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# Agribusiness Opportunity Costs and Environmental Legal Protection: Investigating Trade-Off on Hotspot Preservation in the State of São Paulo, Brazil

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**Abstract** Prior to deforestation, São Paulo State had 79,000 km$^2$ covered by Cerrado (Brazilian savanna) physiognomies, but today less than 8.5% of this biodiversity hotspot remains, mostly in private lands. The global demand for agricultural goods has imposed strong pressure on natural areas, and the economic decisions of agribusiness managers are crucial to the fate of Cerrado domain remaining areas (CDRA) in Brazil. Our aim was to investigate the effectiveness of Brazilian private protected areas policy, and to propose a feasible alternative to promote CDRA protection. This article assessed the main agribusiness opportunity costs for natural areas preservation: the land use profitability and the arable land price. The CDRA percentage and the opportunity costs were estimated for 349 municipal districts of São Paulo State through secondary spatial data and profitability values of 38 main agricultural products. We found that Brazilian private protected areas policy fails to preserve CDRA, although the values of non-compliance fines were higher than average opportunity costs. The scenario with very restrictive laws on private protected areas and historical high interest rates allowed us to conceive a feasible cross compliance proposal to improve environmental and agricultural policies.

**Keywords** Agricultural opportunity costs · Cerrado hotspot conservation · Private protected areas policy · Cross compliance

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## Introduction

A closer look into Brazilian native vegetation draws our attention to the Cerrado, a biome even more threatened than the Amazon Rainforest (Ratter and others 1997). The Cerrado is the world's most biodiverse savanna, with high degree of endemism and very high rate of environmental loss, thus regarded as a biodiversity hotspot (Myers and others 2000). It is the second largest biome in Brazil, and is enduring a rapid land conversion to economic use. Cerrado physiognomies covered more than 2 million km$^2$ in Brazil, and today less than 45% of the original area remains (Klink and Machado 2005). The main reasons to this massive land conversion are the lack of specific legal protection to this biome (in comparison with other biomes, such as the Amazon Rainforest and the Atlantic Forest) and the development of agricultural technologies, which made possible to increase crop productivity in the harsh Cerrado soils (Ratter and others 1997; Klink and Machado 2005).

Land conversion in the Cerrado began in the southeastern states of Brazil, where almost all natural areas have been converted into planted pastures or crops. According to the Brazilian map of biomes (MMA/IBGE 2004), the Cerrado physiognomies covered 32% of São Paulo State (about 79,000 km$^2$), an area equivalent to almost twice the area of the Netherlands. According to Metzger and Rodriges (2008), São Paulo State currently has less than 8.5% of its original Cerrado area, which is today scattered in few and small patches, and less than 6.5% of the remaining patches are protected as natural reserves. Therefore, the major portion of the remaining patches lays in private properties, subjected to landowners' decisions.

São Paulo State represents less than 3% of the Brazilian territory, but accounts for more than one third of the national gross domestic product (GDP), and more than 21% of the

country's population (IBGE 2007a, b). The state also presents a wealthy agribusiness, as the country's major biofuel producer from sugarcane, and the largest wood producer for the paper industry, while cattle ranching accounts for more than 10 million animals (IBGE 2006a, b, c).

The global demand for agricultural goods (food, fiber and biofuel) is increasing the pressure on natural areas in developing countries (Balmford and others 2005) and, in Brazil, the trade-off between agricultural expansion and the preservation of private natural areas is driven by the balance between agribusiness revenues and the non-compliance fines imposed by environmental laws.

Brazil presents very restrictive environmental laws, and the main law for the preservation of private natural areas is the Forest Code (Federal Law 4771), passed in 1965. This law states that a certain percentage of rural properties must keep its natural cover. Such area is called Legal Reserve (LR), and must be assigned on the ownership title. The size of the LR varies from 80% of the rural property in the Legal Amazon region to 20% in other biomes (Chomtitz 2004; Young 2005; Klink and Machado 2005). The Forest Code also states that rural properties must preserve riparian forests, natural vegetation on hilltops and slopes greater than 45°, which are classified as APP (Area of Permanent Preservation), and LR size cannot include the APP (Chomtitz 2004). Therefore, rural properties in the state of São Paulo must preserve at least 20% of their total area as LR, plus areas classified as APP.

Brazilian private protected areas policy presents a "command-and-control" approach, and it relies on the "polluter pays" principle (Siebert 1998). Thus, private benefits of landholders cannot imply public welfare losses, and they have to preserve natural areas in order to provide a minimum amount of public environmental services. Therefore, landholders have to bear all opportunity costs, and non-compliance with environmental laws is punished with expensive fines (Chomtitz 2004; Young 2005). The fine for cutting down LR was established in 1999 through the Federal Decree 3179, and its value was R$1000 per hectare, about US$444 at 03/20/2009 exchange rate (FED 2009). In 2005, the Federal Decree 5523 raised the fine value to R$5000 per hectare (around US$2222). The main landholders' opportunity costs to preserve natural areas are the land use profitability and the arable land price (Ando and others 1998; Naidoo and Iwamura 2007).

In this scenario, the economic decisions of agribusiness managers are crucial to the fate of Cerrado domain remaining areas (CDRA) in São Paulo State. The aim of this study was to investigate the effectiveness of the present private protected areas policy, and to propose a feasible alternative to promote CDRA protection given the main opportunity costs for natural areas preservation in agribusiness activities: the land use profitability and the arable land price.

## Methods

São Paulo State is divided in 645 municipal districts (IBGE 2007a), and we analyzed those that had more than 10% of their area under Cerrado domain (Fig. 1), in a total of 349,

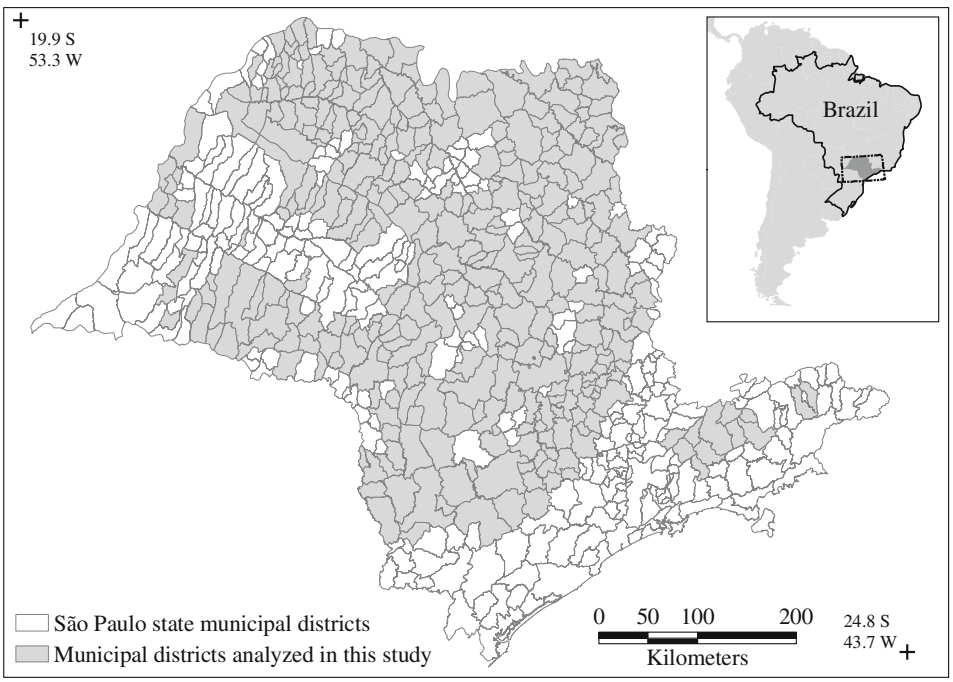


**Fig. 1** Study area showing the 349 municipal districts of São Paulo State with more than 10% of their area as Cerrado domain vegetation (*in gray*)

representing 98% (77,389 km$^2$) of the Cerrado domain area (MMA/IBGE 2004) in São Paulo. We used ArcGIS 9.2 software (ESRI 2008), to undertake the spatial analysis on the natural areas database of São Paulo State (São Paulo 2005), which is the result of a 1:50,000 land use mapping through LANDSAT-TM images from 2002. Since this natural areas database is the most recent spatial data of São Paulo remnants, we undertook all economic assessment (agricultural production, profitability, land price, interest rates and exchange rates) from 2002 data, to allow a suitable analysis. Also, we adopted the 2002 fine value for cutting down LR (R$1000 per hectare) instead of the present fine value (R$5000 per hectare). All economic values in this study were converted from Brazilian currency (reais) to US dollars using the average exchange rate of 2002 (US$1.00 = R$2.92) (FED 2009).

To determine the CDRA percentage in each municipal district of the study area, the Cerrado domain area was superposed to the remnant vegetation patches, which reflected the conservation status of Cerrado domain vegetation. Also, the amount of arable land (AL) was estimated for each municipal district by subtracting urban areas, water reservoirs, natural reserves, and natural vegetation outside reserves from the total municipal district area.

To estimate the average annual agricultural profitability per hectare in each municipal district, we assessed the area covered in 2002 by the 38 main agricultural products (avocado, banana, bean, beef cattle, carrot, coffee, cotton, cucumber, eucalyptus, garlic, grape, guava, lemon, lettuce, maize, mango, manioc, melon, onion, orange, papaya, passion fruit, peach, peanut, pine, pineapple, potato, rice, rubber, sorghum, soybean, sugarcane, sunflower, sweet pepper, tangerine, tomato, watermelon and wheat) (IEA 2002). We assessed the profitability (Agrianual 2003; Anualpec 2003) and the production (IEA 2002) of these items in the total AL for each municipal district. As annual crops usually can be harvested twice a year, the production database (IEA 2002) recorded each harvested area separately, ensuring an accurate assessment of the total agricultural profitability in each municipal district. However, this double-counting of harvested areas could overestimate the real AL. Thus, to avoid double counting, we used the amount of AL estimated from the 2002 land use map (São Paulo 2005).

The assessment of the average profit per hectare (Agrianual 2003; Anualpec 2003) took account of net revenues, variable production costs (e.g., seeds, fertilizers, labor) and management costs. To assess the average profitability per hectare of eucalyptus and pine we adopted the data from EMBRAPA, the Brazilian Agricultural Research Agency (Dossa and others 2002a, b). To estimate the annual average profit per hectare of the extensive cattle ranching activity in each municipal district, we considered the pasture area and the total meat production (revenue and weight) in each municipal district (IEA 2002) and then we assessed the average cost per unit weight in 2002 (Anualpec 2003). This change in the methods was necessary because the profitability per hectare presents wide variations according to cattle density on pastures.

Most arboreal fruits were recorded in the production database as number of plants (IEA 2002), thus we converted that information to cultivated area (hectare) applying a density factor to each crop (Agrianual 2003). The cultivation of perennial products usually requires an implementation stage, which may result in negative profitability for a given time, depending on the product. In this study we considered the average annual product profitability including all the development stages, from implementation to maturity.

Arable land prices in 2002 were surveyed in the IEA database according to the municipal district (IEA 2002). As the assessment of arable land opportunity costs depends on the interest rate, we adopted the average official Brazilian interest rate (SELIC) in 2002, which was 19.11% per year (BCB 2002a).

To explore the existence of correlation between the agricultural opportunity costs (average annual agricultural profitability and average arable land prices) and CDRA percentages, according to the municipal district, we performed a Spearman rank correlation analysis (Zar 1999). Then, we verified if CDRA percentages were in compliance with the minimum percentage of LR imposed by law (20%), and if the fine amount for non-compliance with the law (US$342 per hectare) was higher than opportunity costs. The average annual agricultural profitability was directly comparable to the fine amount, however, the fine amount had to be converted to an equivalent arable land price (EALP) to become comparable to land prices. Therefore, the fine amount (US$342 per hectare) was divided by the interest rate (19.11% per year) resulting in a minimum land value (EALP = US$1,790 per hectare) in which the non-compliance with the law would be economically attractive.

## Results

The 38 agricultural products accounted for 11.3 million hectares in 2002 (Table 1), which represented 86% of the total arable land of the study area (13.2 million hectares) estimated from the spatial database (São Paulo 2005). The total agricultural revenue and the total cost in the study area were respectively US$5.51 billion and US$4.07 billion, resulting in a total annual agricultural profit of US$1.44 billion (Table 1). Thus, the annual average profitability of the study area was US$109.00 per hectare.

The eight main agricultural products in the region accounted for 95.2% of the total cultivated area; cattle ranching (54.4%) and sugarcane crops (19.1%) combined accounted for 73.5% of the total cultivated area (Table 1). Of the eight main products, only orange showed annual profitability (US$1165 per hectare) higher than the fine amount for cutting down LR (US$342 per hectare). That high annual profitability put orange production at the top annual profitability in the study region (36.1 %), although it accounted only for 3.9% of the cultivated area. The set of 13 products included in the class "Fruits except orange" also showed average annual profitability (US$389) higher than the fine value.

Comparing the average annual profitability and the percentage of CDRA in each municipal district with the fine amount for cutting down LR (US$342 per hectare) and the minimum LR percentage imposed by law (20%), we verified that only 6 of the 349 municipal districts of the study area presented average annual profitability above the fine value (Fig. 2—quadrant A), and only 5 municipal districts (1.4%) showed CDRA percentages higher than 20% (Fig. 2—quadrant D). There were 338 municipal districts with CDRA percentages below the legal obligation and below the fine value (Fig. 2—quadrant C), and there were no municipal districts above the legal obligation and above the fine value (Fig. 2—quadrant B).

Municipal districts in quadrants A, C and D (Fig. 2) showed different land uses (Fig. 3). Orange was the main product in A, where its percentage (32.7%) was almost ten times higher than in C and D; conversely, average pasture percentage in A (13.7%) was more than three times lower than in C and D. Land use percentages in C were similar to the percentages showed in Table 1. In D, average CDRA percentage (26.5%) was more than four times higher than the average percentage in A and C, and the main land uses were pasture (45.5%), eucalyptus and pine silviculture (8.1%), coffee (5.4%) and sugarcane (6.7%), which represented less than half the average sugarcane percentage in A and C.

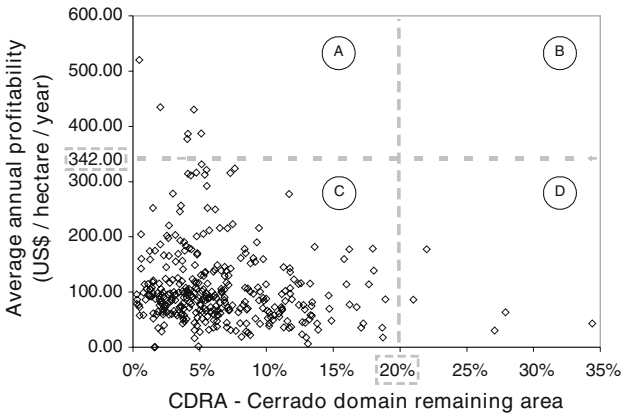


**Fig. 2** Average annual profitability of agricultural activities and percentages of Cerrado domain remaining area (CDRA) in the 349 municipal districts (*dots*) of the study area. The *dashed vertical line* represents the minimum Legal Reserve (LR) percentage imposed by law, and the *horizontal dashed line* represents the fine value for cutting down the LR. Quadrant A (n = 6 municipal districts), quadrant B (n = 0), quadrant C (n = 338), quadrant D (n = 5)

The relationship between the price of arable land and the percentage of CDRA (Fig. 4) showed 100 municipal districts with average arable land prices higher than EALP (US$1790 per hectare) in which it would be economically attractive not to comply with the law (Fig. 4—quadrants A and B). There were 246 municipal districts with CDRA percentage below the legal obligation and average arable land price below US$1,790 per hectare (Fig. 4—quadrant C). In the entire study area, average arable land price was US$1,799 (standard deviation = US$725).

Both opportunity costs analyzed, the average annual agricultural profitability ($r^2 = 0.032$; 347 d.f.; $P = 0.0008$) and the arable land price ($r^2 = 0.077$; 347 d.f.; $P = 0.0000001$) did not show significant correlation with CDRA percentages in the study area.

**Table 1** Total planted area, average annual profitability, and total annual profit of the 38 main agricultural products in the 349 municipal districts of São Paulo State with more than 10% of their area covered by Cerrado domain vegetation (study area), in 2002

| Agricultural product | Total area | | Annual profitability | Total annual profit | |
|---|---|---|---|---|---|
| | x1,000 ha | % | US$/ha/yr | x1000 US$ | % |
| Cattle ranching (on pasture) | 6157 | 54.4 | 54 | 335,328 | 23.3 |
| Sugarcane | 2158 | 19.1 | 134 | 288,903 | 20.1 |
| Maize | 787 | 7.0 | 80 | 63,188 | 4.4 |
| Eucalyptus | 494 | 4.4 | 79 | 39,160 | 2.7 |
| Soybean | 463 | 4.1 | 149 | 69,012 | 4.8 |
| Orange | 446 | 3.9 | 1165 | 519,853 | 36.1 |
| Coffee | 131 | 1.2 | −127 | −16,728 | −1.2 |
| Pine | 120 | 1.1 | 183 | 22,043 | 1.5 |
| Fruits except orange (13) | 91 | 0.8 | 389 | 35,539 | 2.5 |
| Other products (17) | 462 | 4.1 | 180 | 83,229 | 5.8 |
| Total in study area | 11,311 | 100 | | 1,439,528 | 100 |

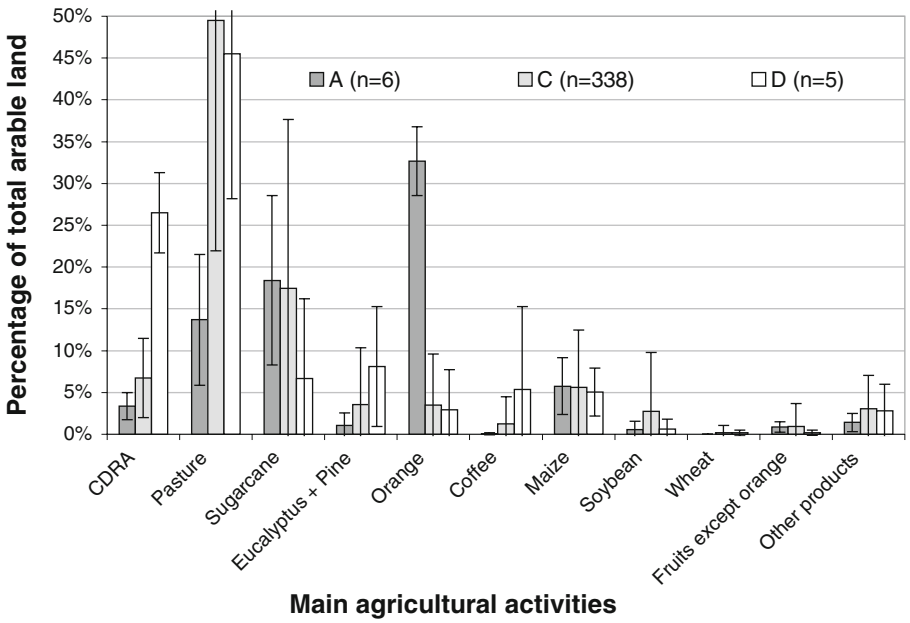


**Fig. 3** Percentages of total arable land covered by the main agricultural land uses and Cerrado domain remaining area percentage (CDRA) in the study area. A = municipal districts with less than 20% of CDRA and average annual profitability above the non-compliance fine value; C = municipal districts with less than 20% of CDRA and below the non-compliance fine value; D = municipal districts with more than 20% of CDRA and average annual profitability below the non-compliance fine value. Error lines = one standard deviation

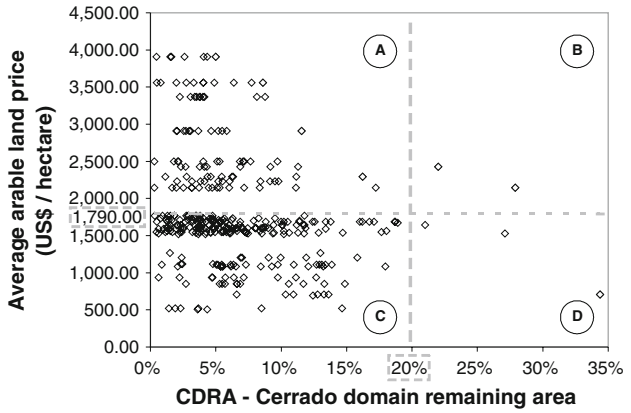


**Fig. 4** Average arable land price and percentages of Cerrado domain remaining area (CDRA) in the 349 municipal districts (*dots*) of the study area. The *dashed vertical line* represents the minimum Legal Reserve (LR) percentage imposed by law, and the *horizontal dashed line* represents the fine value converted to Equivalent Arable Land Price through the annual interest rate (EALP = US$342/19.11%). Quadrant A (n = 98 municipal districts), quadrant B (n = 2), quadrant C (n = 246), quadrant D (n = 3)

## Discussion

### Opportunity Costs and Private Protected Areas Policy

Our survey on the literature reporting agricultural opportunity costs corroborated the average annual profitability found in this study. Naidoo and Iwamura (2007) undertook a global scale study and found an average gross agricultural revenue of US$55 ± US$130 per hectare. In finer scale studies, Azzoni and Isai (1994) in Brazil, Naidoo and Adamowicz (2005) in Uganda, Kosoy and others (2007) in Nicaragua, Norton-Griffiths and Southey (1995) in Kenya, Muñoz-Piña and others (2008) in Mexico, Rasul and Thapa (2007) in Bangladesh, Yaron (2001) in Cameroon, and Olschelski and Benitez (2005) in Ecuador assessed agricultural revenues as opportunity costs for natural areas preservation and found values ranging from US$25 to US$492. The variation in agricultural revenues depends on the type of agricultural activity, the estimation method, the interest rate adopted, distance from producer to consumer centers, the country's trade characteristics, available transportation structure, and several other variables.

The agriculture in São Paulo State is strongly concentrated in a few products and the comparison between the type of agricultural land use and CDRA percentages suggest that pasture, eucalyptus, pine tree and coffee cultures can be positively correlated to higher CDRA percentages, while sugarcane production can be negatively correlated. Although there is a wide variation around average values, this is a concerning scenario, given the accelerated expansion of sugarcane crops over other land uses in São Paulo State (Camargo and others 2008).

The municipal districts where the average annual profitability is higher than the fine amount can be explained by the high proportion of orange crops, a more profitable product, and the low amount of pasture for extensive cattle ranching, which is a less profitable activity. Fruit production in general results in very high average revenues (Naidoo and Iwamura 2007). Coffee production caused economic losses due to low prices in 2002, and lowered the average annual profitability in some municipal districts where that culture was representative.

The opportunity costs presented here—the agribusiness profitability and the arable land price—show two different and excludable alternatives to agribusiness managers: they

can either plant the arable land and get the profits, or they can sell or rent the land and get revenues compatible with the interest rate. But both cases represent alternative opportunity costs to the preservation of the CDRA, and must be considered in private protected areas policy for the entire area.

Our results comparing average annual profitability and the level of Cerrado preservation in the state of São Paulo showed a high degree of law disregard, since 98.6% of the municipal districts in the study area had less than 20% of CDRA, although the average profitability value (US$109 per hectare) was quite lower than the fine amount for cutting down the LR vegetation (US$342 per hectare). Moreover in 2002 there was a fine for hindering natural vegetation regeneration (US$103 per hectare) that could be imposed annually and increased 3 times in case of recurrence. The number of municipal districts in compliance with the Forest Code may be even smaller, because the natural areas mapped as CDRA did not differentiate APP from LR, thus, some of the natural areas accounted as LR may actually be APP, which are protected independently.

The average arable land price in the study area was US$1799 per hectare, and if we apply the interest rate (19.11%), the average annual opportunity cost for the land ownership would be US$344 per hectare, slightly above the fine amount. In this case, the fine amount would not be high enough to hinder CDRA exploitation. As the interest rate increases, more municipal districts with cheaper lands would be above the limit imposed by law and therefore would not be interested in keeping CDRA.

The situation where average annual arable land opportunity costs (US$344 per hectare) is more than three times the average annual agricultural profitability (US$109 per hectare) does not make economic sense. To understand the situation, we must take into account the following conditions:

1. the main agricultural products in the study area are commodities (meat, sugarcane, soybean, wheat, orange, coffee, paper pulp), and their prices are determined by international markets;
2. the main input prices (seeds, fertilizers, pesticides, fuel) are also internationally set;
3. thus, the profitability of the main agricultural products in the study area depends on the international economic scenario;
4. the interest rate in Brazil is the main economic policy tool to control inflation, and historically it is far above international levels (BCB 2002a).

Given these conditions, the economic viability of Brazilian agribusiness relies on the subsidized agricultural credit policy. In 2002, while the official interest rate (SELIC) was 19.11% per year, the subsidized interest rate for agricultural activities (rural credit) was 8.75% per year (BCB 2002b), less than half the SELIC rate. Thus, if we apply the subsidized interest rate to the average land value in the study area (US$1799 $\pm$ 725) the annual opportunity cost value falls to US$157 $\pm$ 63, which is compatible with the average annual profitability in the area (US$109).

The payment for environmental services (PES) schemes is not suitable to the study area due to the high opportunity costs (Wunder 2007). In developing countries, such as Mexico (Muñoz-Piña and others 2008) and Costa Rica (Barton and others 2009; Miranda and others 2006; Sierra and Russman 2006; Chomitz and others 1999), the annual values paid to landowners to set aside natural areas were around US$27 and US$42 per hectare respectively. These values are far below the average annual opportunity costs to landowners in São Paulo State. Even the average annual value paid by USDA Conservation Reserve Program (CRP) in United States, which was US$111 per hectare (USDA 2006; Baylis and others 2008), was just slightly higher than the average profitability found in this study. Only in China (Uchida and others 2005) we found a PES value reasonably higher than São Paulo State average opportunity costs, as the Chinese Grain for Green Program paid annually US$353 per hectare for land retirement. Both programs CRP and Grain for Green are too expensive and the Brazilian environmental institutions could not afford such huge expenses (Young 2005). The easier alternative would be to keep the "command-and-control" approach, and raise the fine amount, hoping that higher fine values would change landowners' behavior. And this is exactly what policy makers have recently done. In 2005 the Federal Decree 5523 (08/25/2005) raised the fine amount for cutting down the LR to R$5000 and in 2008 the Federal Decree 6686 (12/10/2008) raised the fine for hindering natural vegetation regeneration to R$5000 (around US$2222 on 03/20/2009 exchange rate, FED 2009). There is no recent comprehensive CDRA survey to assess the effectiveness of such fine increase. Giannakas and Kaplan (2005) and Ozanne and others (2001) emphasize the role of monitoring effort and landowners' sensibility to risk on environmental policy enforcement. Although the fine values were higher than landowners' opportunity costs, the lack of surveillance on environmental compliance probably hinders the achievement of conservation targets. But even if enforcement produced effective CDRA conservation, it would be socially unfair that private landowners bear the costs of conserving the majority of the remnants of a global biodiversity hotspot. This situation could be unsustainable because landowners would certainly apply all their political influence to change environmental laws, and the outcome could be even worse than the present environmental situation.

The absence of a significant correlation between agricultural opportunity costs and CDRA percentages suggests

that landowners disregard the possibility of environmental penalties in their decisions about land use. Even the municipal districts with the least profitable agricultural activities and the cheapest arable lands were not in compliance with LR minimum percentage (20%).

## Cross Compliance Proposal

Given the restrictive set of environmental laws and the historical high interest rates, Brazilian agribusiness faces two challenges: the environmental challenge, in which it faces legal environmental restrictions for land use; and the financial challenge, where high interest rates to finance its costs can endanger the agribusiness economic viability. Furthermore, enforcement of environmental laws could impose heavy financial losses through fine imposition and decrease in cultivated area (illegal cultivated areas in LR and APP). These financial losses could even increase loan insolvency, insurance prices, and consequently increase the financial costs to the entire agribusiness. However, from this double challenge, it is possible to build a feasible cross compliance scheme to conserve hotspots in Brazil.

According to Kramer and Batie (1985), cross compliance strategies had their origins in soil conservation policies during the New Deal era. Government benefits were granted in order to reduce agricultural production in areas more prone to soil erosion. The expected outcome of this policy was the increase in commodity prices and in the level of soil conservation after the crisis of 1929. Later, the environmental objectives of the cross compliance schemes gained more space, and the Sodbuster Bill of 1984 denied federal price support, crop insurance and other benefits to farmers who plow highly erodible land.

In EU, the discussion about cross compliance strategies aiming to conciliate agricultural and environmental objectives emerged in 1990s. Cross compliance strategies took place in "Agenda 2000" reform of Common Agricultural Policies (CAP) and have been implemented since 2003. Agricultural subsides were decoupled from agricultural yield and became dependent on the compliance with environmental standards (Bennett and others 2006).

Cross compliance schemes can either make agricultural benefits (direct payments, support prices, loans, tax credits) contingent to attain conservation standards ("red ticket" approach), or alternatively, the benefits of agricultural programs can increase if farmers meet or exceed conservation standards ("green-ticket" approach) (Batie and Sappington 1986). Despite national particular characteristics, most cross compliance schemes in USA and in EU adopted the "red ticket" approach (Claassen and others 2008; Baylis and others 2008; Posthumus and Morris 2008; Mosnier and others 2009; Graaff and others 2008; Herzog and others 2008; Hoag and Holloway 1991; Giannakas and Kaplan 2005). A "red ticket" cross compliance scheme is also beginning to be implemented in the Legal Amazon, to halt the deforestation produced by cattle ranching and soybean crops. The National Monetary Council, which is the institution responsible for ruling the financial market in Brazil, enacted a norm (National Monetary Council norm 3545, 02/28/2008) that demands some environmental compliance requirements in order to grant agricultural loans in Amazon biome.

However, "red ticket" cross compliance schemes can become unattractive to landowners in Brazil because the two challenges (environmental and financial) would be merged in one even larger challenge, since environmental compliance could become another restriction to attain subsidized loans. Thus a massive landowner support to this type of cross compliance scheme would not be expected (Young 2005).

A "green ticket" cross compliance approach would have much better acceptance, given the unattended demand for cheaper agricultural credit. The results showed that the total costs for agricultural production were US$4.07 billion, while according to the annual report of agricultural subsidized credit program (BCB 2002b), the municipal districts in the study area received US$852 million in agricultural loans. This is slightly more than 20% of the total agricultural costs in the study area, therefore almost 80% of the agricultural costs were being borne by farmers, either by self-financing capacity, or by taking loans at market-set interest rates. Even in the self-financing alternative, when farmers do not have to effectively pay a high interest rate, there are financial losses given the opportunity costs of their own assets (e.g. agricultural land, cash).

Our proposition to build a "win-win" cross compliance scheme is to introduce foreign environmental financial sources (e.g., World Bank or international NGOs) to increase the level of subsidized loans to landowners who are in compliance with environmental targets. The scheme would be attractive to foreign environmental financial sources because even the subsidized interest rates in Brazil are very competitive compared to the interest rates in developed countries (FOREX 2009). Furthermore, these would be short-term loans, if compared to other environmental projects. Landowners would benefit from a higher availability of subsidized resources to make new investments, which could increase the productivity and profitability, even in compliance with environmental laws. And if there would be compliance with Brazilian restrictive set of environmental laws, a significant portion of the Cerrado hotspot and other important biomes would be conserved in private lands. Thus, this cross compliance environmental scheme would induce a more efficient and greener economy (Altman 2001).

However, it is not possible to foreign institutions to lend money directly to Brazilian farmers. The financial operation has to be done through public or private Brazilian banks. There are already two examples of Brazilian private banks (Banco Real and Unibanco) financing environmentally friendly initiatives. Banco Real is a local branch of ABN Amro Bank (recently acquired by Santander Bank), and is a founder-member of the Equator Principles (www.equator-principles.com). These principles aim to assess the social and environmental impacts of the activities to be financed. Banco Real have incorporated the Equator Principles in its risk analysis, and have also achieved in late 2007 a US$200 million credit line from IFC (International Finance Corporation, the financial branch of World Bank Group—www.ifc.org) to finance sustainability-oriented business activities.

Unibanco is a locally controlled private bank of Brazil, which has recently joined its operations to Itaú Bank and became the largest Brazilian private bank and one of the largest banks of America. Unibanco and Itaú have also adopted the Equator Principles, and Unibanco was the first locally controlled bank in Brazil to obtain, in June 2008, a sustainability credit line from IFC. The total credit line is US$200 million, and US$75 million are already available to finance sustainable projects.

Other important public and private banks operating in Brazil have also adopted the Equator Principles, such as Bradesco, Banco do Brasil, HSBC, and could also sign sustainability credit lines with IFC. Thus, this could be a feasible way to implement cross-compliance schemes in Brazil. However, the Equator Principles were intended to assess projects larger than US$10 million, and most agricultural loans in Brazil are much smaller than this value (BCB 2002b). Furthermore, several financial institutions are being accused of using the Equator Principles to "green-wash" their operations in developing countries (Scholtens and Dam 2007).

Banco do Brasil is a federal bank that has adopted the Equator Principles, and is the most important institution for agricultural financing in Brazil. Although 55% of the subsidized agricultural financing in 2002 came from public federal banks (BCB 2002b), this study showed a negligible level of compliance with legal environmental standards in the study area. This may represent a lack of integration between agricultural and environmental public policies concerning the environmental criteria to grant subsidized loans.

The success of the cross-compliance proposal depends on financing institutions truly committed to sustainability, as well as on land use monitoring effectiveness. Monitoring efforts are crucial to cross compliance schemes, but can increase significantly transaction costs (Giannakas and Kaplan 2005). However, as the compliance with LR and APP requirements demands mainly land cover monitoring, remote sensing technologies may help to increase the effectiveness and decrease the costs of compliance monitoring. Furthermore, INPE (Brazilian National Institute of Space Research) has developed high-resolution satellite images free of charge (CBERS-2B), and also an open access GIS software (Camara and others 1996). These remote sensing tools and the growing number of specialized technicians able to undertake remote sensing imagery classification can make the overall monitoring costs become much more feasible.

It is very important to note that the most important agricultural products in the study area (Table 1) are usually part of a broader and integrated supply chain (beef, biofuel mills, pulp and paper, orange juice, food industry), and are usually self-financing activities. Thus, those activities are less prone to be influenced by subsidized credit opportunities. But the achievement of cross compliance benefits may mean more than a direct financial benefit, it may be regarded as an environmental performance indicator. This indicator can be recognized by stakeholders and stockholders as a useful assessment of the environmental liabilities and risks in the organization's supply chain. Thus, cross compliance subsidized credit may bring a double benefit to the organization, and environmental compliance may be seen as an opportunity instead of a threat to the agribusiness strategy (Porter and Linde 1995).

Bunge and Votorantim Pulp and Paper (VCP) may be cited as examples of organizations with highly integrated supply chains, and which have great influence on their suppliers' environmental behavior. VCP is one of the largest enterprises in the Brazilian pulp and paper industry, and has a program called "Poupança Florestal" (Forest Savings) in which the enterprise gives some incentives to small landowners to become eucalyptus suppliers, but keeping the traditional agricultural activities and also complying with environmental standards. The program also has financial support from Banco Real, and public banks, which grant subsidized credit (www.vcp.com.br). This improvement in stakeholder relationship is also reflected in stockholder evaluation, thus VCP was included in the Dow Jones Sustainability Index and the ISE-Bovespa (Enterprise Sustainability Index of São Paulo Stock Market—www.bovespa.com.br).

Bunge is an international enterprise operating in Brazil since 1905, and is another good example of a company influencing the behavior of its integrated supply chain. The enterprise is part of the Amazon Soy Moratorium, an agreement between traders, NGOs and recently the Government, which agreed not to buy soybeans from newly deforested areas in the Amazon biome since 2006. Bunge produces food goods to the final consumer and also produces fertilizers. Thus, Bunge suppliers of grains are committed by contract to comply with labor and

environmental obligations, and in case of violation of these obligations, suppliers have their fertilizers purchasing and supply agreements rescinded (www.bunge.com.br).

VCP and Bunge are examples of positive environmental influence on their supply chain, and present alternative approaches of cross compliance schemes, offering other benefits rather than subsidized credit to foster environmental legal compliance in Brazil. However there are many more examples of environmental disregard, as showed in this study, and there is much work to be done to integrate and conciliate agricultural and environmental aims in Brazil.

## Conclusions

Despite the existence of very restrictive environmental laws and expensive fines in Brazil, the environmental "command-and-control" policy fails to conserve the CDRA. The opportunity costs for CDRA preservation in São Paulo State intensive agricultural lands are very high, and compatible with other opportunity costs in similar conditions around the world. The high opportunity costs in the study area hinder the feasibility of PES schemes. However the scenario with very restrictive environmental laws and historical high interest rates allowed us to conceive a "win-win" cross compliance proposal in which the agricultural subsidized loans become conditional to environmental legal compliance. Thus, the proposed cross compliance scheme could improve and better integrate environmental and agricultural policies.

Curiously, we proposed a cross compliance scheme in a global economic conjuncture similar to that in which it first emerged after the 1929 crisis. We can see the origin of the present global economic crisis, in a very simplistic assessment, as a series of mistakes in financial risk evaluation. If we continue to neglect environmental risks in loan granting to economic activities, this can lead to an even more serious crisis, which would compromise not only the economy, but also the planet's carrying capacity. Obviously cross compliance schemes do not answer all the questions about the paths to environmental conservation, but we are sure that environmental cross compliance policies can be a useful tool to conserve important Brazilian biomes.

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