



The role of agricultural intensification in Brazil's Nationally Determined Contribution on emissions mitigation

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ABSTRACT

Brazil is the first developing country to provide an absolute emissions cut as its Nationally Determined Contribution (NDC), seeking to reduce greenhouse gas (GHG) emissions by 37% below 2005 levels by 2025 and 43% by 2030. The NDC is also noteworthy in focussing on emissions from deforestation control and land use change. Agricultural intensification is a key component of the offer, potentially allowing the country to make credible mitigation commitments that are aligned with a national development strategy of halting deforestation in the Amazon, and increasing livestock production. This apparent contradiction is potentially resolved by understanding the technical, economic and policy feasibility of intensification by pasture restoration. We use bio-economic modelling to demonstrate the extent of cost-effective mitigation that could be delivered by this measure, and to show a result that underpins the target of zero deforestation in Brazil. The analysis was requested by the Brazilian Ministry of Agriculture prior to the NDC announcement at COP21 by the Government of Brazil. The study provided the basis of the livestock sector contribution to the NDC and highlights the on-going role of effective deforestation control policies. It also contributes to the global debate on land sparing by sustainable agricultural intensification.

1. Introduction

1.1. National mitigation actions

Brazil's Nationally Determined Contribution (NDC), offered at COP21 (Brazil, 2015), is the first time a major developing country has committed to an absolute reduction of emissions from a base year (2005), as opposed to reductions in projected emissions or per unit of Gross Domestic Product. The commitment for the 2020–30 period extends previous Nationally Appropriate Mitigation Actions (NAMA) that committed to an emissions reduction of 36.1% - 38.9% relative to baseline projections by 2020 (Brazil, 2010a). Table 1 summarises the land use change and livestock sector contribution to the NAMA and NDC.

Brazil's NAMA was notable for focussing on the largest emissions sources of forestry and land use change, establishing targets for the reduction of deforestation by 80% in the Amazon biome by 2020 (in relation to the average rate over 1996–2005), and by 40% in the

Cerrado (Brazilian savannah - Fig. 1) (in comparison with the average deforestation rate 1999–2008); made technically feasible through the adoption of pasture restoration, and integrated crop–livestock–forestry systems (Mozzer, 2011). These measures aim to reduce emissions directly by increasing soil organic carbon stocks (SOC), and indirectly through land sparing, hence avoided deforestation.

The NDC poses a challenge to reconcile emissions reduction, deforestation and biodiversity conservation, with ambitious goals for livestock production, predicted to grow by 18% over the decade 2014–24 (OECD, 2016).

The policy intervention supporting the livestock contribution to the NAMA and NDC is in terms of a government-funded bank credit line for low carbon agriculture, the *Agricultura de Baixo Carbono* (ABC) - Low Carbon Agriculture program (Mozzer, 2011). The ABC program offers low interest credit lines to farmers adopting mitigation technologies, including pasture restoration.

In essence, the country is betting on large-scale sustainable agricultural intensification (SAI) (De Oliveira Silva et al., 2016; Garnett

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Table 1
Land use change and livestock sector contributions to Brazil's National mitigation actions.

National mitigation action	Deforestation target	Livestock contribution	Action period	Offered at
NAMA	Reduction of 80% and 40%, respectively in the Amazon and <i>Cerrado</i> by 2020, in relation to average rates from 1996 to 2005.	Restoration of degraded pastures	2010–2020	COP15
NDC	Zero deforestation in the Amazon biome by 2030. ^a	Restoration of degraded pastures	2020–2030	COP21

^a Although the NDC explicitly targets zero deforestation in the Amazon, this analysis assumed zero deforestation in all biomes.



Fig. 1. Brazilian main beef cattle biomes.

et al., 2013) of its key production systems, a challenge for agricultural science, technology adoption, and effectiveness of complementary deforestation policies. This paper evaluates the feasibility of this intensification challenge using scenarios tested in a bio-economic optimization model parameterized for the *Cerrado*, Amazon and Atlantic Forest biomes, which account for around 37%, 28.5% and 23.5% of national beef production respectively (IBGE, 2015). The objectives were to derive the livestock sector contribution to the NDC in terms of the degraded pasture area that could potentially be restored cost-effectively (henceforth restoration area), over the period 2020–2030 assuming accomplishment of the target for reduced deforestation (Table 1) and to estimate the demand for the ABC program. The analysis was requested by the Brazilian Ministry of Agriculture through the Brazilian Agricultural Research Corporation (Embrapa) prior to the NDC announcement at COP21 and offers a transparent and robust framework that supported the formulation of the Brazilian NDC, by demonstrating how the livestock contribution was derived.

The paper is structured as follows. The next section provides background on the historical trends linking agricultural production, deforestation and emissions, setting the scene for the role of SAI measures. Section three outlines the relevant data and modelling to represent pasture restoration as a key SAI measure. Section four provides

modelling results, discussion and conclusions are presented in sections five and six respectively.

2. Agricultural development, deforestation and emissions

Brazil's international environmental profile is significant in terms of the supply of global public goods associated with tropical forest conservation, including significant carbon sequestration and biodiversity (Nepstad et al., 2014a). Brazilian beef production accounts for 15.5% of global production (FAO, 2015), most for domestic consumption. Exports have long been competitive, mainly because predominantly pasture grazed animals are less costly than feedlot systems used in competitor countries (Pedreira et al., 2015). Historically (1950–1975), pasture expansion and extensive ranching explained around 86% of growth in production (Martha et al., 2012). These ranching systems were typically characterized by limited mechanization and low input use, e.g. fertiliser or seeds. Growth was also supported by government research and development programs focussed on the expansion and establishment of agriculture in frontier regions of the *Cerrado* and parts of the Amazon (Martha et al., 2012). Ranchers also cleared forests to secure properties rights (Mueller, 1997).

Development of the *Cerrado* was a steep-change accelerating Brazil's

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