Mitigation in Agriculture, Forestry and Other Land Use (AFOLU): A Brazilian Perspective

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1. Current situation and recent trends

Land use change had a substantial reduction in its share of total Brazilian GHG emissions since 1990, when this sector emitted 57% of the total. After peaking at 68% in 2005, it has dramatically dropped to 26% in 2010. Not only land use emissions have decreased substantially, about 55% since 1990, but there was an increase in emissions from other sources. Building upon this record, Brazilian Nationally Determined Contribution (NDC) to the Paris Accord has set a target of economy-wide GHG emissions reduction of 37% in 2025 and of 43% in 2030 compared to the 2005 level. However, in 2010-2015, La Rovere et al. (2017) estimate that GHG emissions from all sectors have grown and the country total is now above the 2030 NDC target.

Table 1 – Brazilian GHG emissions estimates (in million tons of CO_2eq)

	1990	2000	2005	2010	2015
Energy	189	287	317	375	454
IPPU	52	75	78	91	93
Agriculture	338	385	460	473	524
Land Use Change	797	1,276	1,922	355	515
Waste	34	59	60	71	76
Total	1,410	2,082	2,837	1,364	1,662
% of 2005			100%	-52%	-41%

Source: Brazil (2015) for 1990, 2000, 2005 and 2010. La Rovere et al. (2015) for 2015.

Recent reductions in GHG emissions from land use change are a consequence of lower levels of deforestation rates in the Amazon Region that decreased 71% between 2004 and 2016. (INPE, 2017). According to Assumpção et al. (2015) almost 60% of the slowdown in forest clearing that took place in the past decade was due to environmental policies. These policies, most of them included in the Plan of Action for Prevention and Control of Deforestation in the Amazon – PPCDAM launched in 2004, embrace both command & control and economic instruments: stricter territorial monitoring, coordination of activities between government agencies, expansion of protected territories, fighting illegal deforestation with an increase in sanctions, and the adoption of environmental requirements for the access to soft rural credit.

Still according to Assumpção et al. (2015), other causes of deforestation go beyond environmental policies and are attributable to price variation of agriculture products. For example, crop prices exert a positive and significant impact on forest clearings between the year that prices go up and the subsequent year. Cattle prices have a heterogeneous impact as they induce forest clearing for more pasture areas in the subsequent year after prices go up but reduces the pressure in the same year.

Providing property rights enhances accountability and incentives for producers to increase food production while ensuring environmental protection. Therefore, a major aspect underlying deforestation is the lack of a unified national registry coordinating and managing several cadastres that have been created by different laws and governments over time for real estate, fiscal, economic and environmental purposes. The low level of clear land rights results in property overlapping and rural conflicts fomenting forest clearing as a way to define ownership (Chiavari, et.al. 2016).

With the approval in 2012 of the new Forest Code that makes it mandatory to register all rural properties in the Rural Environmental Registry (CAR) with georeferenced information of property and environmental data, the issue of property rights is likely to be tackled more effectively.

The Code has also created the Environmental Regulation Program (PRA), an instrument that rules how the land owner who deforested beyond legal limits can restore native vegetation in situ or through tradeable forest quotas since 80% of the rural property in the Amazon Region, 35% in the Cerrado and 20% in other regions should remain under native vegetation. The legal requirements of the new Code open room for around 11.4 million ha of reforestation with native species according to Soares Filho, 2012. However not all the code regulations have been put in place and its effectiveness has not been observed yet.

In Agriculture, the government launched the Low-Carbon Agriculture National Plan (the ABC Plan) in 2010, aiming to expand some low carbon technologies and practices through specific credit lines and rural extension. The targets originally set for 2020 were then extended to support the implementation of Brazilian NDC, with targets set for 2025 and 2030. In the period 2010-2015, credit lines used to bankroll ABC Plan investments adopted interest rates around 5.5% p.y. while regular credits would reach 6.5% p.y.

2. Future Prospects

In a scenario for 2050, La Rovere et al. (2017) explore the GHG emissions pathway and the long-term implications on the country's economy of current policies (Governmental Plan Scenario) up to 2030, assuming full NDC implementation and its pure extension up to 2050 with no additional mitigation efforts. The main scenario assumptions have included:

- population growth from 212 million in 2020 to 223 million in 2030, its peak around 2040 and decline towards 226 million in 2050;
- GDP average annual growth of 0,33% in 2015-2020, and 3% from 2020 to 2050;
- international market oil prices of 2013US$85 per barrel.

For the Agriculture Sector and assuming the efficiency gains projected by the government (EPE, 2016), La Rovere et al. (2017) have tested a 172% increase in grain production, 94% in wood production and 21% in the cattle herd in 2050, compared to 2015 levels. If these efficiency gains are achieved then those high agricultural outputs might be reached simultaneously with a reduction of about 20% in the cultivated area demanded by agriculture. These results reveal that, although there is still room for legal deforestation to occur - especially in the Cerrado and Caatinga biomes where areas covered with native vegetation area still above the minimum legally required to be preserved– an increase in agriculture outputs may not require more land clearing than that currently available (Moreira et al., 2016).

To mitigate GHG emissions in the agriculture sector, one of the actions of the ABC Plan is the recovery of 30 million hectares of degraded pasture up to 2030. Such area would lead to 19.3 Mt CO_2eq of extra carbon stocked in soil in 2050. At the same time, it would restore productive capacity, with better nutrition improving animal health and higher levels of soil and water conservation.

Another ABC Plan mitigation measure consists of adopting production systems that integrate cropping, cattle raising and / or forestry activities in the same area in intercropping, succession planting or rotational farming, aiming at obtaining synergistic effects between the components of the agro-ecosystems. The goal of another 5 M ha under these systems was set for 2030, supplying 3 M ha more of fast-growing planted forests (mainly eucalyptus and pinus) that along with the dedicated 7 Mha of forests required to meet the manufacturing and energy industries' demand for biomass would result in an increase of 10 M ha of economic forests planted areas. Total additional carbon sequestration would amount to 62 $MtCO_2eq$ in 2050.

Zero tillage is also being fomented by the ABC Plan. This cropping technique captures and fixates carbon in soil, mainly through avoiding mechanical preparation of soil and by covering it with agricultural residues. It eliminates erosion and enhances soil and water conservation while substantially reducing fuel consumption. La Rovere et al (2017) have calculated that, if this system was adopted in 100% of land devoted to grain cultivation, it would be possible to incorporate 11.9 $MtCO_2eq$ to the soil by 2030 with an additional carbon storage capacity of 0.8 $MtCO_2eq$ in 2050.

Expanding the biological fixation of nitrogen is also included in the ABC Plan. It is a process that by inoculating nitrogen fixing bacteria to seeds before sowing, eliminates the need for nitrogenous fertilizers. If this technique was used in 100% of the area with soya and corn (71% of the total area with grains) by 2050, it would avoid the emission of 11.9 $MtCO_2eq$ compared to the levels observed in 2015, when only 57% of the area with grains adopted this technique.

There is also an opportunity to increase the treatment levels of swine waste with biodigesters in order to use methane for electricity generation and the remains as biological fertilizer. Government targets are that more than 4.3 million cubic meters will fuel biodigesters by 2020. La Rovere et al. (2017) have tested and increase of this amount up to 6.5 million cubic meters by 2050. However, GHG emissions from swine waste would increase by almost 30%, since the herd should grow beyond this increase in the capacity of treatment.

The prospects for biofuels production are impressive. Not only there is available land for feedstock cropping but also mature technology for both production and use. Currently, more than 65% of the road fleet is flex fuel (ethanol and gasoline) and diesel oil is already blended with 7% of biodiesel, in volume (B7). In the scenario simulated by La Rovere et. al (2017), the flex fuel road fleet would reach almost 75% in 2050 and the the blend of biodiesel would reach 15% (B15). In Brazil, ethanol is made from sugarcane, a feedstock that has recently been modified to reach higher productivity ("cana-energia"), yielding 2.32 times more ethanol (second generation) than traditional sugarcane (volume of ethanol per hectare). In terms of land use, the area devoted to sugarcane would increase 2.8 million hectares in 2050 compared to that of 2015, while the biodiesel being mostly a by-product of soya would not demand dedicated cropping area. The carbon footprint of these fuels is lower than that of fossil fuels[1] and electricity is not being considered as a main source for the near future yet.

Lastly, it is important to highlight the potential for forestry, both through reforestation and afforestation schemes. As already mentioned, the new Forest Code requires a reforestation of more than 11 million ha of native species, corresponding to a carbon uptake of 155 $MtCO_2eq$ in 2050. In the simulations made by La Rovere et al. (2017), biomass as feedstock for power generation and other industrial purposes would add another 10 million hectares, an uptake of more 42 $MtCO_2eq$ from forests.

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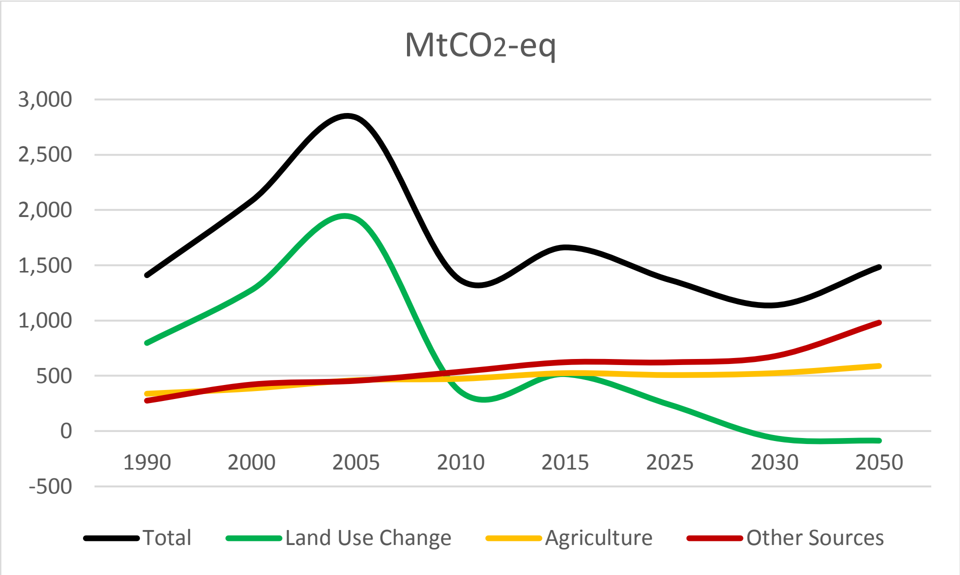
[1] A life cycle assessment indicates that one liter of ethanol from sugarcane can mitigate between 61% and 96% of CO_2e emissions from one liter of gasoline, varying according to the type of ethanol (anhydrous or hydrated). One liter of biodiesel can reduce emissions from one liter of mineral diesel by 60-94%, depending on the feedstock used to produce biodiesel and the type of alcohol used in the transesterification process (ethanol or methanol) (EPE, 2007).

Figure 1 below summarizes the Brazilian GHG emissions pathway under the assumptions of the long-term Governmental Plan scenario built by La Rovere et al (2017). Thanks to the full implementation of its NDC, Brazilian GHG emissions would reverse the 2010-2015 trend and decline up to 2030. If no additional mitigation measures (e.g. through a more ambitious NDC) are taken, GHG emissions would resume growing in 2030, but in 2050 they would be still 48% below the 2005 level.

Figure 1 – GHG Emissions up to 2050 in the Governmental Plan Scenario



Source: La Rovere et al, 2017.

Figure 1 shows that avoided GHG emissions in the AFOLU sector not only were key to explain the recent drop in the overall country emissions but also that its potential remains very important in the next decades, allowing to counter the forces driving GHG emissions up in other sectors (mainly fossil fuel combustion).

Conclusion

The substantial decline in Brazilian GHG emissions is a consequence of a dramatic drop in deforestation rates, considerably attributable to governmental policies like stricter territorial monitoring, better coordination of activities between government agencies, expansion of protected territories, increase in sanctions in case of illegal deforestation and the adoption of environmental requirements for the access to rural credit.

There is still a huge potential for the Land Use Change sector to contribute to the country's overall mitigation. Considering the policies already in place, the simulation of a long-term Governmental Plan Scenario with an average annual GDP growth around 3% p.y, shows that Brazilian GHG emissions from land use change could be negative by 63 $MtCO_2eq$ in 2030 and 87 $MtCO_2eq$ in 2050 (La Rovere et al, 2017).

However, to achieve these results it is extremely important that new instruments like the CAR are fully enforced, as this kind of instrument is one of the most efficient ways of monitoring farms and inducing legal behaviors through fines and credit restrictions.

There is also a huge potential for bio-energy, mainly first and second-generation ethanol as well as third generation as soon as it is commercially available. Biomass for power generation is also particularly promising since not only there is plenty of sugarcane bagasse but also a vast amount of land to be dedicated to wood production. It is important to highlight that a great part of the GHG emissions mitigation in transportation, industry and the power generation sectors depends on the availability of these outputs from the Agriculture sector, as envisaged in the Brazilian NDC.

Lastly, it is important to mention that despite the huge mitigation that could be achieved in the land use change sector, the scenario simulations up to 2050 did not identify any constraint to food production and other agricultural outputs in Brazil. On the contrary, they show that in the Brazilian case there is considerable potential to simultaneously increase the production of grains and other crops, of bio-energy and feedstocks to the industry.

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