POLICY BRIEF

THE NEXT STEP TOWARDS CLIMATE CHANGE MITIGATION: IMPROVING PRODUCTIVITY OF BRAZIL S AGRICULTURAL LANDS

HISTORY REVEALS THAT MODERNIZATION OF AGRICULTURE IS COMPATIBLE WITH PROTECTION OF FORESTS IN THE COUNTRY

On November 4, 2016, after decades of global negotiation and planning, the historic Paris Climate Change Agreement entered into effect. This unprecedented, international effort galvanizes 191 nations, including Brazil, who signed the accord to cut carbon emissions within ten years. Already, Brazil has deepened its commitment by ratifying the agreement at the national level. Now, as each country faces the challenge of meeting their reduction goals, Brazil needs to employ strategies to comply with its obligations and meet its targets.

Given its abundant biodiversity and the sweeping scale of the Amazon rainforest, Brazil plays a critical role as steward to vast natural resources. The nation s success in slowing deforestation and emissions in the last decade through stronger enforcement and the passage of the 2012 Forest Code bode well for its ability to meet its conservation demands. However, the recent increase in deforestation shows that this challenge remains.[1]

As a leading world agricultural producer, Brazil has benefited greatly from its plentiful and verdant land. However, INPUT researchers at Climate Policy Initiative (CPI)/ PUC-Rio show that the nation does not use its cleared lands to their fullest potential. This creates an opportunity for agriculture to expand without compromising environmental protection. Much of Brazil s agricultural output centers in relatively small proportion of land 18% of the country's farmland accounted for 63% of its overall production in 2006.[2] A substantial part of cleared land is underused, mainly for cattle grazing, which is one of agriculture s least productive activities.

This inefficient use of agricultural and cleared lands has created a situation in which Brazil does not necessarily face a trade-off between increasing agricultural production and deforestation. By transitioning these lands to crop production and improving cattle grazing efficiency on existing lands, Brazil can accelerate its growth without making an additional environmental compromise. Since the 1970s, the nation has experienced a transition from land intensive farming practices to those which are more technologically efficient. This transition has helped slow deforestation by allowing producers to do more on their existing land.

1 Recent data from Brazil's National Institute for Space Research (INPE) indicate that deforestation in the Brazilian Amazon forest in 2016 increased by 29 percent from the previous year.

2 Data from Brazil's latest Agriculture Census (2006).

This brief outlines the new evidence from CPI/ PUC-Rio research that shows major transformations in agriculture have promoted yield gains, without increasing new forest clearings. The studies provide four examples in which this is the case the soybean revolution in the Cerrado, the expansion of electricity in rural areas, a recent surge of sugarcane, and a change in the relative crop-to-beef prices.

The studies depict encouraging signs that profound gains in agricultural production that do not compromise environmental protection are within the nation s reach. In fact, in all four areas where productivity increased, deforestation fell. Thus, through continued innovation and improvement of policies, Brazil can continue to simultaneously strengthen its economy and environment.

HISTORY REVEALS WHY BRAZIL CAN INCREASE AGRICULTURAL PRODUCTION AND ALSO PROTECT FORESTS

Since the colonial period, Brazil s abundance of land has driven its agricultural and natural resource policies, institutions, and technological choices. This has resulted in an agricultural sector where incentives are largely misaligned on a widespread scale, and land is not matched to its most productive purposes.

In the early stages of Brazil s agrarian economy, rentier landowners succeeded largely based on their access to slave labor to farm large tracts of land. The availability of slaves fostered the expansion of a slash-and-burn agriculture, expanding the land dedicated to farming, but without creating incentives for yield gains or increasing labor productivity. This considerably distorted the use of the land.

Since the beginning, cattle raising has also been an important component of the territorial occupation process. Besides food, cattle provided means to overcome the lack of transport infrastructure or to establish entitlement in cases in which property rights were based upon effective use of land.

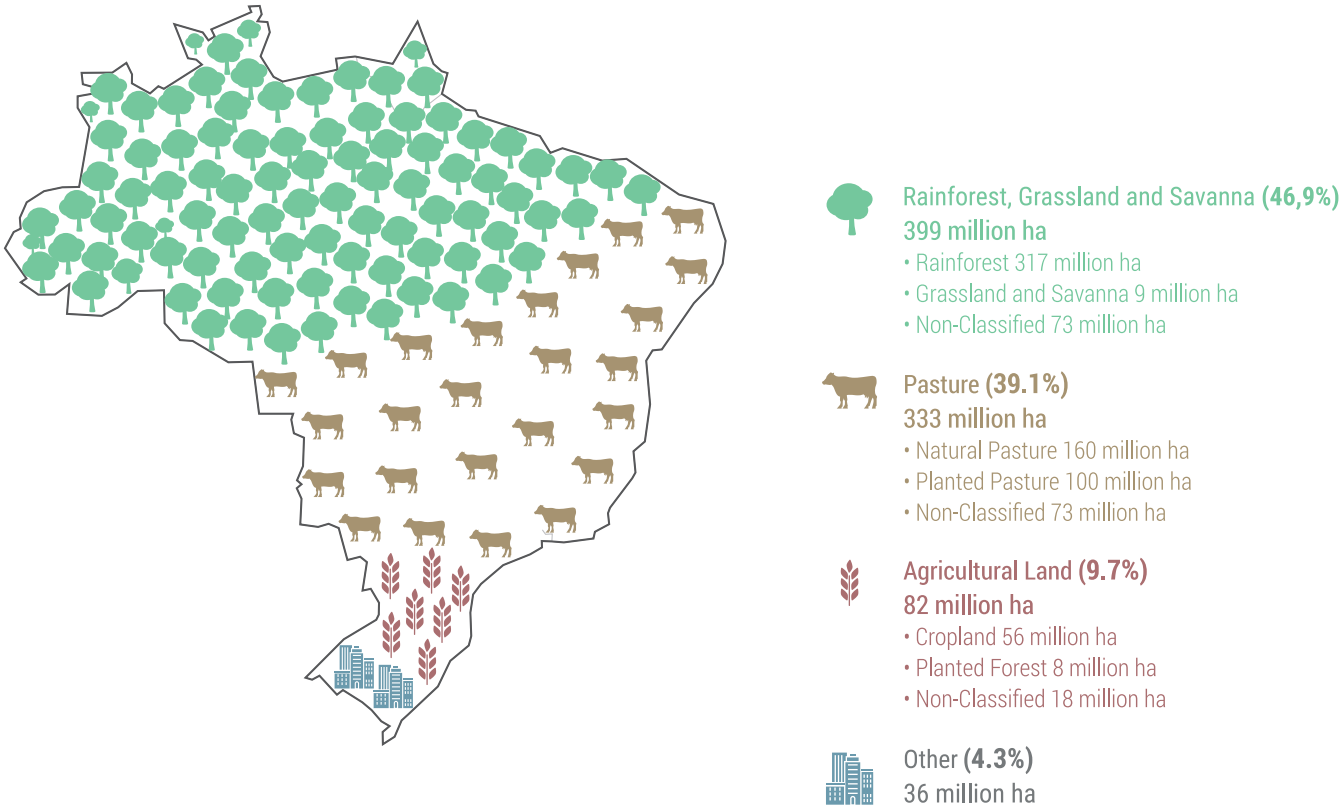
In addition to the inefficient use of agricultural lands and their low productivity, non-agricultural incentives for holding land or keeping it unproductive have emerged, such as the purchase of land for the sole purpose of avoiding or minimizing taxes or as an investment to protect against political or macroeconomic changes. This has further skewed the landscape and agricultural sector.

Today, the area occupied by native vegetation represents almost half of the Brazilian territory. From the remaining area, more than 70% serve as pastures (Figure 1). Pastures, which are mainly used to raise cattle, yield as few as a single head per hectare on average and are a relatively unproductive use of land.

This trend of inefficient land use is not isolated. Throughout Brazil, levels of agricultural production vary substantially, which suggests pervasive and substantial shortcomings in production and practices. This variation persists even in areas with similar geographical characteristics where it might be expected that growing conditions and resources would produce similar results.

CPI/ PUC-Rio researchers examined four cases of productivity increases and their implications for land use. These studies provide new evidence that yield gains promoted an expansion of cropland on pastures rather than on forests.

Figure 1: Land Use in Brazil



Climate Policy Initiative Calculation

Source: Mudan as na Cobertura e Uso da Terra do Brasil. *IBGE, 2016*

Note 1: *The Non-classified category refers to data obtained from IBGE s Miscellaneous categories (which include: Miscellaneous cropland with forest remnants; Miscellaneous rainforest with agricultural activity; and Miscellaneous cropland with grassland remnants). For each category, IBGE established a percentage level. CPI researchers then redistributed each of the categories between native vegetation, pasture and agriculture considering the midpoint of intervals and the national averages of the remnant categories).*

Note 2: *The Other category includes Artificial area , Continental water bodies , Coastal water bodies , and Barren land , according to the IBGE classification.*

FOUR STUDIES PROVIDE EVIDENCE OF BRAZILS POTENTIAL TO REACH ZERO DEFORESTATION WHILE IMPROVING PRODUCTIVITY OF AGRICULTURAL LANDS

To understand the potential of Brazil s agricultural sector to improve its productivity, CPI/ PUC-Rio researchers examined four separate drivers of productivity: uptake of an adapted type of soybean; agricultural access to electricity; expansion of the sugarcane industry; and a hike in crop-to-beef prices. They discovered, in each case, that boosts in technological innovation led to changes in land use patterns that improved productivity. Moreover, the four studies show that modern agricultural practices have helped to reduce the pressures on deforestation. These findings illustrate that it is possible to shift Brazil's land use at scale based on technological innovation and dissemination, private investment, and improved policies.

STUDY 1

ADAPTING SOYBEANS TO THE BRAZILIAN CERRADO RAISES PRODUCTIVITY[3]

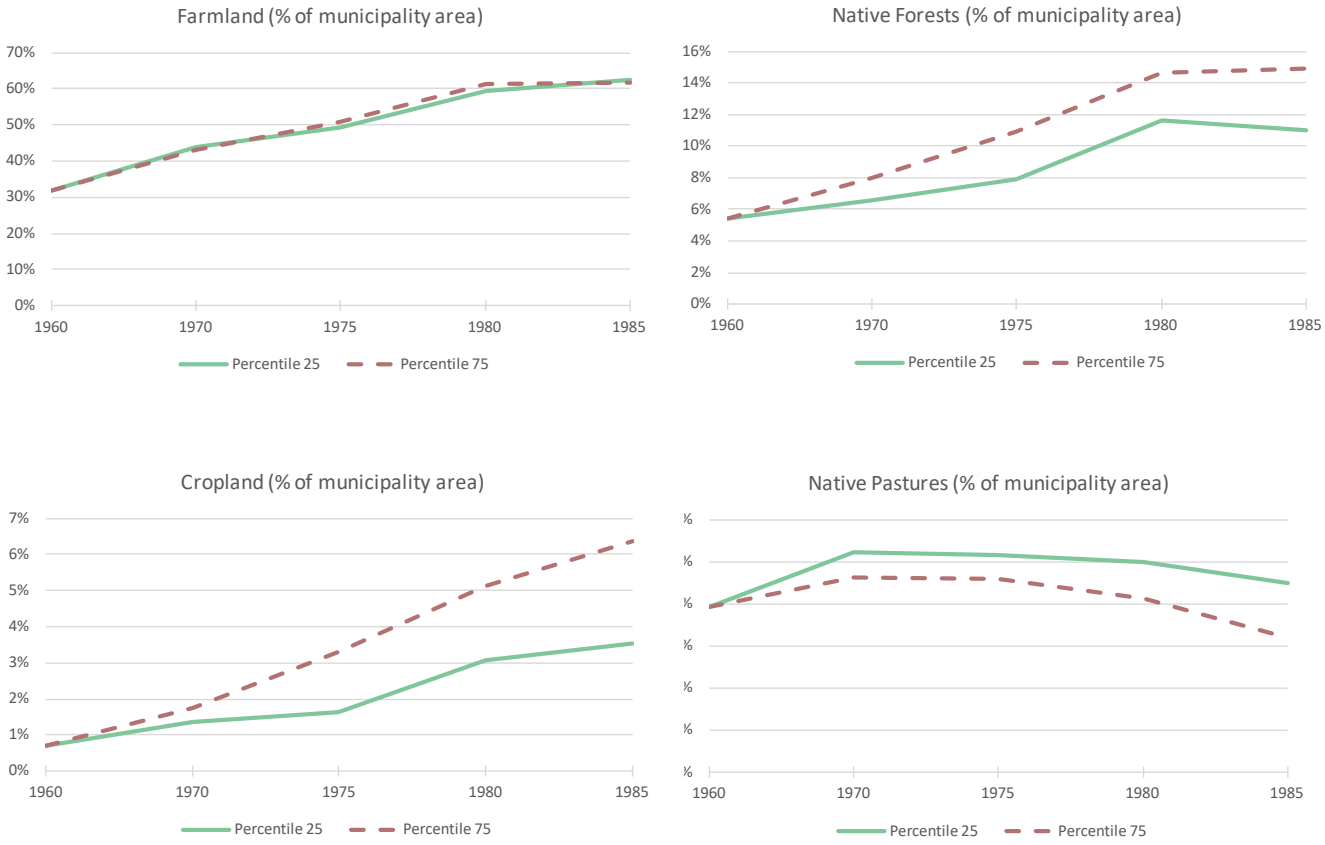
A first CPI/ PUC-Rio study investigated the impact of innovations that adapted soybeans and allowed its cultivation to thrive in Central Brazil. During the 1970s, research and design efforts introduced soybean cultivation throughout the Brazilian Cerrado. The adaptation of soy to suit Central Brazil s growing conditions represented a major technological change, and it reshaped agriculture in the region. CPI/ PUC-Rio s researchers compared results for municipalities with high and low potential for soybean cultivation to be able to distinguish the effect of this particular innovation from the expansion of the agriculture frontier that was happening all over Central Brazil.

The results show that these technological innovations created not only economic but also environmental benefits. After the introduction of the adapted soybean, a major shift in land use toward soybean cultivation occurred, with an expansion in total cropland. However, this expansion happened mostly through a substitution of native pastures (Figure 2). As the rise in cropland was smaller than the decline in native pastures, deforestation increased less in municipalities more suitable for soybean cultivation.

Increases in fertilizer adoption and tractor use accompanied the changes in land use, suggesting that the technological innovations introduced led to a substitution from investments in forest clearing for investments in more modern methods of production. The economic benefits associated with the technological innovations were also relevant and were reflected in higher farm and land values.

3 Assunção, J., Bragança, A. (2015). Does Technological Change in Agriculture Increase Deforestation? (Working Paper). http://www.inputbrasil.org/wp-content/uploads/2015/08/Technological_Change_and_Deforestation_Working_Paper_CPI.pdf.

Figure 2: Simulated Changes in Soybean Cultivation and Production



STUDY 2

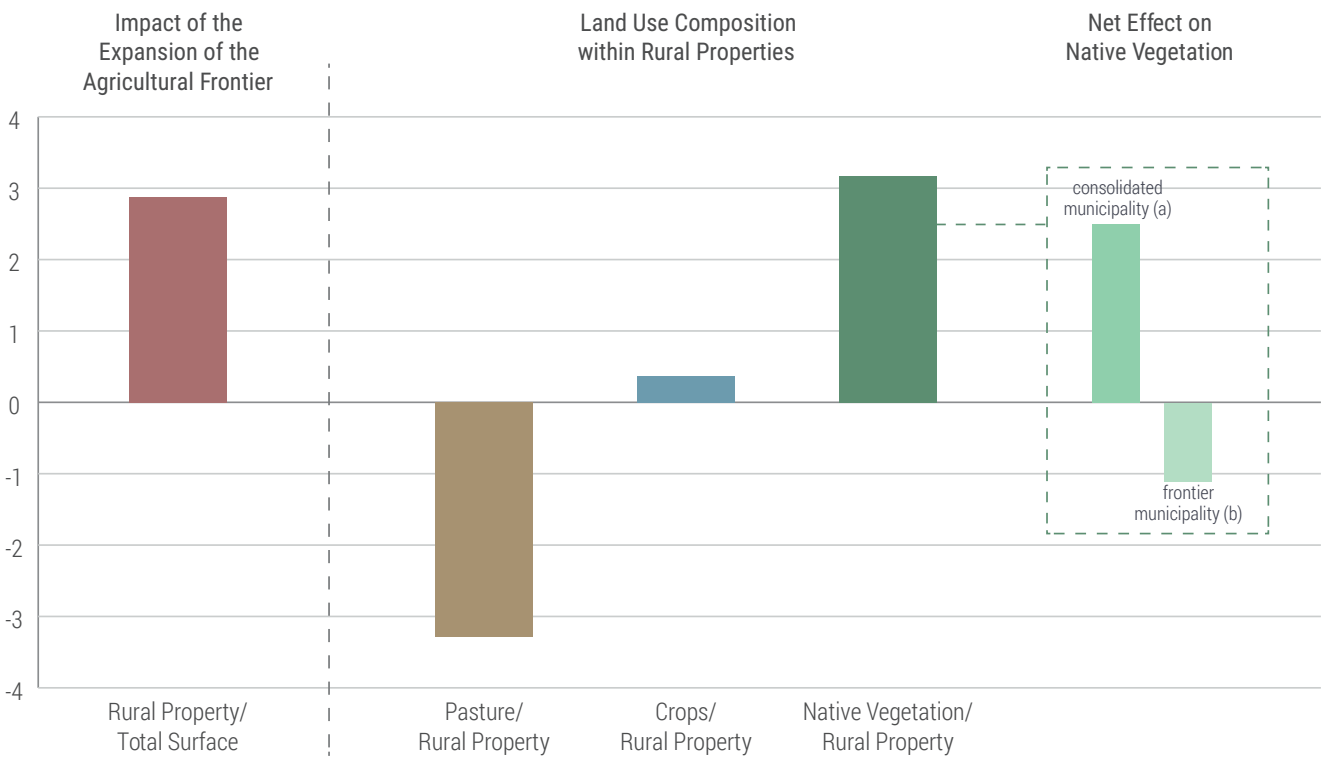
EXPANSION OF ACCESS TO ELECTRIC POWER BOOSTS PRODUCTIVITY IN RURAL BRAZIL[4]

Between 1960 and 2000, Brazil expanded access to electric power throughout large parts of its rural areas. CPI/ PUC-Rio researchers used this expansion, which naturally brought improved technologies to farms, as a means for understanding how improved productivity affects land use decisions. They found that the arrival of electric power in a county induced farmers to shift away from cattle grazing toward crop cultivation. A ten percent increase in access to electric power led to a 3-percentage point decrease in land dedicated to cattle grazing (Figure 3). It seems this shift occurred because the electricity improved crop productivity but did not increase the productivity of raising cattle. Therefore, the farmers shifted toward growing crops, the more productive activity.

4 Assunção, J., Lipscomb, M., Mobarak, A.M., Szerman, D. (2016). Electrification, Agricultural Productivity and Deforestation in Brazil (Working Paper) http://www.inputbrasil.org/publicacoes/eletrificacao-produtividade-agricola-e-desmatamento-no-brazil.

These farmers who intensified their crop production were also more likely to retain native vegetation, the study showed. Raising crops is capital intensive, requiring large investments, and this limited the ability of farmers to immediately shift all the land that they previously used for cattle to grow crops. Moreover, the study showed that farmers changed the types of crops they grew. They moved away from lower-yielding crops, such as cassava, and planted higher-yielding ones, such as grains. These findings emphasize how improved productivity in one agricultural area can shift activities and save lands from clearings.

Figure 3: Impact on Land Use After a 10 Percent Increase in Access to Electric Power



(a) Net effect on native vegetation taking into consideration the expansion of the agriculture frontier in a consolidated municipality. A consolidated municipality is that in which 95% of the municipality area is made up of rural properties, 20% of the rural properties area is covered in native vegetation, and 40% of the area outside rural properties is native vegetation.

(b) Net effect on native vegetation taking into consideration the expansion of the agriculture frontier in a frontier municipality. A frontier municipality is that in which 20% of the municipality area is made up of rural properties, 40% of the rural properties area is covered in native vegetation, and 100% of the area outside rural properties is native vegetation.

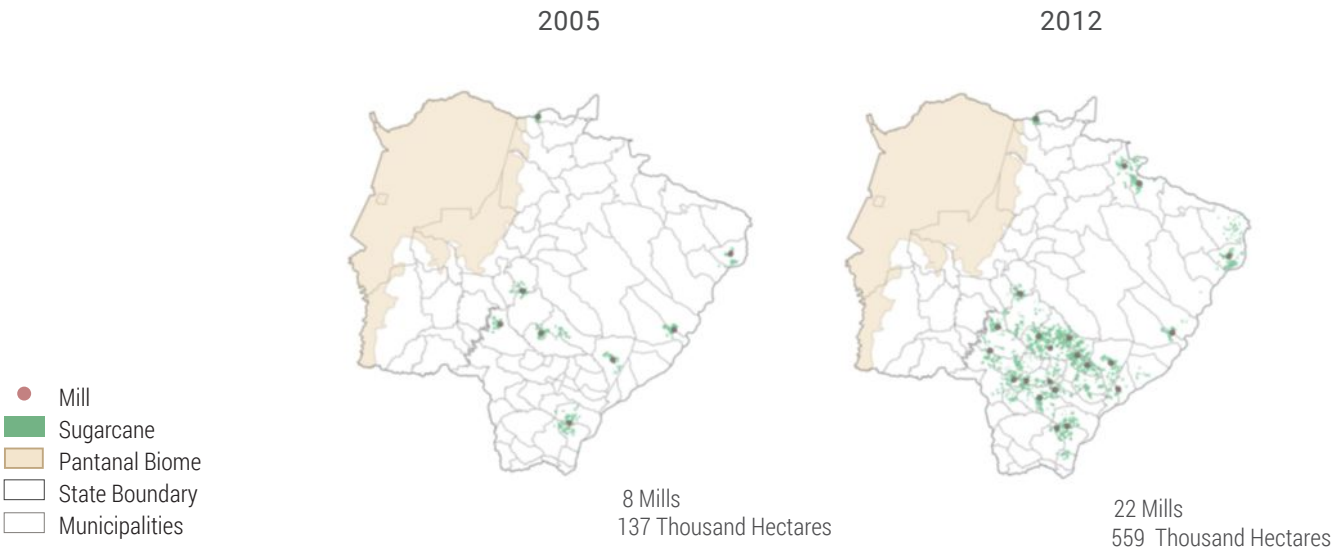
STUDY 3

EXPANSION OF SUGARCANE MILLS IN MATO GROSSO DO SUL[5]

Between 2005 and 2012, large private investors constructed 14 sugarcane mills in the Brazilian state of Mato Grosso do Sul (MS), a booming agricultural region the size of Germany (Figure 4). This increased sugarcane cropland area by more than 300%, compared to an increase of almost 70% in Brazil over the same period. The bulk of sugarcane area expansion in MS occurred over pasturelands. The sugarcane expansion also created positive co-benefits for agriculture, particularly by increasing grain soybean and corn productivity, and positively influenced other economic sectors. Three years after a mill was built, the findings show that a typical municipality had a 30% increase in GDP in addition to population increases of 10%, employment jumps of 40%, a wage hike of 44%, and tax revenue increase of 31%.

The new mill also attracted suppliers of agricultural inputs and services and a more skilled labor force and increased the provision of rural credit, which may have benefited all local agricultural producers. Moreover, there were also positive environmental impacts. After three years, municipalities with new mills reduced deforestation by 6.3 thousand hectares on average.

Figure 4: Growth in Mills and Sugarcane Crops in Mato Grosso do Sul



5 Assunção, J., Pietracci, B., Souza, P. (2016). Fueling Development: Sugarcane Expansion Impacts in Brazil (Working Paper). http://climatepolicyinitiative.org/publication/sugarcanes-role-fueling-economy/.

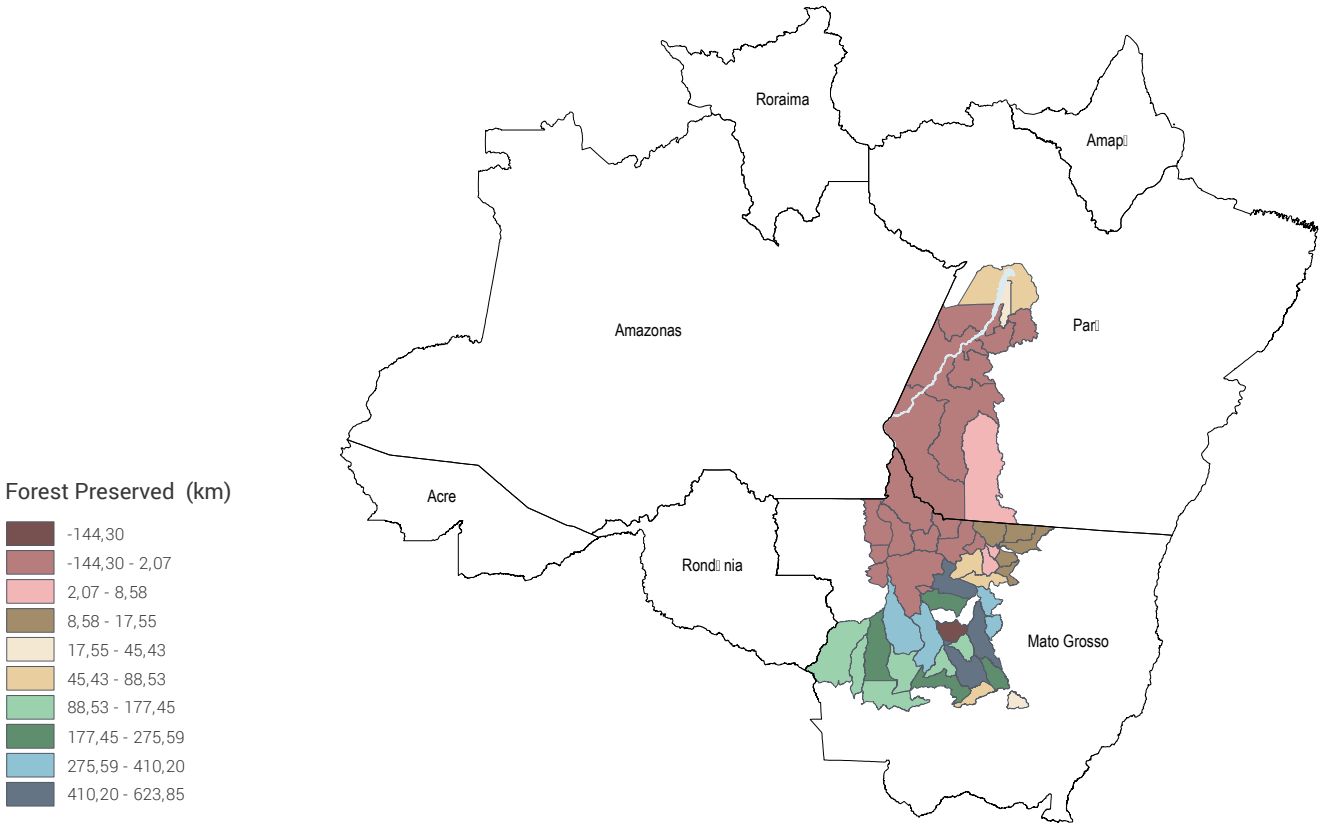
STUDY 4

A RISE IN CROP-TO-BEEF PRICES IN THE TAPAJÓS BASIN INCREASES PASTURE-TO-CROPLAND CONVERSIONS[6]

In the Tapaj–s Basin, a fourth CPI/ PUC-Rio study showed that when relative crop-to-beef prices increased, farmers shifted their land use toward crop cultivation and reduced the pressures on deforestation (Figure 5). The land conversion that resulted from pasture-to-cropland shifts reduced deforestation by 5,300 km2 from 2002 to 2012 in the area.

The study also explains the link between the crop-to-beef price surges and the reduction in deforestation. Crops generally require larger investments (e.g., seeds, tractors, fertilizers, etc.) and are more labor intensive (e.g., technicians, tractor operators, etc.). When farmers choose to convert their production to crops, this investment often constrains their production activities to smaller areas of land due to financial restrictions, for instance. So the pastures move to more productive purposes and the forested land is protected. .

Figure 5: Forest Preserved (in Square Kilometers) between 2002 and 2012 in the Tapaj–s Basin



6 Bragança, A. (2015). Prices, Land Use and Deforestation: Evidence from the Tapajós Basin (Working Paper). http://www.inputbrasil.org/wp-content/uploads/2015/08/Prices_Land_Use_and_Deforestation_Working_Paper_CPI.pdf.

ENFORCEMENT OF THE NEW FOREST CODE PRESENTS A UNIQUE POLICY OPPORTUNITY

As Brazil seeks to increase agricultural productivity while protecting its natural resources, an effective link between public policy and market mechanisms is required. Neither the government nor the market can solve everything, but public policy can serve as a catalyst for promoting better use of the nation s natural resources. Pairing the implementation of the 2012 Forest Code with innovative marketing strategies is an important policy in this area that deserve greater development and support.

The 2012 Forest Code requires that each rural property separate part of its area as a Legal Forest Reserve, with percentages ranging from 20% to 80%. Where there are rivers, streams and slopes, the land must be protected as permanent preservations (vegetation must be left intact). The new law favors increasing production through increased productivity rather than via more land clearing. It serves as a guarantee that food production in Brazil will be pursued in ways that diminish the potential for further forest clearing.

This positions Brazil well to introduce innovative marketing strategies that leverage the country s commitment to sustainable agriculture by distinguishing the nation's products in the global marketplace. Through the offering of Brazilian products that have been produced sustainably, the world could help support the protection of natural resources. Such programs could also create a virtuous circle by opening new markets and providing a source of revenue to farmers who comply with the 2012 Forest Code.

CONCLUSION

Throughout Brazil s history, a series of policies stimulated large-scale occupation characterized by low-productivity. This expansionist approach led to large deforested areas and inefficient agricultural practices. However, this is changing. CPI s analysis demonstrates a transition to higher agricultural productivity that corresponds to a reduction in forest clearings. The results of four different studies presented by CPI (technological changes that lead to soybean uptake; access to electricity; a jump in sugarcane production; and results of a surge in the ratio of crop-to-beef prices) suggest that Brazil has the potential to improve the nation s productivity while saving lands from further clearing. Nevertheless, for this reality to take hold, the country must strengthen the alliance between its agricultural and its environmental sectors. The Forest Code provides an example of a tool Brazil has at its disposal to make this happen.

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*The **Land Use Initiative (INPUT Iniciativa para o Uso da Terra)** is a dedicated team of specialists who work at the forefront of how to increase environmental protection and food production. INPUT engages stakeholders in Brazil s public and private sectors and maps the challenges for a better management of its natural resources. Research conducted under INPUT is generously supported by the Children s Investment Fund Foundation (CIFF) through a grant to the Climate Policy Initiative.*