MAINSTREAMING BIODIVERSITY CONSERVATION IN AGRICULTURE:

POLICIES ANALYSIS OF THE LAST TEN YEARS

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November, 2017

Interdisciplinary Term Paper

Bonn International Graduate School for Development Research (BIGS-DR)

ABSTRACT

All over the world, biodiversity loss is considered as a big challenge. Among the drivers of the biodiversity loss, agriculture is considered as the major one, and its effect is exacerbated by the remote consumer needs. It results that a well planned agricultural policy can slow down the loss when environmental factors are considered during their elaboration. Brazil as both a biodiversity and agricultural hotspots represents an ideal case study. This paper aims at identifying in recent national agricultural policies and programs whether biodiversity conservation is considered. In order to achieve the paper objective, a content analysis of main policies and the data visualization methods were used. Results showed the within ten main policies that were selected for analysis, all of them somehow dealt with biodiversity conservation. However, the ground application of the agricultural policies gave a mixed results. Hence, it can conclude more incentive policies can give more effective results than restrictive policies which amplified biodiversity lost. It can be recommended that for a successful management of biodiversity and agriculture the use of more participatory approaches.

Key words: agricultural policies, biodiversity conservation, agri-environmental indicators

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1. INTRODUCTION

1.1. Background and Justification

The biodiversity loss emerged as an urgent topic in the Rio Earth Summit in 1992, which was followed by a succession of more than eleven agreements and conventions signed by more than 150 nations worldwide (Secretariat of the Convention on Biological Diversity 2017). The recent new pulse of interest for biodiversity conservation was in 2015, underpinned by the elaboration of the sustainable development goals (SDGs), which intend to protect the environment and end the hunger in the world (Nation 2015). However, the achievement of some SDGs could have negative effects on others goals, for instance, increasing food production versus biodiversity conservation. Therefore, the measures for achieving these goals should be elaborated with a holistic view in order to maximize benefits for all goals.

The habitat change due to land-use and land-use change (LULUC) is considered one of the main drivers of biodiversity loss along with climate change, overexploitation of resources, invasive alien species and pollution (Millennium Ecosystem Assessment (Program) 2005). Agriculture has potential impacts on the environment which can lead to biodiversity loss. The main threats are the conversion of natural habitats, especially considering that some commodities are produced in biodiversity hotspots; intensification of crop management through the increasing use of agrochemicals (e.g. pesticides, fertilizers) and, hence, the water and soil pollution; air pollution through the use of fire to clear the fields and greenhouse gas emissions; loss of genetic diversity through the widespread use of few crop species in monocultures and the use of genetically modified organisms which may affects ecosystem dynamics and gene pool of wild relatives as well as possibly increase in the use of herbicides (Darkoh 2003; Donald 2004; Leibowitz 2012; Dudley and Alexander 2017). Environmental-harmful practices are exacerbated in exporting countries which satisfy commodities demand of remote consumers (Green et al. 2005; Lenzen et al. 2012). Due to such global trade, more than 30% of species are threatened (Donald 2004; Lenzen et al. 2012).

Agriculture, for historical, socioeconomic and geographical reasons, remains a relevant activity in Brazil's national scenario but also presents significant developments in the scope of international trade. With the focus on the domestic market, it is possible to highlight the agricultural sector as a thriving sector responsible for 37% of the labour market places and 25% of the GDP (MAPA 2012). The magnitude of the growth in the agricultural sector can be seen in the increase of national agriculture production index from 15.68 in 1961 to 134.97 in 2014 (FAO 2017). In a global view, Brazil comprises nearly 6% of the land suitable for agriculture (Lima Junior 2013) and is one of the main countries in international trade of agricultural products such as soybeans and corn (World Bank Indicators 2017). Since 2003, Brazil has steadily increased its agricultural output and the exports of goods and services emerging as the one of the biggest net agricultural exporter in the world (FAO 2017, World Bank Indicators 2017).

Besides the positive effects in the national economy, the expansion of agriculture in Brazil has come with a high cost to its biodiversity. One of the major contributors to deforestation was the expansion of the soybeans crops and the associated infrastructure boosted by the increasing import demand, especially from China (Fearnside 2001). It is argued that the adoption of policies and certain practices can emulate both the satisfaction of consumers demand as well as the conservation of biodiversity (Fischer et al. 2008). According to Green et al., for instance, policies that promote the increased density of wildlife and wild plant can be used to promote both the intensive agricultural production and species conservation (Green et al. 2005). Therefore, considering that increasing agricultural productivity with no harm to biodiversity is a big challenge, especially for countries which are the main producers of agricultural commodities and are also biodiversity hotspots, such as Brazil (MMA 2016; Valsecchi et al 2017), this study aims at conducting a critical analysis of the main agricultural policies implemented in Brazil, from 2007 to date, in order to assess the integration of biodiversity concerns and assess possible impacts of their application on environmental indicators.

1.2. Research questions

Considering the increasing awareness for biodiversity conservation and the important role of the agricultural sector, two main questions can be proposed:

Has Brazil considered biodiversity conservation in agriculture policies of the last 10 years?

Is it possible to perceive impacts of these policies on reducing biodiversity threats?

1.3. Objectives

i) To identify the main recent national policies and programs in the agricultural sector and whether they consider biodiversity conservation;
ii) To identify if there is a trend towards sustainable agricultural practices based on indicators directly related to biodiversity conservation or loss and whether the selected policies can be associated;

2. CONCEPTUAL FRAMEWORK

Worldwide, there is a decreasing rate of biodiversity due to the combined effect of anthropogenic activities and environmental hazard (Cardinale et al. 2012; Van Der Ploeg et al. 2017; Ding et al. 2017). Recently many authors demonstrated that the globalization and the consumption pattern have amplified the loss of biodiversity (Lenzen et al. 2012). Hence, many agreements were signed to ensure that the loss rate would decrease. The Millennium Ecosystem Assessment revealed the importance of agricultural policies and their impacts on the biodiversity conservation (Millennium Ecosystem Assessment (Program) 2005). The theoretical framework (Fig.1) shows that agricultural policies can interfere in agricultural production and practices. When agricultural policies are not properly planned or implemented, it may result in unsound agricultural practices, disservices of agriculture (Dewha 2009) and increase in biodiversity loss.

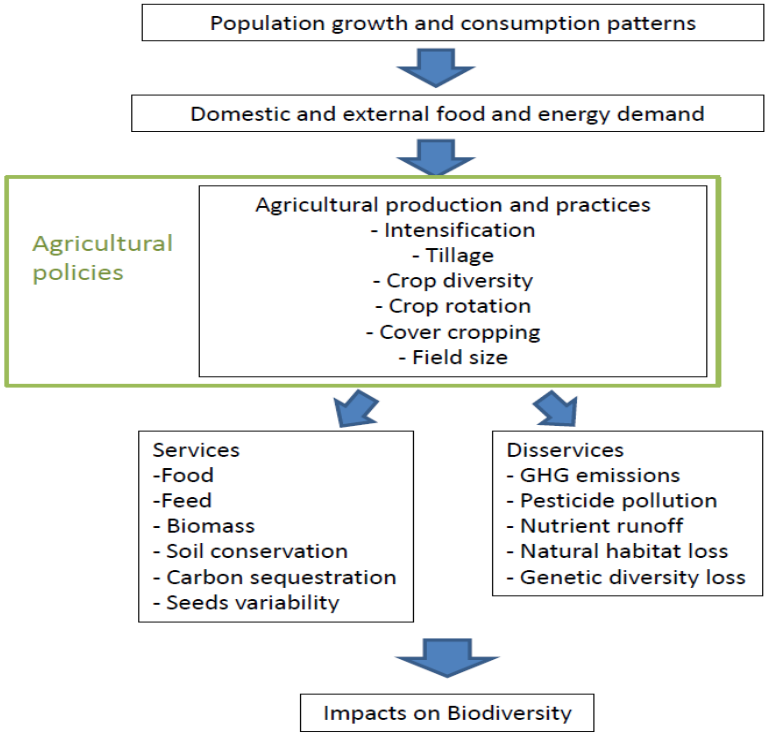


Fig. 1: **Conceptual framework linking agricultural policies and impacts to biodiversity.**

3. MATERIALS AND METHODS

3.1. Description of the Study area

Brazil is located in South America between 6°N and 34°S latitude and 28°E and 74°W longitude (Wikipedia 2017). Brazil shares borders with ten countries and comprises a total area of 8,515,767.049 km2, being the largest country in the world (IBGE 2017, Worldatlas 2017). A compilation of available data on species lists made by the Brazilian government for the Fifth Report for the Convention of Biological Diversity confirmed that the country is the most biodiverse in the world, hosting roughly 44 thousand plants and 104 thousand animal species, and besides being the most degraded Brazilian biome with only 21% of remaining natural areas, the Atlantic Forest is still home to the higher number of species, followed by Amazon and Cerrado (MMA 2016). Although the current numbers are impressing, the proportion of species still waiting to be discovered is far higher. For instance, a recent study conducted in 2014-2015 in Amazon was responsible for describing 381 new species (Valsecchi et al 2017).

The National Biodiversity Targets for 2010 were approved in 2006 (Resolution CONABIO nº 03/2006) and included agricultural related issues such as conservation of genetic diversity of cultivated plants and extractive species of socioeconomic value (Component 2), sustainable use, innovation and adding value to products from biodiversity (Component 3) and control of the sources of water and soil pollution and the impacts to biodiversity (Component 4) (MMA 2006). These targets were updated to a 2020 timeframe (Resolution CONABIO nº 06/2013) considering the global Aichi Targets and the role of agriculture in biodiversity conservation became more explicit (MMA 2013).

Brazil climate is characterized by six types of climate these are desert, equatorial, tropical, semiarid, oceanic and subtropical (INMET - Instituto Nacional de Meteorologia 2017). Such wide range of climate is favorable for the production of different commodities such as corn, soybean, sugar cane, palm oil, rice, canola, sunflower, and planted forests (World Bank 2010, Flexor and Pereira Leite 2017). All these elements contribute to Brazil being the major's supplier of word commodities (Flexor and Pereira Leite 2017).

3.2. Methods

To assess whether biodiversity conservation has been included in the agricultural policies, first, a selection of the main agricultural policies and programs implemented between 2007 and 2017 was performed. Then, regarding the main threats that agriculture imposes to biodiversity identified in the literature, a content analysis of each policy was conducted. In order to identify potential variations on these threats in the same timeframe, agri-environmental indicators were selected for secondary data collection and analysis. Finally, the content analysis and the quantitative analysis were integrated to assess potential impacts of the policies on biodiversity conservation. A methodological framework is shown in Fig. 2 and is described in detail in the following sections.

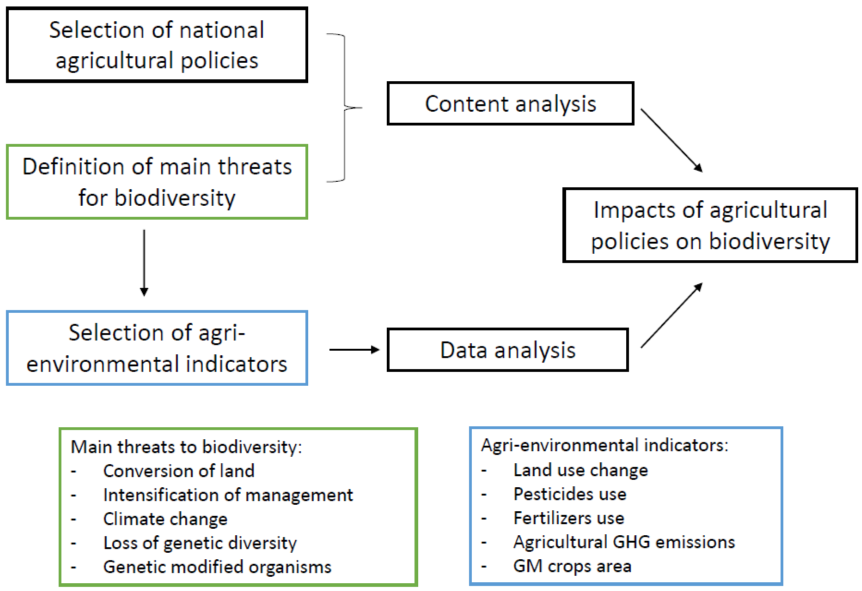


Fig. 2 : Conceptual framework of the methodological process.

3.2.1. Policies content analysis

Policies that may affect the impacts of agriculture on environment and biodiversity are divided into three categories (OECD, 2008):

Agricultural policies: can provide incentives and subsidies for intensification, increase of production. Can have either negative or positive effects on the environment, but objectives are not directly related to environmental protection.

Agri-environmental policies: explicitly aim at positive impacts on the environment that are related to agricultural activities

Environmental policies: specifically aim at environment issues but may have effects on agriculture.

The aim of this study is to assess policies implemented by authorities of the agricultural sector therefore, environmental policies were not selected as main policies but may be associated with them. The selection of the main agricultural policies of the last decade was done through two main sources. First, an exhaustive search of grey literature was conducted on the Brazilian Ministry of Agriculture, Livestock and Food Supply website (www.agricultura.gov.br) and all available policies were considered. Second, through the

Google Scholar search tool literature was selected using the search terms: present in the title (agricultural OR agriculture) AND (policy OR policies) AND (Brazil OR Brazilian). From the 46 results of this search, papers which the full text was not available, out of the time frame, duplicated or out of the scope were not considered. Policies mentioned in this papers were extracted. In total, were collected 51 policies.

For each policy document was explored the implicit and explicit potential impacts to biodiversity considering the main threats mentioned in the literature about the topic. Therefore, the content analysis of the policy documents aimed at identifying objectives and actions which could affect the main threats to biodiversity: conversion of natural land, climate change, water and soil pollution, genetically modified organisms and genetic loss (Table 1). The evaluation of each policy was done according to qualitative indicators of impact “negative, null and positive”. Additionally, was considered if the policy explicitly mention biodiversity conservation and if any of the objectives could be related to the National Biodiversity Targets according to the timeframe of the policy (targets for 2010 and 2020) (MMA 2006, 2013). From all the policies analyzed, the ones who could be clearly related positively or negatively to at least one threat to biodiversity were selected to be described in this paper.

Table 1. Criteria for content analysis of the agricultural policies.

Does the policy mention/encourage conversion of new land for agriculture/livestock (negative) or use of already altered/degraded areas (positive)?	Negative (-) Null (0) Positive (+)
Does the policy mention/encourage conventional management intensification (negative) or sustainable practices (positive)?	
Does the policy mention/encourage the reduction of GHG emissions (positive) or imply an increase in emissions (negative)?	
Does the policy mention/encourage the use of GMO (negative) or the use of varieties of indigenous plants (positive)?	
Does the policy explicitly mention biodiversity conservation?	Yes or No
Does any objective of the policy can be related to any Biodiversity National Target?	Yes (number of the target) or No

3.2.2. Quantitative assessment

In order to observe whether the policies could have had an impact on biodiversity conservation in the last 10 years, agri-environmental indicators (AEIs) were used since they have been adopted in policy monitoring and evaluation to assess the environmental conditions of agriculture sector (OECD, 2008). A set of AEIs was selected according to relevance to biodiversity loss or conservation, availability and quality of data. Therefore, the indicators included in this study are greenhouse gas emissions, land use change, pesticides use, fertilizers use, GMO area and organic farms area, which were quantitatively assessed using different secondary datasets sources (Table 2) . Different value obtained for areas and consumption were scaled and plotted. As datasets used came from different sources, scaling them facilitated their visualization. Based on the trend observed, land use time series analysis was used to assess the conversion rate. The rationale of the land use/ land cover change analysis was to ascertain that the observed deforestation was due to agricultural practices. Furthermore, different rate (r) were computed using (eq. 1)

$$r = \frac{Q2 - Q1}{Q1} \qquad \text{(eq. 1)}$$

Where Q_1 is the quantity in the first year and Q_2 the quantity considered in the following year

As well as the geometric mean $\overline{r_g}$ using (eq. 2)

$$\overline{r_g} = \sqrt[n]{\prod_{i=1}^{n} r_i} \qquad \text{(eq. 2)}$$

Where n is the number of (i) elements in the set of rate considered

Data visualization and statistical analysis were done with R (R Core Team 2013) and the land cover change was done with ARGIS V10. 2 (ESRI 2011).

Table 2. Summary of secondary dataset collected with their sources

Indicators	Nature of data	Data sources
Carbon flux	Numeric	SEEG 2017
Land use datasets	Numeric	FAOSTAT 2017
Land use mapping data	Images (.shp)	IBGE 2017
Organic farmland	Numeric	FAOSTAT 2017
GM farmland	Numeric	CONAB 2017
Pesticides	Numeric	AGROFIT 2017, CONAB 2017
Fertilizers	Numeric	AGROFIT 2017, CONAB 2017

4. RESULTS

From the total number of policies collected, ten policies could be clearly related to impacts on biodiversity and are addressed in detail in the following sections (summary on Table 1 – Supplementary Material). The most comprehensive policy was the ABC plan, which targets three main threats to biodiversity. The most recent policies considered biodiversity conservation explicitly in their documents and could also be related to specific National Biodiversity Targets. It is possible to notice that significant targets have been addressed by the policies such as the sustainable use of biodiversity (Target 3), sustainable production (Target 4), promotion of sustainable practices in agriculture (Target 7) and maintenance the genetic diversity of cultivated plants (Target 13).

4.1. Greenhouse gas emissions

4.1.1. Content analysis

Agriculture and livestock account for one-fourth of the greenhouse gas (GHG) national emissions (MAPA 2012). However, when considering the emissions related to land use change, the sector is considered the major contributor (MAPA, 2012).

The Low Carbon Agriculture Plan 2010-2020 (ABC) is a climate-related sectoral policy resulted from the National Plan for Climate Change (PNMC) implemented in 2009 after the country’s commitment with the reduction of GHG emissions assumed in the COP-15 (MAPA 2012). The government has been offering incentives to the adoption of agricultural practices such as direct seeding instead of conventional tillage practices, commercial forest plantations, biological nitrogen fixation, restoration of degraded pasture lands through proper management and fertilizing. The plan identifies the practices of agroforestry and integrated systems of crop-livestock-forest as means to protect and use biodiversity in a sustainable way and also to adapt to climate change. These practices have been recognized as beneficial in terms of either sequestration of carbon or avoidance of emissions (Corbeels et al 2006, Paustian et al 1997).

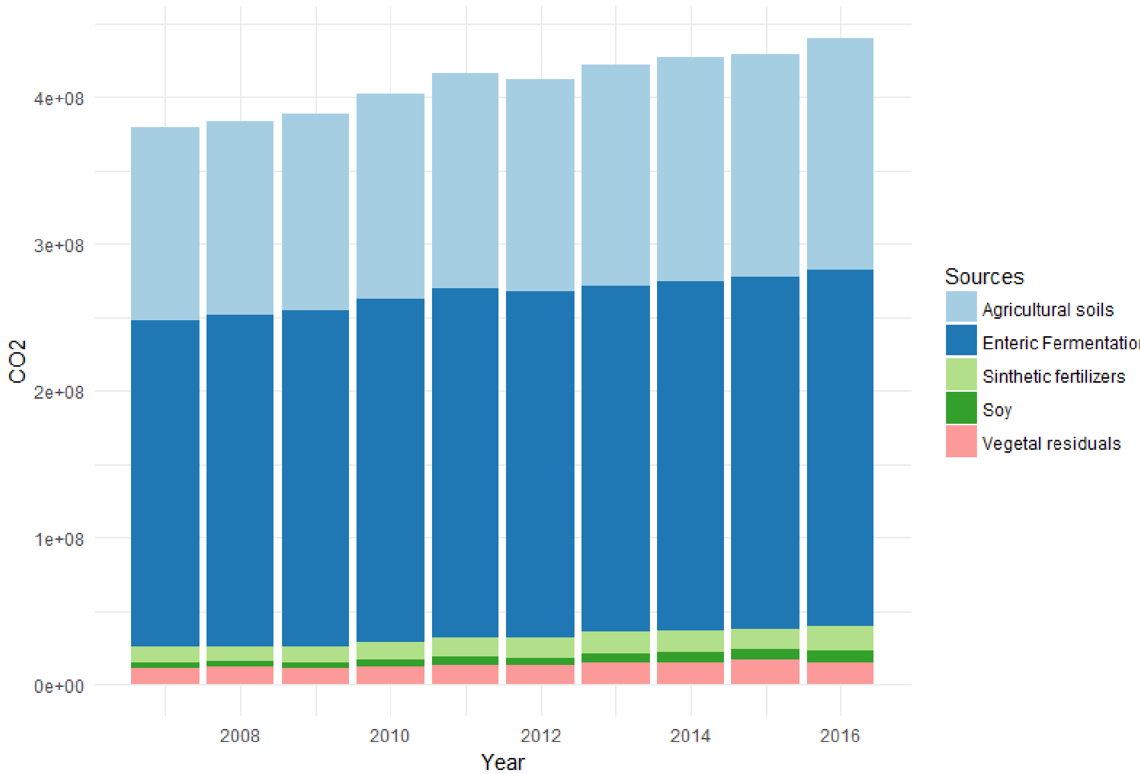
The credit given by the ABC Program, line of credit associated with ABC Plan, has increased since its creation with a peak in the 2014/2015 harvest, with R$ 3.5 bi invested by farmers (Table 3). However, after this peak the interest in the program seems to have decreased as the government cut more than 30% of the budget for this program and applied rates fell, being only R$ 1,15 billion used by farmers in the 2016/2017 harvest. In the last harvest-year, one third of the program financing was applied in the central-west region (MAPA, 2017).

Table 3. . Evolution of Low Carbon Agriculture credit line made available by the government and the amount executed from 2010/2011 to 2016/2017 harvests (Source: MAPA 2017).

ABC Credit line (R$ billions)			
	Total offered	Total Applied	%
2010/2011	3.15	0.42	13.3
2011/2012	3.15	1.51	48.1
2012/2013	3.4	2.9	84.4
2013/2014	4.5	2.6	58
2014/2015	4.5	**3.5**	78
2015/2016	3.0	1.96	66
2016/2017	2.99	1.15	39

4.1.2. Quantitative assessment

The impact of this policy on the reduction of total agricultural sector emissions is still not significant as, apart from a slight decrease in 2012, the total number keeps increasing (Fig. 3).



Enteric fermentation measures the methane emissions from ruminants, synthetic fertilizers equivalent to N2O emissions from the application of nitrogen fertilizers, vegetal residuals and soy residuals that remained in the crops, agricultural soils aggregate remaining factors. All gases were transformed to carbon equivalent (CO2e (t) GWP-AR2). (Source and methodology SEEG 2017).

Fig. 3 .Carbon emission in the agricultural sector in the timeframe of 10 years.

The second set of carbon emissions variables (Fig 4 and Table 4) are independently from the previous set (Fig 3) and reflects soil condition and management, measuring not only emissions from areas with conventional crops and degraded pasture, but also carbon sequestration derived from sustainable practices. Although these variables have not been included yet in the Brazilian national report, they were considered in this study because of the close relation with the practices addressed by the ABC plan. The general trend (Fig 4) shows that soil emissions decreased until 2010 but, after few years of stabilization, it has increased from 2013 to 2016. On the other hand, the sequestration of carbon has increased through the whole timeframe. Carbon emission rate is significantly higher than the sequestration (t = 2.24, df = 17.78 ci=[1823421, 59189365]).

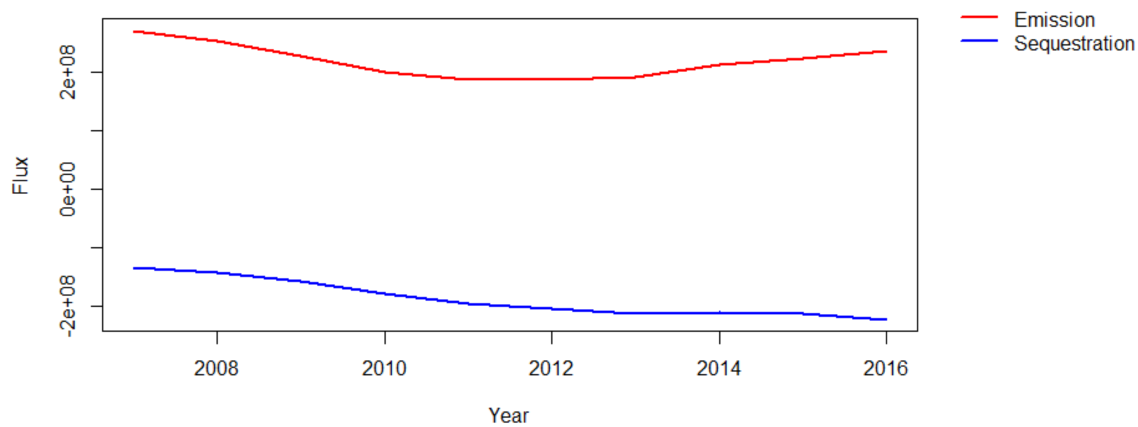


Fig. 4 **Carbon flux, emission and sequestration, over the time, from 2007 to 2016 (Source: SEEG 2017).**

However, when analyzing in detail (Table 4) it is possible to see that the increase in emissions after the policy implementation in 2010 was driven by degraded pasture areas (average increase of 5,8%) whilst the emissions from conventional crop systems continued to decrease, even at a higher rate (average decrease of 2.85%). The average sequestration rate which increased in 4.6% before the policy rose to 2,67%, mainly due to the bad performance in the variables crop-livestock-forest and well managed pasture. Comparing the carbon flux before to after implementation of such policy, it can be conclude that the ABC policy has not been successful either in reducing carbon emissions or improving sequestration (Table 4).

Table 4. **Carbon emission and sequestration rate before and after the implementation of the ABC plan.**

		Before	After
Emission	Agricultural soil (General)	-4.55%	4.68%
	Degraded pasture	-4.84%	5.81%
	Conventional system crops	-2.42%	-2.85%
Sequestration	Agricultural soil (General)	4.59%	2.67%
	Well managed pasture	0.14%	-5.03%
	Crop livestock forest integrated systems	23.08%	3.67%
	Vegetal	5.51%	5.93%
	Forests and plantations	4.39%	1.51%
	Direct seeding crops	5.60%	5.76%

4.2. Conversion of natural habitats

4.2.1. Content analysis

In Brazil, one of the most dramatic cases of conversion of natural areas is Cerrado, the second largest biome after Amazonia, where cattle raising and agriculture were the main reasons for decreasing by half the original area of natural vegetation (Klink and Machado 2005, MMA/IBAMA 2011). The consolidation of the agribusiness expansion into central-west started in the 70s promoted by technological and genetic advances to adapt crops to the specific conditions of the new agricultural frontier (Lima Junior, 2013). Public policies for the economic development of the region, mainly through agriculture and livestock, allied to the facility of clearing the land due to biome's phyto-physiognomy characterized by small and sparse trees, resulted in the region being a large national contributor to the exportation of grains (Viana et al 2013). The external demand increased after the ban on livestock feed containing animal proteins in 2001 by the European Union (Hazen 2010). To support the expansion of the agribusiness, in 2007 the government launched policies, such as the Logistic and Transport National Plan (PNLT), to create and improve infrastructure connecting the agricultural frontiers to the internal and international markets (Lima Junior, 2013).

The Program for Commercial Planting and Recovering of Forests (PROPFLORA) financed the planting of forests and the recovery of legal reserves and permanent preservation areas in Brazil giving grant credits up to 35% of project's value (Syed 2012). Other policies related to PROPFLORA are PRONAF forestry and Eco PRONAF initiated by the Ministry of Agrarian Development in 2007 for mostly family farmers to focus on agroforestry, reforestation timber and non-timber products, renewable energy and recovery of environmental preservation areas. The beneficiaries are more than 1.2 million families nationwide and has 75% market share of financing to family producers

The Brazilian Agroenergy National Plan 2006-2011 followed the National Program for the Production and Use of Biodiesel (PNPB) launched in 2004. The Agroenergy Plan supports public and private initiatives to strengthen the development of knowledge and sustainable technical innovations in the bioenergy sector as well as the competitiveness of Brazil in this market, aiming a global leadership (Brasil 2006). It is based mainly on the production of energy from the biomass of sugarcane (ethanol), animal and vegetal sources (biodiesel), forest biomass and agro-industry waste. The plan states as an advantage of the country towards the leadership in this market the possibility of converting land to energy crops with "social accepted environmental impacts" which are not defined or specifically discussed in any part of the document (MAPA 2006). It is mentioned, however, the availability of already altered or deforested areas which could be used to increment the production (e.g. deforested area comprising 5 million hectares in the northern region suitable for palm oil cultivation). The need of more land for sugarcane and oilseeds crops was confirmed in the following Agriculture and Livestock Plan 2007-2008, which mentions an estimated expansion of 10 million hectares in the next decade (2007-2017) due to the demand for biofuels (MAPA 2007). However, this plan also presents the possibility of meeting this increasing demand through the improvement in the productivity of areas already under use. For encouraging the expansion of crops for biomass production without defining clear sustainable measures, the policy was considered negative in terms of conversion of land.

The Program for Fostering Sustainable Farming (PRODUSA) focused on promoting the use of technologies and cultivating systems which are consistent with national environmental and sustainability objectives (Santana 2012). Are aspects included the recovery and preservation of soils and pasture. The investment funds allocated to this program totaled BRL 1.0 billion in 2008/2009 and then increased to BRL 1.5 billion in 2009/2010. According to Santana 2012 the program has seen some increased utilization of sustainable practices of agricultural production by various farmers suggests that the program is produced positive results (Santana 2012).

The incentives to sustainable practices and restoration of areas given by the ABC plan are assumed to contribute to reducing the pressure for new land conversion. An economic model developed to calculate the potential effects of this policy estimated that, even if only the objectives of 15 million hectares (Mha) of restored pasture areas and 4 Mha expansion of crop-livestock-forest system are achieved, a reduction of 1,4 Mha of agricultural area and 5 Mha of pasture, along with an increase of at least 4,8 Mha of forest area and non-forest vegetation could be expected (Observatório ABC, 2017). Therefore, it can be categorized as a land sparing policy because the sustainable practices encouraged have the potential to reduce the pressure for conversion of new areas and use of natural resources.

4.2.2. Quantitative assessment

Although agricultural policies tackle deforestation, our analysis shows that forest area continues to decrease while agricultural area climbed gradually with a sharp increase between 2012 and 2014 (Fig 5). The adoption of Agro Energy has slightly decreased the deforestation rate. In this period from 2009 to 2011, the deforestation rate decreased from 0.33% to 0.20%. However, the implementation of either ABC plan, in 2010, or the New Forest Code, in 2012, did not change the decreasing trend of forest area.

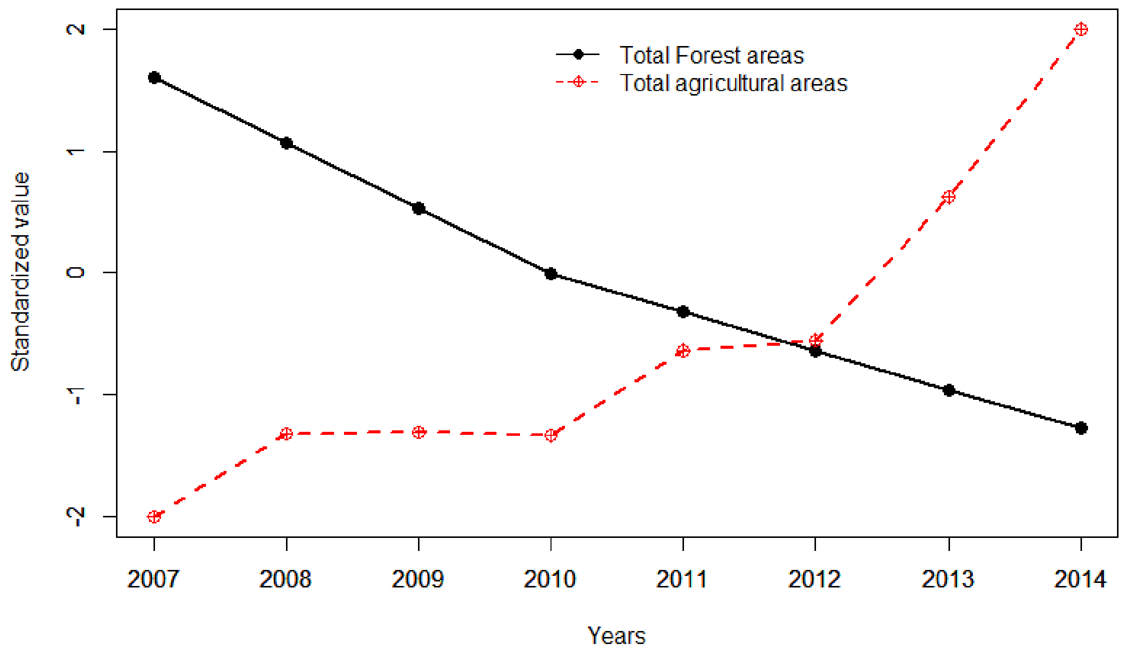


Fig. 5 Trend of evolution of both forest and agricultural areas

In order to identify the nature of land use change in this period (Fig. 6), a conversion matrix was developed to compare year the 2010 with 2014 (Table 5). Our results show that forest area was converted into planted pasture (about 2,5 Mha) and agricultural areas (0,5 Mha) while only 0,2 3 Mha of agricultural areas were afforested. Additionally, can be highlighted that the largest part of area converted to agriculture was from natural pasture areas (4,82 Mha) followed by planted pasture areas (2,27 Mha). Regarding the planted pasture areas, it expanded mainly into natural pasture areas (11 Mha). Therefore, the expansion of agricultural areas has been mainly into pasture areas and this is in the line with the objectives of the ABC plan.

Table 5. **Land use conversion from 2010 - 2014.**

		Land use 2014						
		Agricultural areas	Artificial area	Natural pasture	Planted pasture	Plantations	Grassland	Natural Forest
Land use 2010	Agricultural areas	45299.57	26.61	354.12	644.18	120.73	0.49	23.61
	Artificial area	31.49	3818.69	8.03	28.85	2.26		0.51
	Natural pasture	4825.43	120.04	157076.12	10992.43	1134.54	30.98	15.54
	Planted pasture	2274.83	66.48	1305.73	80127.29	452.72	0.26	74.48
	Plantation	161.29	6.79	32.00	126.99	5798.74		0.65
	Grassland	13.83	0.66	311.01	24.75	3.26	8750.78	11.29
	Natural Forest	506.43	42.85	24.56	2445.93	89.24	19.76	317151.54

Agricultural areas- temporary and permanent crops; Artificial area- urbanized; Natural pasture- grassland with low intensity of grazing or other anthropic activities; Planted pasture- herbaceous vegetation cultivated for grazing; Plantation- commercial forest of exotic species; Grassland- non-forest vegetation, predominantly grasses and shrubs; Natural forest- forest vegetation (Source IBGE). Values in 1000 hectares.

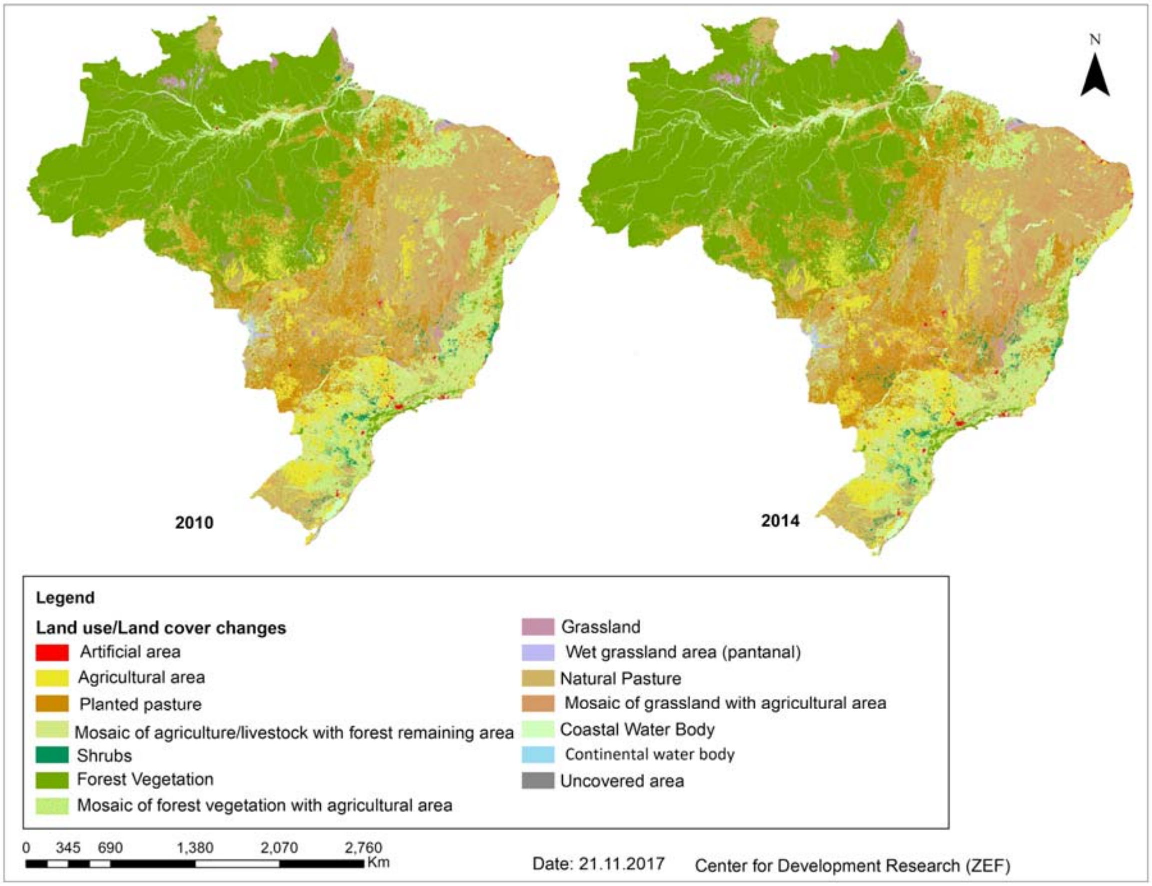


Fig. 6 Time series map showing the conversion of land cover change from 2010 to 2014

4.3. Intensification of management

4.3.1. content analysis

Unsound use or overuse of fertilizers can lead to significant environmental impacts when the runoff water from crops areas reaches natural water bodies. High level of phosphorus, for instance, may trigger an unusual multiplication of aquatic organisms, such as algae, leading to eutrophication and imbalance of the ecosystem. The Brazilian Water National Agency (ANA) found phosphorus contamination in all regions where this nutrient was monitored, referring to the use of fertilizers as the main source of the problem in rural areas (ANA 2016).

Since Brazil relies basically on the importation of the fertilizers used in the agricultural sector, the government has provided benefits to farmers such as tax exemptions for fertilizers. In 2007, was approved the inclusion of more two types of fertilizers on the list of previous seven fertilizers free from tax importations in the Mercosul trade (MAPA 2007). The Agriculture and Livestock Plan 2009-2010 introduced the Fertilizers National Plan which has as the main objective the reduction of the international dependence of fertilizers through the expansion of internal production, including the exploitation of new deposits of phosphorus, potassium (in Amazonian areas) and a new factory of urea (MAPA 2009). However, to date this plan has not been officialized.

In 2008, Brazil has assumed the position as the largest consumer of pesticides, being glyphosate the most used one (IBAMA 2009). Regarding the water contamination with pesticides, the country's monitoring is far from adequate due to the high costs for their detection and the lack of trained staff to conduct the analyses (ANA 2013). Therefore, the magnitude of the pesticides contamination in soil and water is still unknown.

The Program for Modernization of Agriculture and the Conservation of Natural Resources (MODERAGRO), provides subsidized credits to improve production systems and revitalize soil and pastures for rural farmers and cooperatives (FAPDA 2014). MODERAGRO promotes the recovery of degraded pasture, the fertilization of soils and the implementation of projects which contribute to the sustainable production of agriculture. In addition, supports investment activities in production of fruits, milk, honey, flowers, poultry, pork and aquaculture (Santana 2012). MODERAGRO provide credit at controlled interest rate to participating medium and large farmers (Santana 2012). The implementation of MODERAGRO program has contributed to a significant expansion of farmers´ investment in irrigation, as well as sustainable output expansion of the agricultural products (Santana 2012). However, financing the acquisition, transport and application of agricultural products to correct the soil, it gives incentive to an increasing use of synthetic fertilizers.

After a long debate and pressure from the civil society, the production and commercialization of organic products were approved in 2003 (Law No 10.831), but its regulation was done only in 2007 (Decree Nº 6.323). The Agriculture and Livestock Plan 2008-2009 merged the Prolapec and MODERAGRO (items related to conservation) programs into a new credit line named Agricultural Sustainable Production (Produsa) which included the financing for organic farms systems implementation and certification (MAPA 2008). However, public policies were still weak. The turning point was a women-led demonstration organized by agricultural labor unions called "Marcha das Margaridas" in 2011, which few claims were attended starting the process towards the Agroecology and Organic Production National Policy approved in 2012 (CIAPO 2016). Through this policy was created the National Plan of Agroecology and Organic Production (Planapo) which the main objectives are to strengthen the organic and agroecological production and disseminate knowledge on sustainable use of natural resources. In the first phase of the plan (2013-2015), many difficulties were identified such as the availability and access to phytosanitary products adequate to these systems (MDA 2016), and lack of technical and policy normative. Additionally, the plan was not successful in implementing two main policies. Either the Pesticides Use Reduction Program, finalized in 2014 after a long participatory process, and the reevaluation of permitted pesticides were not implemented. However, with the pressure of institutions and civil society, a new bill creating the National Policy on Pesticides Reduction (Bill No 6670/16) are currently being discussed and the second phase of the program still aim to officialize the program developed (MDA 2016). Regarding the evaluation of the first phase implementation, from R$ 2.5 billion made available through PRONAF credit line, only 2.5% (R$ 63,1 million) were executed in 1.973 contracts mainly in the southern region, and through the ABC Program credit line from the total amount of R$ 4.5 billion, only 0,2% (R$ 9,2 million) were directed to organic and agroecology production (CIAPO 2016). The result was interpreted as lack of expertise in the area by the financial and technical actors who proposed the amounts for credit and lack of awareness by the farmers to this specific program (CIAPO 2016). On the other hand, the financing for cooperatives and networks of agroecology, organic production and extractivism, through the Ecoforte program, was successful in supporting 28 projects (from 167 submitted) with estimated more than 20.700 families involved and the number of organic production units under a program of quality control slightly rose from 12.160 in 2013 to 13.916 in 2015, even though the target was to achieve 28.000 units (CIAPO 2016).

In the current second phase (2016-2019), Planapo officially included extractivism to the supported systems supported and integrated the actions already been developed under the National Plan for Socio-biodiversity Products Chains Promotion (PNPCPS) created, in 2009, with the aim to support traditional communities with the conservation and use of biodiversity through sustainable extractivism systems (MDA 2016). This policy explicitly relates the extractivism activity made by traditional communities to biodiversity protection.

Yet, the main support for smallholder farmers is through the National Program for the Strengthening of Family Agriculture (PRONAF) which provide subsidized credit and technical assistance. The program has enhanced the investment of small farm households in agriculture, increase food production and expand income of rural households as the interest rate was 2.5% in 2010 (Santana 2012). Farmers able to meet the credit criteria set were 4.2 million and each year farmers can get up to BRL 130,000 (USD 73600) of investment credit and BRL 50,000 (USD 28,000) working capital per crop (Santana 2012). The Guarantee Program of Agricultural Activities PROAGRO was set up for the protection of farmers' investment against weather adversities and outbreaks of pests, weeds and diseases for various crops and to operate the Rural Insurance Premium Subvention Program (PSR) in order to provide increased protection to farmers' investment in agriculture (Santana 2012). The Government pays part of the rural insurance premium to farmers and in 2008 amount of R$ 13 billion credit had been given to farmers (Santana 2012).

4.3.1. Quantitative assessment

It is clear the effect of the Decree Nº 6.323/2007 (Brasil 2007) on the sharp decrease of organic farming land (Fig. 7) since this normative stipulated the deadline of 31 December 2010 for the registration of organic farms. The possible reasons for the organic area had been low since then could be the slow process of certification, lack of interest from the farmers, or even most of the previous farms qualified as organics have not attended the requirements defined by the government.

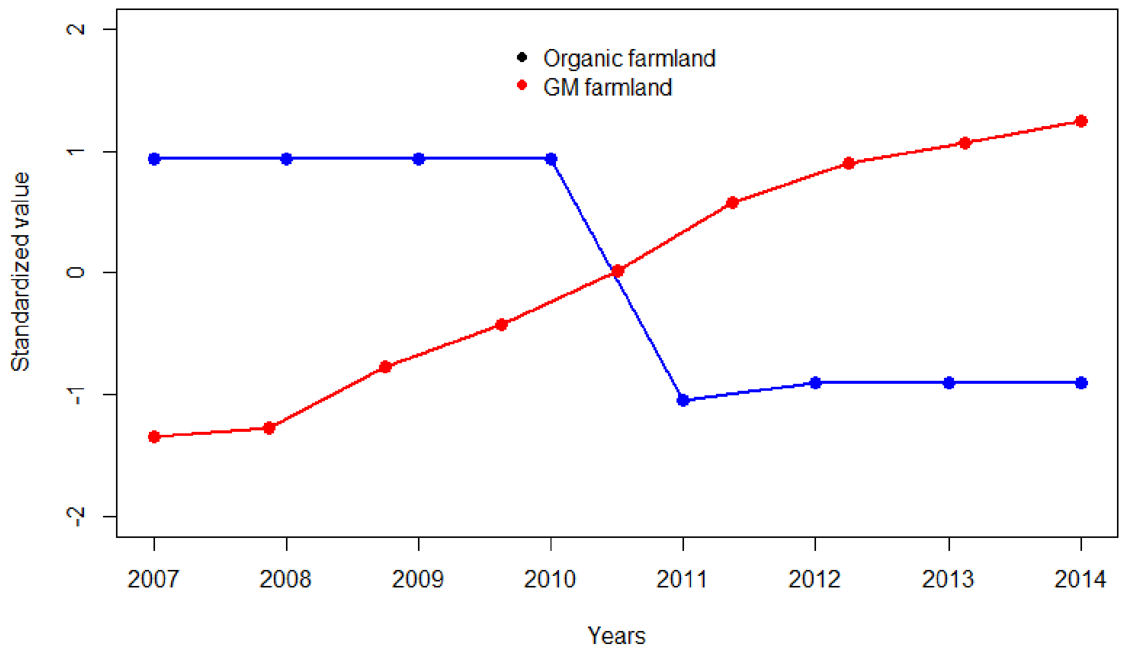


Fig. 7 : Organic farming area versus genetically modified (GM) farming area trend.

However, pesticides and fertilizers have not responded to these policies. Data visualization over the years showed that the adoption of less harmful policies were not really effective on the ground and none of the policies described could directly explain the decline in the year 2013 (Fig 8).

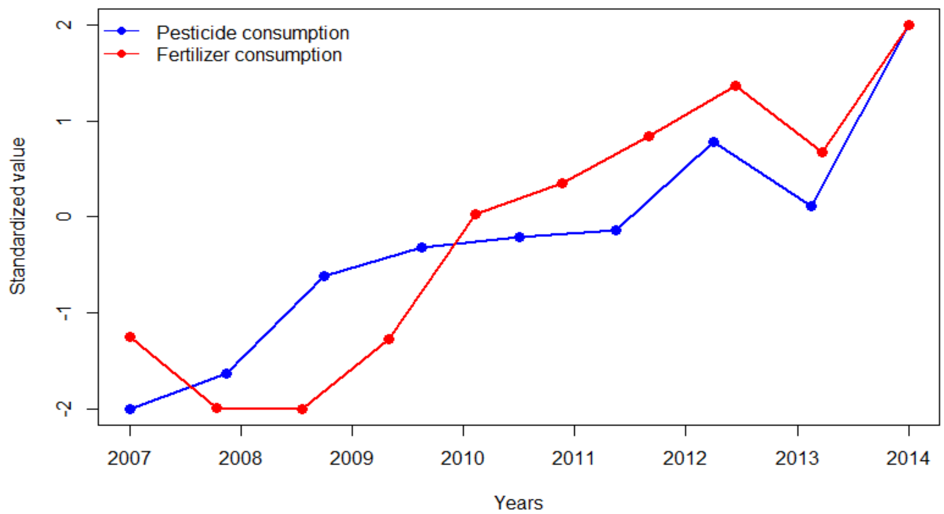


Fig. 8: Consumption of fertilizers and pesticides over the time

4.2. Genetic diversity loss

The Agroenergy Plan present the Brazilian biodiversity as an advantage in terms of variety of plants that could be used for agroenergy production (MAPA 2006). In the case of biodiesel from vegetable oils, the plan mentions the possibility of production from different sources such as soy, palm oil (dendê), sunflower or castor bean, depending on the regional potentialities. However, it recognizes that, from the current available crops, soybeans corresponds to 90% of the national vegetal oil production, instead of coconut and dendê being far more productive (MAPA 2006). The plan fails in not exploring further these alternatives.

Another field of action of the National Plan of Agroecology and Organic Production (Planapo) is to support the elaboration of public policies that strengthen the conservation of agrobiodiversity genetic resources, through the multiplication, distribution, and access by farmers and traditional communities to indigenous (crioulas), organic and varieties seeds. In the first phase, it supported about 700 communitarian seed banks, involving about 12.000 farmers (MDA 2016).

Based on the Agroecology and Organic National Policy, in 2015 the government sanctioned the Seeds and Seedlings Program for Familiar Agriculture (PNSMAF) (Interministry Decree Nº 1, 21 December 2015) aiming at extending the access of small farmers to seeds and seedling of quality and adapted to the local environment strengthen agroecology and organic systems and agrobiodiversity conservation. The program has a strong focus on the maintenance, multiplication and enrichment of local cultivars and native seeds and plants, contributing positively to genetic biodiversity. Unfortunately, the program is just starting to be implemented this year, being the first partnership with Bahia state (http://www.mda.gov.br/sitemda/noticias/programa-de-sementes-e-mudas-fortalece-agricultura-familiar).

However, the area of genetically modified crops continued to increase over the ten years timeframe (Fig. 7), meaning that the adoption of traditional cultivars by small-scale farmers did not halt the expansion of GMO, represented mainly by soybeans varieties.

5. DISCUSSION

5.1. Policies problems and challenges

One positive aspect is that the Brazilian agricultural sector has started to include biodiversity conservation concerns into policies. The effects are still not significant in the total numbers of the country but, in relation to the expansion of agricultural and pasture areas, some progress seems to be happening. Also, some policies may have a better efficiency in specific regions but the results are not detectable at the national level.

Unfortunateky, policies which present potentially benefits to biodiversity conservation suffer from inadequate farmers' engagement, and limited scale focusing mainly on smallholder farmers, who own a small share of agricultural lands in Brazil. For instance, in the case of conversion of land, targeting mainly small scale farmers in the adoption of sustainable practices probably will not provide significant results as the main proportion of deforestation is linked to large scale farmers (Fearnside 2005).

Engaging farmers for the transition of conventional to organic or agroecological systems is not an easy task as was mentioned before in the evaluation of Planapo. However, one alternative could be changing the main focus of credit and effort from the individual farmer to cooperatives and networks of farmers. Networks offer more competitiveness and security to farmers and may be a strategy to boost the organic farming industry in Brazil.

Additionally, some contradictions in the public policies must be reviewed. On the one hand, the government encourages plans and credit programs to organic and agroecological systems, targeting the smallholder farmers. On the other hand, there are still many subsidies to pesticides, fertilizers and genetically modified seeds accessible especially to large scale farmers.

Although Brazil has restricted environmental laws to avoid deforestation, such as the Forest Code in the national level, agricultural land expansion is still driven by the advantages of agricultural products revenues in comparison to potential fines (Igari, Tambosi, and Pivello 2009). According to Hazen 2010 the Brazilian property laws encourage deforestation by providing titles to land developers through "use it or lose it" principle, incentives to agricultural development and land use regulations which are inadequately enforced. Actions for the reduction of biodiversity loss in Brazil's forest cover is to encourage tradeable carbon credits for reductions in deforestation rates and a reduction in the market demand for commodities causing amazon deforestation i.e. eating less beef (Hazen 2010).

Since the main policy for climate change (ABC) do not tackle the enteric fermentation, the largest source of GHG emissions, can be assumed that the government do not consider the reduction on the cattle stock but the possibility of an expansion using the recovered degraded areas. Therefore, the aim at reducing significantly the emissions of the agricultural sector through efforts in the improvement of agricultural practices to sequester more carbon will unlikely have successful results if not accompanied with measures to control and reduce enteric fermentation emissions.

Finally, the commitment of the government in putting the environmental-friendly agricultural policies in the center of action is far from adequate. As an example, one of the policies with the highest potential to impact positively the biodiversity conservation, the ABC plan, received only 8.8% of the rural credit budget available for 2016/2017 harvest.

Brazil's agricultural policies main components over the years has been minimum price guarantees, rural credit and agricultural insurances subsidies. agricultural land zoning, biofuel promotions and organic production policies have not received much attention, nether have sustainable and environmental aspects given a conditioned approach to fit into already existing policies (Moraes 2014).

5.2. The role of global supply chain and consumption patterns

Usually, economic recessions slow down economic activities and consequently may have a positive impact on the environment with less deforestation and pollution. This was true for Brazil in the 1987 and 1991 when domestic economic crisis were considered the reason for significant declines in Amazonian deforestation rates (Fearnside 2005). However, despite of the fact that Brazil is facing an economic crisis since 2014 (GDP decreased 26,8%, World Bank Indicators 2017), deforestation rates continue to increase (reference) as well as GHG emissions and agrochemicals use. This may lead to the acknowledgment that as a big actor in the global supply chain the agricultural sector are not crucially impacted by domestic economic variations anymore, having the international demand, especially for soybeans and beef, playing an important role (Fearnside 2005).

Being Brazil a major player in the international commodity market there is the need for policies encouraging the sustainable use of biodiversity for food production which need to be enhanced especially in Amazonia, since the Europe Union restrictions on GMO puts a pressure on this region which is the world's largest producer of non-genetically modified soy (about 6 million tons imported by EU annually) (Hazen 2010, Ngera 2014).

Other possible actions include encouragement on the trade of carbon credits for reductions in deforestation rates (Hazen 2010) and a reduction in the market demand for commodities causing deforestation i.e. eating less beef.

5.3. Limitations of current study

The study did not pretend to evaluate direct impact of policies on biodiversity loss. Usually, it is difficult to link variations on indicators directly to one policy because many factors may contribute to the outcome. Also, some policies involve impacts in the long run. Also, the availability of qualified and continuous data limits the extent to which analysis and interpretation can be done to analyze the impact of a policy.

6. CONCLUSION

Incentive policies seems to require long-term efforts and engagement to provide significant results, in contrary with punitive policies with have results in short term. However, non-punitive policies are likely more sustainable in the long run and should be implemented. Government should involve all stakeholders living or benefiting from biodiversity in planning and implementing public initiatives that foster and benefit communities around forests.

Brazil's production and productivity has increased over the last decades at the expense of the environment and biodiversity. Soil nutrient have been mined and restoring them will take time and high efforts by the government. The alternative of expanding to virgin lands that require less inputs cannot be allowed anymore. Sustainable land intensification involving soil restoration technologies are available and need efforts to be promote and scaled. Soil recovery management and intensification techniques if well adopted can benefit farmers, with an increased income, and help biodiversity conservation.

Biodiversity conservation in face of the increasing food demand is a complex issue and requires a holistic, multi-disciplinary approach in order to find sustainable solutions that benefit the people without harming our environment

7. AKNOWLEDGMENT

Authors would like to thanks tutors and seniors Dr. Daniel Callo-Concha and Dr. Lisa Freudenberger for their advice, suggestions which were really helpful.

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Supplementay Material

Table 1. Results from the content analysis. Impacts to biodiversity covered by each policy can be positive (+), null (0) or negative (-). * relate to 2010 National Biodiversity Targets.

		Impacts to biodiversity					
Name of the policy/program	**Main aspects of the policy**	**Conversion of natural habitats**	**Intensification of management**	**Climate change**	**Genetic diversity**	**Explicit biodiversity conservation**	**Biodiversity National Target**
Agroenergy Plan	Production of energy from biomass and animal sources	-	-	+	0	No	3.11*
Program for Fostering Sustainable Farming (PRODUSA)	Support to sound practices and organic farming	0	+	0	0	No	2.14*
Program for Commercial Planting and Recovering of Forests (PROPFLORA)	Forest plantations, restoration of preserved areas	+	0	+	-	No	4.1*
Modernization Program of the National Fleet of Tractors, Combines and Farm Machinery (MODERFROTA)	Improve productivity through agricultural machinery efficiency	0	-	0	0	No	No
Program for the Modernization of Agriculture and the Conservation of Natural Resources (MODERAGRO II)	Incentive to fertilizers use for soil recovery	+	-	0	0	No	No
Program for Irrigation and Production Stock (MODERINFRA)	Incentives for irrigation systems	-	-	0	0	No	No
Agroecology and Organic Production Plan (PLANAPO)	Strengthen the organic and agroecological production	+	+	0	+	Yes	4
Sociobiodiversity Products Chains Promotion Plan (PNPCPS)	Support to extractivism activities	0	+	0	+	Yes	3.1*, 3
Low Carbon Agriculture Plan (ABC)	Adoption of sustainable production systems to decrease GHG emissions	+	+	+	0	Yes	7
Seeds and seedlings Program for Familiar Agriculture (PNSMAF)	Access of small farmers to seeds and seedling of quality and adapted to the local environment	0	0	0	+	Yes	13

Main Agricultural policies and strategies related to biodiversity since 2007