 112
- 113 Soussana, J.F., Allard, V., Pilegaard, K. *et al.* Full accounting of the greenhouse gas (CO<sub>2</sub>,  
114 N<sub>2</sub>O, CH<sub>4</sub>) budget of nine European grassland sites. *Agric. Ecosyst. Environ.* **121**, 121–134  
115 (2007).
- 116
- 117 Spera, S.A., Galford, G.L., Coe, M.T., Macedo, M.N. & Mustard, J.F. Land-use change  
118 affects water recycling in Brazil's last agricultural frontier. *Glob. Change Biol.* (in press) doi:  
119 10.1111/gcb.13298
- 120
- 121 Strassburg, B. B. N. *et al.* When enough should be enough: Improving the use of current  
122 agricultural lands could meet production demands and spare natural habitats in Brazil. *Glob.*  
123 *Environ. Change* **28**, 84–97 (2014).