How can one develop the rural economy without deforesting the AMAZON?

Paulo Barreto & Daniel Silva da Silva
With collaboration from Paula Ellinger

Imazon

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Summary

Executive Summary

▶ Main Message

It is possible to combat deforestation of the Amazon and promote the growth of the rural economy in the region. That tendency has been occurring since 2007 and may become consolidated over the next few years. The critical factor in increasing production without deforesting is to increase productivity, especially for ranching, the main use made of deforested areas. We estimate that it would be possible to supply the increased demand for beef projected up to 2022 by increasing productivity by around only 24% of pasture with agronomic potential for intensification existing in 2007. Thus, it would be possible without deforestation to increase the value of agricultural ranching production by around R$ 4 billion by 2022 – a 16% increase in the value of agriculture and ranching in 2010. In order for agricultural and ranching production to grow only in already deforested areas the public sector needs to correct failings in policies that discourage investment in those areas and others that encourage deforestation.

Policies against deforestation in the Amazon stimulate two arguments: that they threaten economic development in the region, by impeding the increase of agricultural and ranching production; and that it is possible to drastically reduce deforestation and increase agricultural and ranching production in areas already deforested. The debate is confusing, partly because the relation between the value of agricultural and ranching production and the deforestation rate has been contradictory in recent years. For example, from 1999 to 2006, the value of agricultural and ranching production in the Amazon was correlated with deforestation rates. However, from 2007 to 2010, the value of production began to grow again and became stable, while deforestation dropped.

To help establish policies against deforestation that will be socially and politically sustainable it is necessary to better understand the relation between deforestation and the economic growth of the agricultural and ranching sector. To do this we performed several analyses. First, we evaluated if the recent disassociation between deforestation and the value of production resulted from the gain of productivity or from other temporary or cyclical factors such as the increase in the price for agricultural products. Next, we assessed the potential for increasing agricultural and ranching production without deforestation and the challenges to following this path.

What stimulated the increase in the value of agricultural and ranching production?

Our analysis revealed that the increase in the value of agricultural and ranching production from 2007 and 2010 resulted from the combination of several factors, but part of the increase may be only cyclical. The increase of the value ranching production resulted from an increase in slaughter of cattle, the increase in the price of cattle and the increase of productivity

in previous years. For example, stocking in pastures rose around 50% from 1999 to 2004 due to: i) opening of new pastures (about 10 million hectares from 1999 to 2004 for ranching), that were naturally fertilized by burning the forest; and ii) investment in the sector, exemplified by rural credit contracted exclusively for ranching, which totaled approximately R$ 14.5 billion from 1997 to 2009.

In the case of agriculture, the main factor for the growth of the value of production from 2007 to 2008 was the rise in prices for some grains, especially soy, which encouraged an increase in the planted area of this crop. Despite the increase of the area planted with soy and corn, the total area planted with agricultural crops remained stable, especially because of the reduction in rice planting beginning in 2006. Another factor that influenced the growth in the value of agricultural production was a rise in productivity for major crops, especially corn.

What is the potential for increasing the value of agricultural and ranching production in the area already deforested?

Despite the advances, agriculture and ranching productivity is still below its potential, especially ranching, whose average productivity is about 80 kilograms of meat per hectare per year, and whose potential is 300 kilograms per hectare per year. We estimate what would be the potential for increasing ranching production in areas already deforested with potential for intensification and its effects on the value of agricultural and ranching production and other socioeconomic indicators. We focused on ranching, which occupied 64.2% of the deforested area in 2007.

We estimate that it would be viable to meet the demand for beef projected for 2022 by increasing productivity on approximately 6.7 million hectares already deforested – or the equivalent to about 24% of the pasture area with good and fair agronomic potential existing in 2007 and outside of Protected Areas in the Amazon biome. On the other hand, if current average productivity were maintained, it would be necessary to deforest approximately 12.7 million hectares to meet the projected demand up to 2022. In this scenario, the average annual deforestation rate up to 2022 (1.27 million hectares) would be approximately 3.4 times higher than the goal established by the federal government up to 2020 (380 thousand hectares).

Increasing production without deforestation would make it possible to increase the value of ranching production by R$ 4.16 billion up to 2022, the equivalent of a 16% increase in the total value of agricultural and ranching production in relation to 2010. The additional production without deforestation would employ approximately 39 thousand persons.

To increase productivity in pastures it would be necessary to invest up to R$ 1 billion per year up to 2022. This level of investment would be viable considering that it would be equivalent to around 70% of the average annual rural credit granted in the Amazon biome for ranching from 2005 to 2009. The rate of return on the investment would be about 20%, and therefore fully compatible with interest rates available for rural credit.

What blocks an increase in productivity for ranching?

If it is technically and financially possible to increase production in areas already deforested, why does deforestation continue and why is ranching productivity still so low? Several factors explain this contradiction.

Part of the deforestation has still been happening in order to assure possession of public lands for speculation. In this case, the investment tends to be precarious (and may include the use of labor analogous to slavery), which results in an enormous stock of poorly utilized lands. Speculation persists because the government has historically changed the rules in order to validate irregular occupations of public lands, including donation and sale below the market price. Furthermore, collection of the Tax on Rural Territorial Property (ITR), which calls for higher rates for properties with a low degree of use, is ineffective. For example, in 2002, ITR collection in Brazil was only 6% of the estimated potential according to an estimate by a technician from the Brazilian Federal Revenue service.

There is also evidence that the use of lands for money laundering and tax evasion stimulates occupation and deforestation of lands in the region. These practices are especially attractive because the Rural Income Tax (IRR) for an individual is applied to only 20% of gross income for a property. Thus, criminals can simulate rural business with money of illegal origin and pay a relatively low tax to legalize it. According to specialists, the agencies that are supposed to combat this crime are unprepared and lack the necessary coordination and specialization.

On the other hand, there are several barriers to investment in areas already deforested. For example, the manager of an agroindustrial company reported in eastern Pará reported that the company rejected 88 out of 100 properties seeking investments, due to environmental and land title irregularity. The prevalence of irregularities is the result of land title and environmental policies that are unstable, ineffective and insufficiently supported.

The investment also is complicated: i) by low educational levels among rural producers (25% of them in the Amazon were illiterate and 51% had concluded only the first level of schooling, according to the Agriculture and Ranching Census of 2006); ii) by insufficient technical assistance (only 32% of the families settled in land reform projects throughout the country received technical assistance in 2011); and iii) because of precarious infrastructure; for example, up to 2012 only 40% of roads in the Amazon were in good conditions for traffic (Brasil, n.d.).

Taken together, those deficiencies have led to enormous environmental losses (biodiversity, greenhouse gas emissions) and socioeconomic losses, as well as violent conflicts.

What to do in order to grow without deforesting?

In order to increase agricultural and ranching production without deforestation integrated solutions are necessary. Besides environmental enforcement it is necessary to eliminate incentives for deforestation and remove barriers to investments committed to sustainability.

To discourage deforestation, we note the following recommendations:

☑. Conclude and consolidate allocation of public lands in the region that continue being illegally occupied. To that end, it is essential to prioritize constitutional rights to recognition of Indigenous Lands and *Quilombola* Peoples (descendants of escaped slaves) and use approaches that conciliate development with conservation, such as the destination of

forests for public uses through creation of Conservation Units.

- ☑. Eliminate donation and sale of public lands at prices below market value, as recommended by the Parliamentary Enquiry Commission on land speculation in the Amazon in 2002. Currently, donation and sale below the market price is in effect in the Legal Land Program (*Terra Legal*), which seeks to regularize possession in 67 million hectares in public lands in the region, and in state land title regularization programs. Furthermore, it is necessary to effectively collect the ITR in order to discourage speculators who maintain vast unproductive areas.
- ☑. Combat the use of rural properties for tax evasion and a money laundering. One form of discouraging money laundering in rural areas would be for the National Congress to end the distinction of the IRR for individuals, making it similar to other incomes. Additionally, there need to be integrated and specialized actions by enforcement (Public Prosecution Service, Federal Revenue and Finance Secretariats) and the judiciary against the criminals. A good example of this type of action occurred in Mato Grosso do Sul, where the Specialized Court for Combating Organized Crime arrested persons involved in drug trafficking and corruption and confiscated 85 ranches from them with a total area of 368 thousand hectares.
- ☑. Focus on measures against speculation and illicit gains in the municipalities that are leaders in wasteful land use – meaning those with the largest underutilized deforested areas. This recommendation follows international best practices and the successful recent example of combating deforestation by focusing on critical municipalities. Specifically, we recommend a focus on the 46 municipalities that totaled 50% of the overgrown pasture (deforested areas with poorly maintained pasture, usually having and abundance of shrubs and small trees) area in lands with good and fair agronomic potential, which represented 10.5% of the 438 municipalities in which these pastures occurred in 2007. It was no surprise to find the municipalities that continue having high rates of deforestation heading the list of areas with overgrown pasture such as São Felix do Xingu, Novo Progresso and Altamira. (See list of municipalities in Appendix V).

To encourage investments in productivity, we present the following recommendations.

- ☑. Establish stable and effective environmental and land title policies. To do that, government leaders at the highest level need to commit themselves to and coordinate negotiations, allocate resources and demand implementation of the necessary measures. If that does not happen, the policies will continue to be fragmented, precarious and insufficient.
- ☑. Create lasting programs to support small-scale producers in adhering to environmental laws as authorized by the new Forest Code. This support is important because many small-scale producers will face difficulties in following the rules, even if they are simplified.
- ☑. Make the best use possible of the benefits of geoprocessing technologies (satellite images, georeferenced property maps). For example, use of such technologies could eliminate the field inspection that currently is a prerequisite for granting environmental licenses.

Finally, we emphasize that commitment by high levels of government towards eliminating bottlenecks to land title and environmental regularization might encourage private and public initiatives for eliminating other investment bottlenecks such as the scarcity of qualified personnel and precarious infrastructure.

Introduction

Some politicians and rural leaders argue that policies against deforestation in the Amazon hinder economic development in the region (See statements in Machado, 2008; Val-André Mutran, 2008 and AC 24 Horas, 2012). On the other hand, scientists, environmentalists, and some politicians and rural leaders argue that it would be possible to continue increasing production through increasing agriculture and ranching productivity in already deforested areas (See statements in Machado, 2008 and Silva *et al*., 2011). Who is right? Analysis of this debate has been complicated by the fact that the relation between the value of agricultural and ranching production (the value that was produced and sold) and the deforestation rate has been contradictory recently.

From 1999 to 2006, the value of agricultural and ranching production in the Amazon biome was in fact correlated with deforestation rates – meaning, they either rose or fell together. However, from 2007 to 2010, the value of agricultural and ranching production began increasing again while the deforestation rate fell, as will be detailed in the next section. Did this recent disassociation between deforestation and the value of production result from a gain in agricultural and ranching productivity or from other temporary factors such as increase in the price of agricultural products? If the disassociation was temporary, what is necessary for increasing productivity of agriculture and ranching and growing the rural economy without deforesting? In this paper we seek to answer these questions in

order to help promote policies against deforestation that are politically sustainable.

In the first section of the paper we present details of tendencies in the factors that influence the value of agricultural and ranching production. Our analysis demonstrates that the recent increase in the value of agricultural and ranching production was the result of cyclical factors such as the increased price of agricultural products, an increase in cattle slaughtering and increasing productivity for some crops. However, despite the advances, deforestation continues and average productivity for cattle ranching is very low. Because of that we dedicate the second section to an analysis of the potential for increasing agricultural and ranching production without deforesting and its accompanying socioeconomic and environmental impacts. We focused on ranching because average productivity is well below the potential and because pastures have occupied the majority of the deforested area: 64.2% of the area in 2007 according to Inpe/Embrapa (2011).

Our analysis revealed an enormous potential for increasing production without deforestation. We dedicate the last section of this paper to explaining what are the factors that continue to stimulate deforestation and that inhibit investments for increasing productivity in areas already deforested. Finally, we present recommendation for dealing with the various limiting factors evaluated.

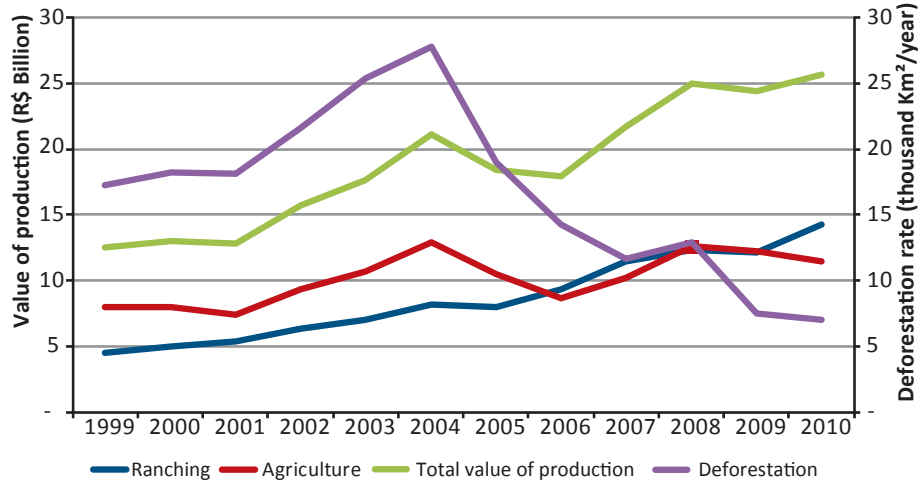
The methodology and sources of information are presented in Appendices referenced in the text or directly throughout the text.

The decoupling between the deforestation rate and the value of agricultural and ranching production in the amazon

From 1999 to 2010 the relation between the value of agricultural and ranching production and the deforestation rate presented two quite distinct periods (Figure 1). From 1999 to 2006, these variables traveled in the same direction (in other words, they were positively correlated): they grew together from 1999 to 2004 and fell together from 2005 to 2006[1]. However, the correlation weakened and changed direction from 2007 to 2010[2]. The value of production rose and became stabilized while deforestation continued its downward trend. What explains this recent decoupling?

The drop in the deforestation rate since 2005 was partially influenced by the drop in agriculture and ranching products and in part by more effective control policies (such as confiscation of cattle and embargoes of illegally deforested areas – Barreto *et al.,* 2009 Soares-Filho *et al.,* 2010; Assunção *et al.*, 2012; Barreto & Araújo, 2012). For example, Assunção *et al*. (2012) estimate that 52% of the drop in deforestation from 2005 to 2009 resulted from policies, and the remainder from the drop in prices.

Figure 1. Value of agricultural and ranching production and the deforestation rate in the Amazon biome from 1999 to 2010. Value deflated by the IGP-DI with base year 2010.



Source for the data: Inpe (2012), IBGE (n.d. (a)) and FGV (n.d.).

[1] The correlation coefficient (r^2) between the value of agricultural and ranching production and the deforestation rate in this period was 0.56. The correlation between value of agricultural production and deforestation was even stronger = 0.83.

[2] The correlation coefficient (r^2) between the total value of agricultural and ranching production in this period was -0.43. However, the contribution of each sector to the correlation was quite distinct: the correlation coefficient between deforestation and the value of agricultural production was null (0.04), while the value of ranching production was at 0.6.

And what lead to an increase in the value of agricultural and ranching production without an increase in the deforestation rate? To answer that question, we analyze the factors that influenced the value of agricultural production and of cattle ranching (See data source and method for estimates in Appendix I).

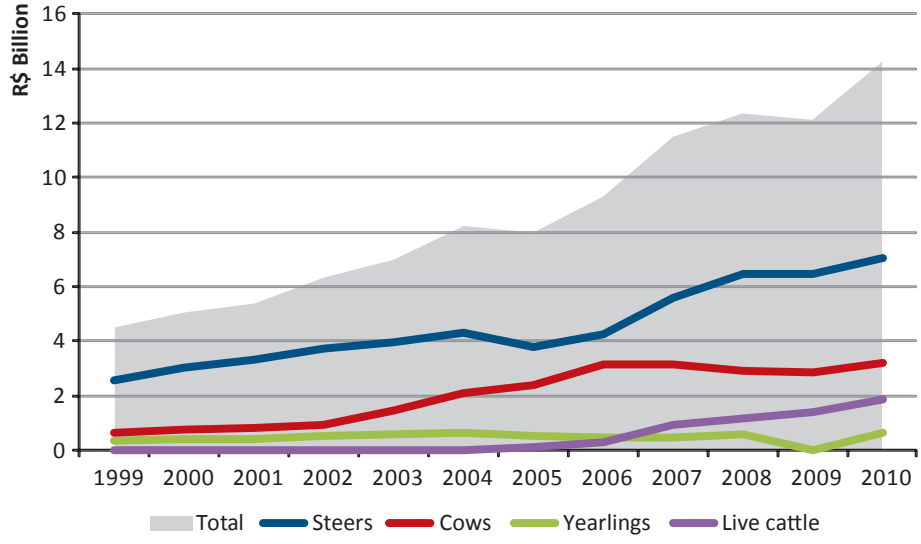
The value of agricultural production is the result of the total planted area cultivated, of the quantity produced by each unit of area cultivated (productivity) and of the price of agricultural products. In the case of ranching, the value of sales is the result of the same factors as those of agriculture, but also due to decisions about the sale of cattle stocks - for example, when the price of beef is low, many ranchers decide to slaughter a large number of cows to avoid increasing their herds (supply). Thus, the value of ranching production increases temporarily, but without a necessary increase in productivity.

Our analysis reveals that between 2006 and 2010 ranching contributed to 64% of the increase in the total value of production, while agriculture contributed with 36%. Growth in the value of ranching production occurred initially because of consumption of the stock and later on with recovery in prices. The opening of new pastures and investments in pasture renewal contributed towards increasing productivity in previous years. In the case of agriculture, the value of production increased mainly due to the increase in prices, especially for soy, and grain productivity. In the following subsections we present the evidence that support these principal results.

Ranching

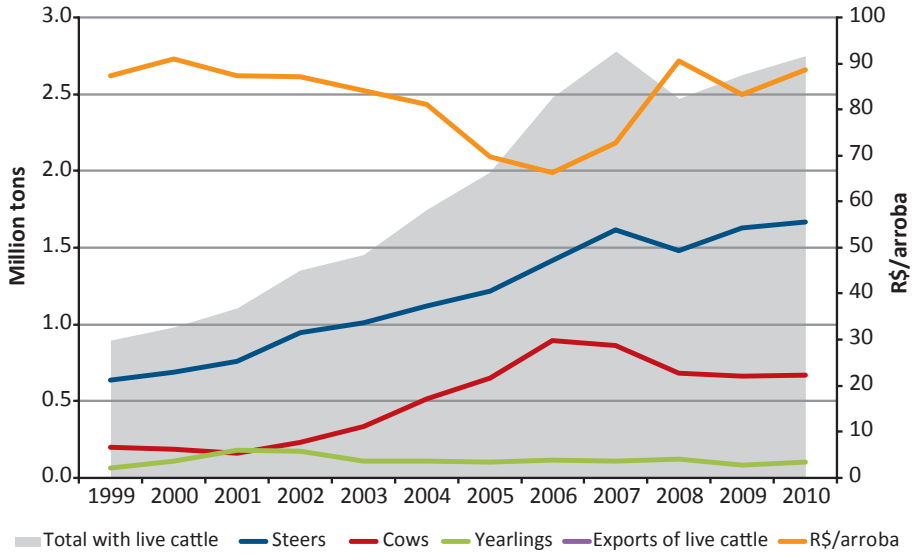
From 2006 to 2010 the value of ranching production rose from R$ 9.3 billion to R$ 14.2 billion in the region (Figure 2) mainly due to cyclical factors associated with the price of cattle and the gain in productivity in previous years. The drop in cattle prices stimulated an increase in slaughtering of mother cows (Figure 3), which led to a reduction in the herd (Figure 4). For its part, the scarcity of supply stimulated a 36% price increase from 2006 to 2008: from R$ 66.3 to R$ 90.6 per *arroba* (1 *arroba* = 15 kilograms of beef).

Figure 2. Valor of ranching production in the Amazon biome corrected by the IGP-DI (base year 2010). Total value, by type of herd slaughtered (Steers, cows and yearlings) and sale of live cattle..



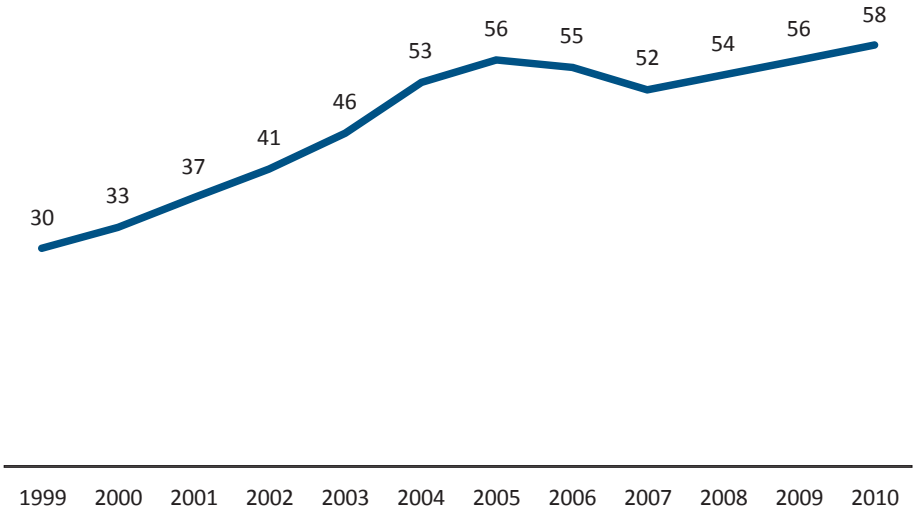
Source: Prepared by the author with data from MDIC (n.d.) and IBGE (n.d. (a)) and IEA (n.d.).

Figure 3. Cattle slaughter by type of herd in the Amazon biome and average price per arroba of live cattle in Brazil.



Source: Slaughter (IBGE, 2012). Price of cattle: Prepared by the authors with data from IEA (n.d.) and FGV (n.d.). Values were deflated by the IGP-DI (base year 2010).

Figure 4. Cattle herd (million head) in the Amazon biome from 1999 to 2010.



Source: Estimated with data from IBGE (n.d. (b)).

The contribution of the gain in productivity towards the increase of the value of ranching production is complex. Productivity, indicated by the average stocking of pastures in the region (cattle/hectare), fell and then stabilized from 2006 to 2010, the period with the largest growth in the value of production for the sector (Figure 5). However, the average stocking of pastures had increased about 50% from 1999 to 2004. This means that in this period the herd grew more than the increase

of the deforested area and generated an extra supply that allowed a stronger increase in the value of production beginning in 2005.

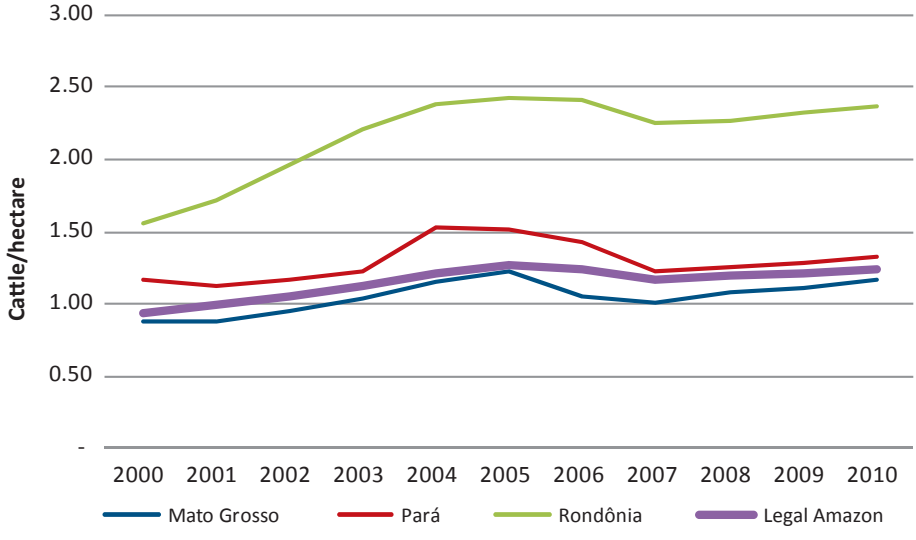
Increasing stocking in the pastures from 1999 to 2004 probably occurred due to the combination of several factors. The significant increase in deforested areas enabled the formation of new pastures that are fertilized by burning the forest. These new pastures are more fertile than old pastures that are not fertilized (Hecht *et al*., 1988), resulting in greater productivity.

Assuming that 75% of the deforested area from 1999 to 2004 was allocated to pastures, around 9.6 million hectares of new pastures were created in this period. This area would be equivalent to approximately 24% of the pastures existing in 2007 according to Inpe/Embrapa (2011). Therefore, the natural fertility of those new pastures could explain a major part of the increase in stocking (50% from 1999 to 200).

Besides forming new pastures, some of the producers have invested in reforming old pastures and in confinement and semi-confinement. The use of confinement and semi-confinement has grown, but only 1.2% of the herd in the region has been fattened with these methods, according to data from FNP (2010)[3].

Maintenance and reform have been practiced by many producers. According to Inpe/Embrapa (2011), in 2007, 75% of the 44.6 million hectares of pastures were clean. However, the fact that about 10 million hectares or 25% of the pastures in 2007 were overgrown (Inpe/Embrapa, 2011) shows that an enormous area has been underutilized. As a result, the average productivity for the region, around 80 kilograms per hectare per year, is still far below the potential with adoption of best practices: 240 to 720 kilograms per hectare per year (See details in Appendix II).

Figure 5. Average stocking of pastures (cattle/hectare) in the Legal Amazon and in the three States with the largest herds (Mato Grosso, Pará and Rondônia).



Source: Prepared by the authors with data from IBGE (n.d. (b)) and Inpe (2012). The average was weighted considering the proportion of the herd and stocking in the nine States of the region.

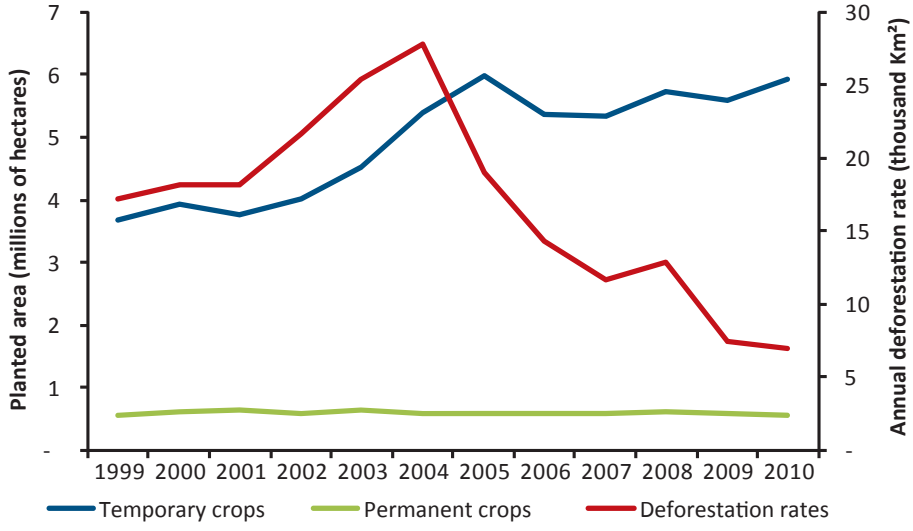
[3] We found data on confinement and semi-confinement only for Tocantins and Mato Grosso. That may be explained by the fact that such systems require use of grains to supplement feeding and are thus viable only in regions close to areas with more intensive agriculture.

Agriculture

According to the IBGE (2012), for the period analyzed a few agricultural products were responsible for a major part of the value produced and of the area cultivated: soy, corn, rice, manioc and perennial crops totaled 92% of the value of production and 66% of the planted area in 2010 (Appendix I). Soy was individually the most important product, with 44% of the value of production and 34% of the planted area.

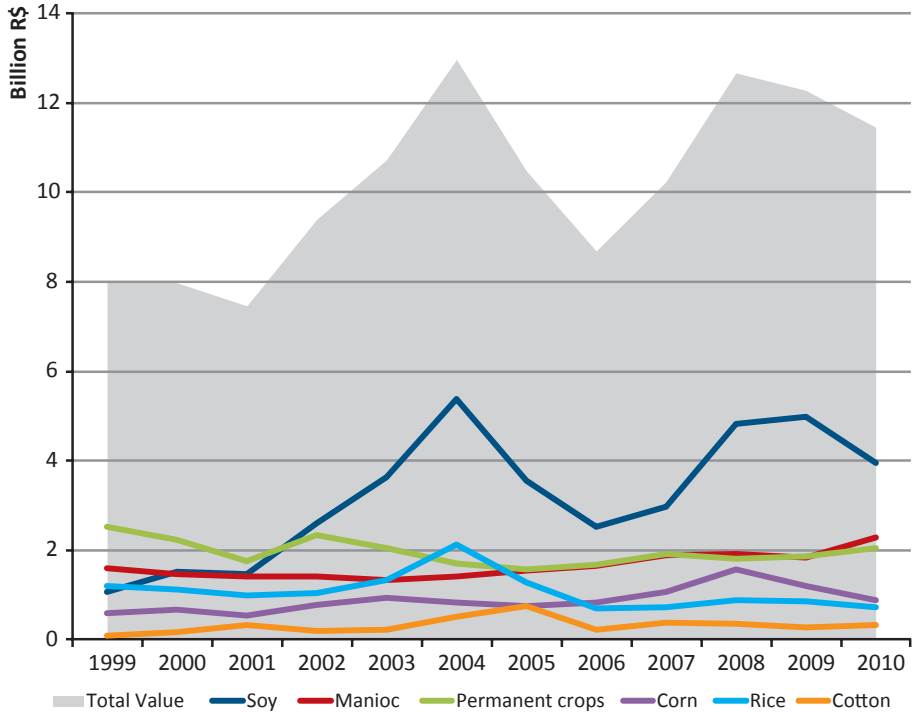
The variations in the prices and productivity with soy and corn crops were the factors that most contributed towards the increase in the value of agricultural production, while the agricultural area remained relatively stable from 2006 to 2010 (Figure 6). As shown in Figure 7, the variation in the value of soy production was the principal influence on the variation in the value of total production from 1999 to 2010. The main factor for a return in the growth of the value of agricultural production after 2006 was the rise in soy prices (Figure 8), which stimulated an increase in the planted area of this crop (Figure 9). Despite the increase of the area in soy and corn, the total area planted remained stable, especially because of the reduction in rice planting beginning in 2006 (Figure 9). Another factor that influenced growth in the value of agricultural production was the growth in productivity of major crops, especially corn (Figure 10).

Figure 6. Planted area of annual crops in the Amazon and annual deforestation rate from 1999 to 2010.



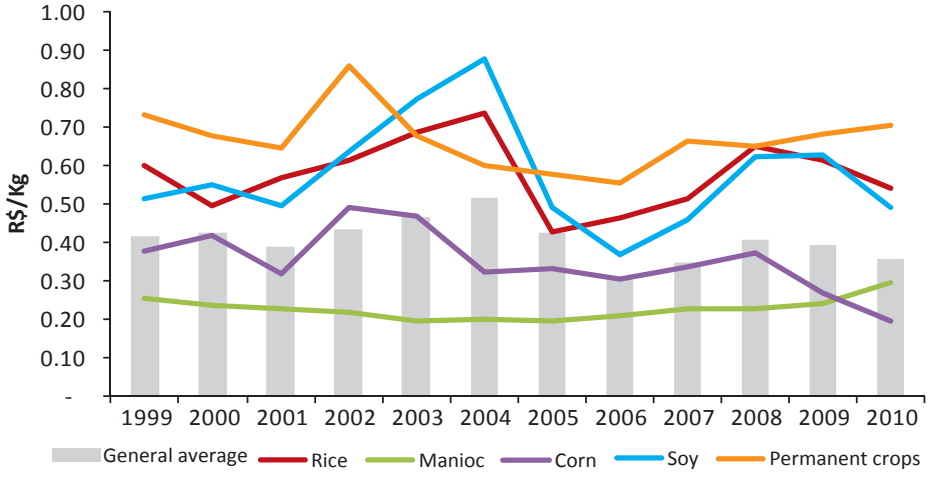
Source: Inpe (2012) and IBGE (n.d. (a)).

Figure 7. Total value of agricultural production and principal agricultural crops in the Amazon biome, corrected by the IGP-DI (base year 2010).



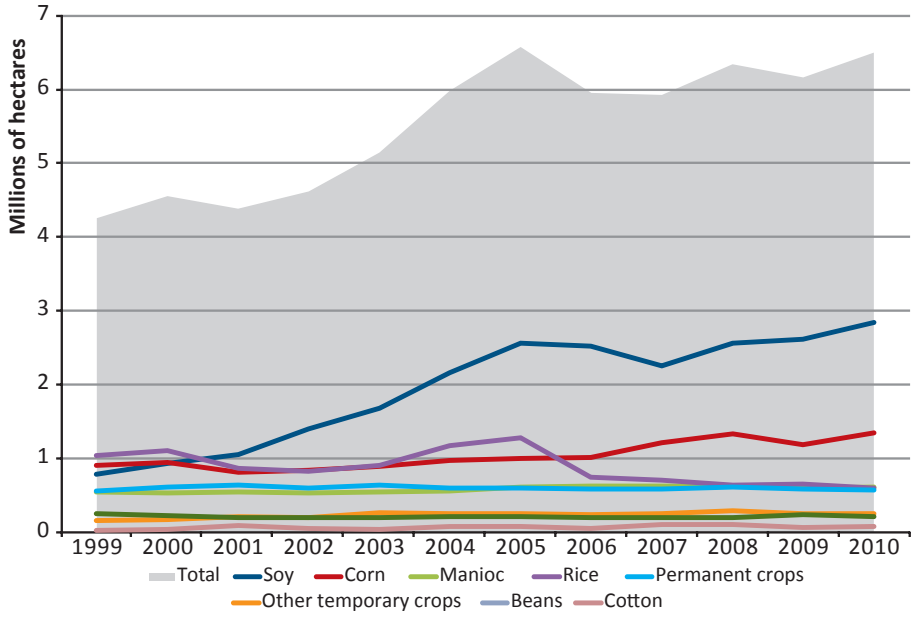
Source: Values for production: IBGE (n.d.(a)). Values from IGP-DI used by the authors: FGV (n.d.).

Figure 8. Average value of principal agricultural crops in the Amazon, corrected by the IGP-DI (base year 2010).



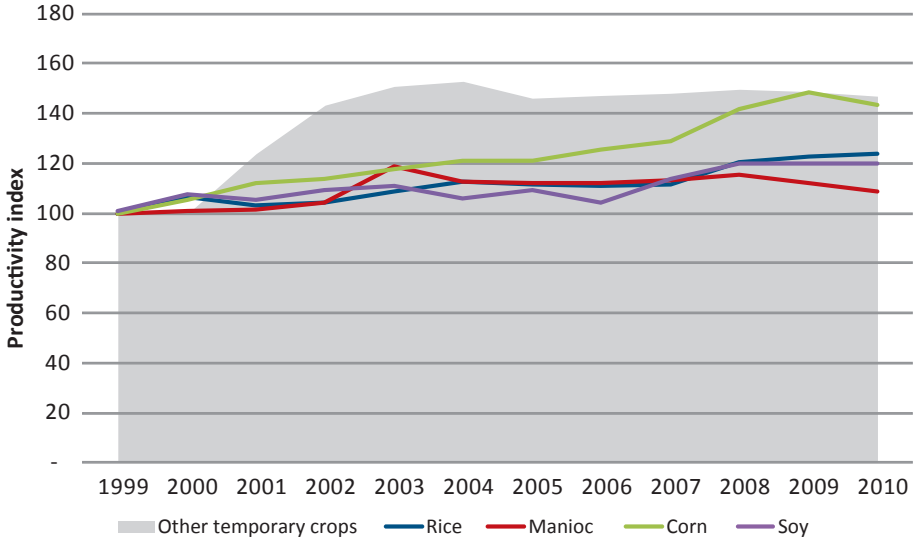
Source: Prepared by the authors with data from IBGE (n.d. (a)) and FGV (n.d.).

Figure 9. Planted area of major crops in the Amazon biome from 1999 to 2010.



Source for data: IBGE (n.d.(a)).

Figure 10. Productivity index for major crops in the Amazon and average of the other temporary crops. Base 100 in 1999.



Source: Prepared by the authors with data from IBGE (n.d.(a)).

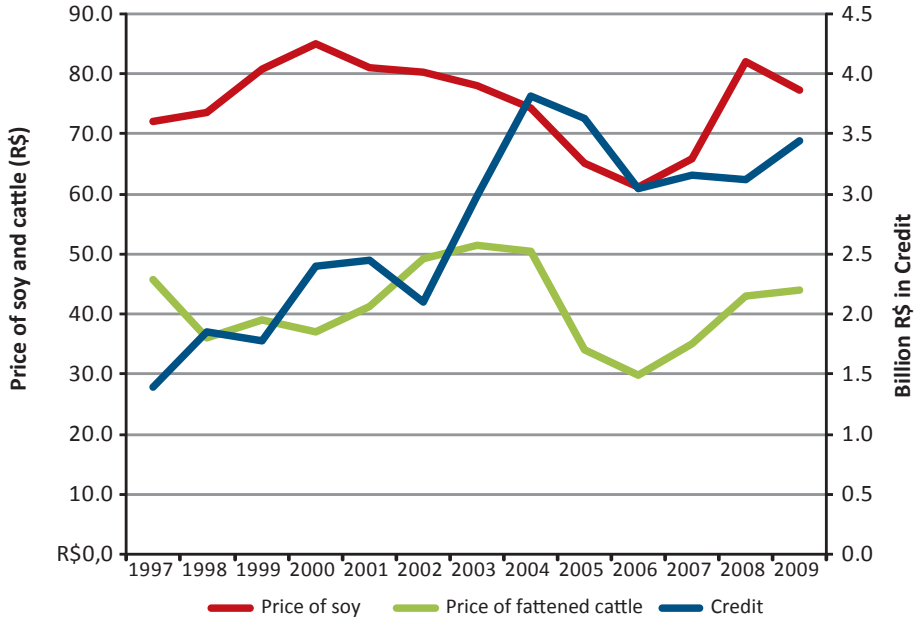
The increase in rural credit

Part of the expansion in the increase of the area cultivated and in productivity has been the result of credit availability. From 1997 to 2009 R$ 78 billion in rural credit were contracted in the Legal Amazon, of which about 38 billion were in the Amazon biome. During this period, the value contracted annually increased, especially beginning in 2000 (Figure 11).

Cattle raising by itself received the largest share of financing (36% of the total) followed by soy and other grains (24%) and machinery, equipment and infrastructure (19%), which can be used for both agriculture and ranching (Figures 12 and 13).

The total financed during the period evaluated varied both due to factors in the credit supply policy and in the climate that encouraged seeking credit. Beginning in 2004, the credit contracted was strongly correlated with the price of soy and less with the price of cattle[4] (Figure 11). Furthermore, two policy decisions influenced credit taking. First, the government increased the limit of the amount of credit that could be contracted (Figure 14) to help producers deal with the debts resulting from the drop in prices that began in 2005 and later to deal with the financial crisis of 2008. Second, the government reduced the controlled interest rate for rural credit from 8.75 to 6.75% per year beginning with the 2007/2008 harvest (Brasil, 2007).

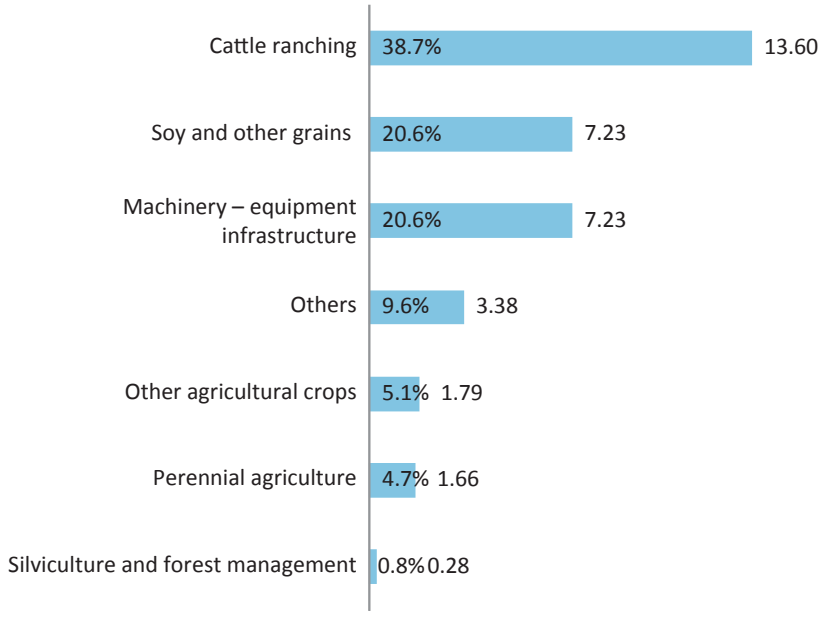
Figure 11. Variation of the total credit contracted and the prices for fattened cattle (R$/arroba) and soy (R$/60 kg), corrected by the IGP-DI (base year 2010).



Source: Prices for cattle and soy: IEA/SP (n.d.). Credit: data from Central Bank . Values were deflated using the price index IGP-DI (base year 2010): FGV (n.d.).

[4] The correlation coefficient (r2) between the price of soy and cattle and the volume of credit was respectively 0.61 and 0.20 from 2004 to 2009.
[5] The Federal Public Prosecution Service (MPF) in Pará compiled the data on rural credit for the Amazon while preparing a public civil suit against banks accused of granting rural credit for illegally deforested areas. The data compiled by the MPF made it possible to assess for which activity credits were granted. A summary of the data is available at: http://bit.ly/ysarAe.

Figure 12. Distribution of the type of undertaking financed (% and billion R$) by rural credit in the Amazon biome from 1997 to 2009.



Source: Calculation by authors with data from Central Bank. Values corrected by the IGP-DI (base year 2010).

Figure 13. Rural credit granted annually, by type of undertaking, in the Amazon biome from 1997 to 2009.

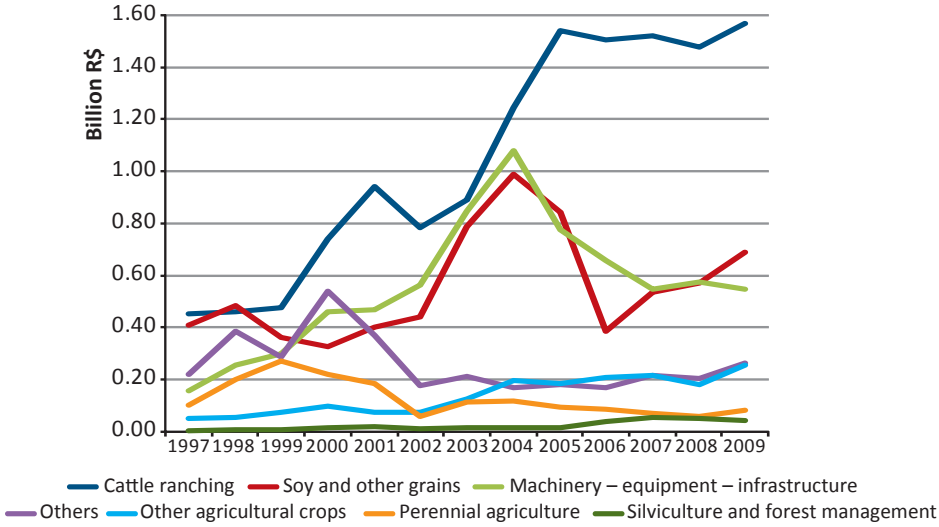
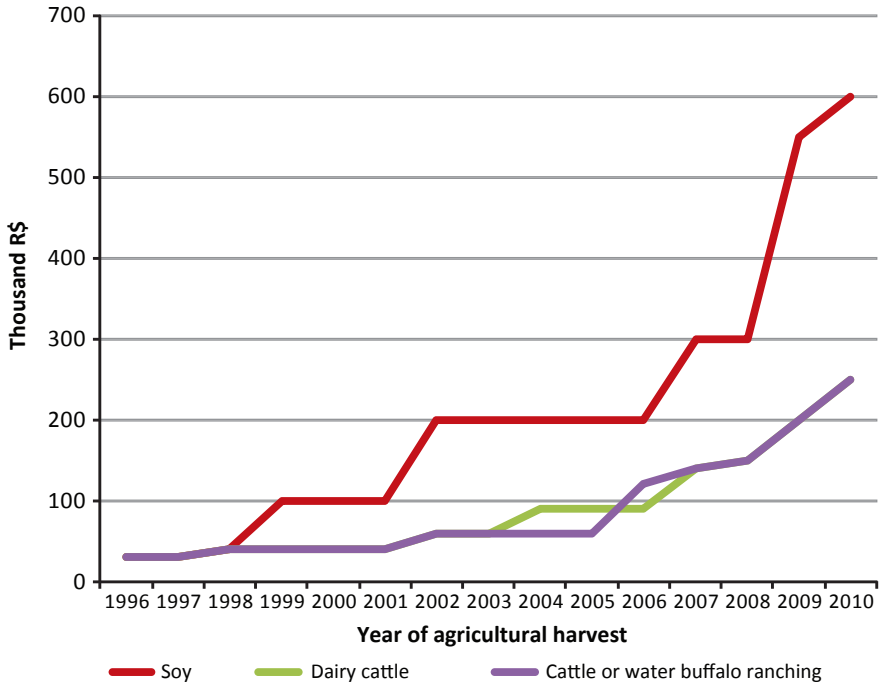


Figure 14. Limits on financing by contract, by type of crop in the Amazon, in Harvest Plans from 1995 to 2010.



Source: Agricultural and Ranching Plan - http://www.agriculture.gov.br/plano-agricola.

The potential for increasing the agricultural and ranching production without deforestation

In the previous section we showed that gains in productivity and cyclical factors such as price increases contributed towards increasing the value of agricultural and ranching production. However, deforestation continues, while at the same time there are enormous underutilized areas. There is thus an enormous space for increasing the value of agricultural and ranching production by increasing productivity in existing deforested areas. In order to strengthen the fight against deforestation, we dedicate the rest of this work to estimating the potential and challenges for land use intensification.

In this section, we assess the potential for increasing productivity in areas deforested for ranching, its effects on the value of agricultural and ranching production and the need for investments. We focused on ranching because average productivity is well below the potential and because pastures occupy the majority of the deforested area: 64% in 2007 according to Inpe/Embrapa (2011).

To estimate the potential for increasing ranching production without deforestation we considered the areas with potential existing in 2007 and the potential for increasing productivity by adopting best practices. We use this date as the cutoff considering that: i) this is the most recent year for which there is a vegetation cover map for the deforested areas developed by the TerraClass Project (Inpe/Embrapa, 2011); and ii) the use of areas illegally deforested after 2008 may be limited by restrictions in the new Forest Code.

We estimate that of the total area planted in pasture in 2007 (40.4 million hectares) only about 28 million hectares would have good potential for increasing productivity and were outside of Protected Areas, where raising of large animals is prohibited (See method for estimation in Appendix III). The remainder were areas considered by IBGE as having restricted and unfavorable agronomic potential, due to factors such as risk of flooding, little soil depth and mountainous and sloping terrain. Additionally, we excluded regions with rainfall rates above 2,800 millimeters per year. Chomitz & Thomas (2001) found that stocking in pastures in such areas was low, probably because they were more propitious for developing diseases and pests and due to the rapid loss of soil nutrients.

According to the specialists we consulted, the adoption of best practices in ranching would initially allow a production of 300 kilograms of meat per hectare per year (Appendix II). This valor would be conservative compared to the higher potential of 740 kilograms per hectare per year (Homma *et al*., 2006). However, the specialists considered that it is necessary to begin with a moderate level of technology and investment compatible with the producers' capacity for adaptation. Based on that assumption, we estimate that production could reach 8.3 million tons on the 28 million hectares of pastures existing in 2007 with better agronomic potential. That would be equivalent to about three times the production in 2010 (2.7 million tons). Thus, ad-

ditional production could be approximately 5.6 million tons per year or the equivalent to about R$ 30 billion additionally per year considering the average price of fattened cattle in 2010. However, in practice such an immediate increase in productivity would be improbable due to several limiting factors (See next section). Furthermore, it would not be necessary to increase production so rapidly due to limits on demand.

To estimate the potential for a plausible increase in meat production over the next few years, we considered the demand projected by the Ministry of Agriculture and Ranching in Brazil (Mapa). Based on projections by Mapa (Brasil, 2012a), we estimate that consumption of Brazilian beef (including exports) would increase considerably by 28% up to 2022 in relation to 2010[6]. That would mean that by 2022 it would be necessary to produce approximately 770 thousand additional tons in the Amazon than were produced in 2010, assuming that the region would continue to produce in the same proportion in relation to the rest of the Country. The value of this additional production would reach R$ 4.16 billion per year in 2022, considering the average price for cattle 2010, and would be equivalent to a 16% increase in the value of agricultural and ranching production in the Amazon in 2010.

To meet the additional demand without deforestation it would be necessary to invest in best practices for increasing. What is the necessary area of pastures with best practices and what is the necessary volume of investments? We estimate that with the adoption of best practices on 6.6 million already deforested hectares it would be possible to meet the additional demand (Details in Appendix IV). This area would be equivalent to only 24% of the pastures with better potential existing in 2007.

Investments for improving productivity would vary according to conditions in the pastures. To increase the use of clean grass pastures it would be necessary to invest in infrastructure for managed rotation in the pasture (fences, water distribution) and training of personnel. In the case of overgrown pastures, it would be necessary to invest additionally in improving the pastures. The investment in this case would be around R$ 1,575 per hectare (Details in Appendix II) considering the reform and the infrastructure. Thus, in order to meet all of the demand projected up to 2022, assuming that all of the investment were in overgrown pastures, it would be necessary to invest approximately R$ 10.4 billion (R$ 1,575/hectare x 6.7 million hectares) in 10 years, or about R$ 1.04 billion per year up to 2022. This amount is equivalent to about 70% of the average annual rural credit granted to ranching from 2005 to 2009 (Figure 13). Thus, our estimate indicates that fund for credit would not be a limiting factor to adoption of best practices. The rate of return on investment in overgrown pastures would be about 20% (Appendix II), and thus fully compatible with interest rates available for rural credit (maximum of 8.5%).

The Amazon States with the best chances for increasing production without deforestation would be Mato Grosso, Pará and Rondônia, where 85% of the pastures on soils with fair and good potential were located, excluding areas with rainfall above 2,800 millimeters and outside of Protected Areas[7] (Figures 15 and 16).

[6] According to Mapa (Brasil, 2012a), projected increase from 2011/2012 to 2022 would be 25.9%. To estimate the increase in relation to 2010, we added an annual growth rate of 2.1%, which was the average for the period projected. Thus, the rate of increase would increase would be 28% from 2010 to 2022.

[7] The only exception for including pastures within Protected Areas was exception for including pastures within Protected Areas was Environmental Protection Areas (APA).

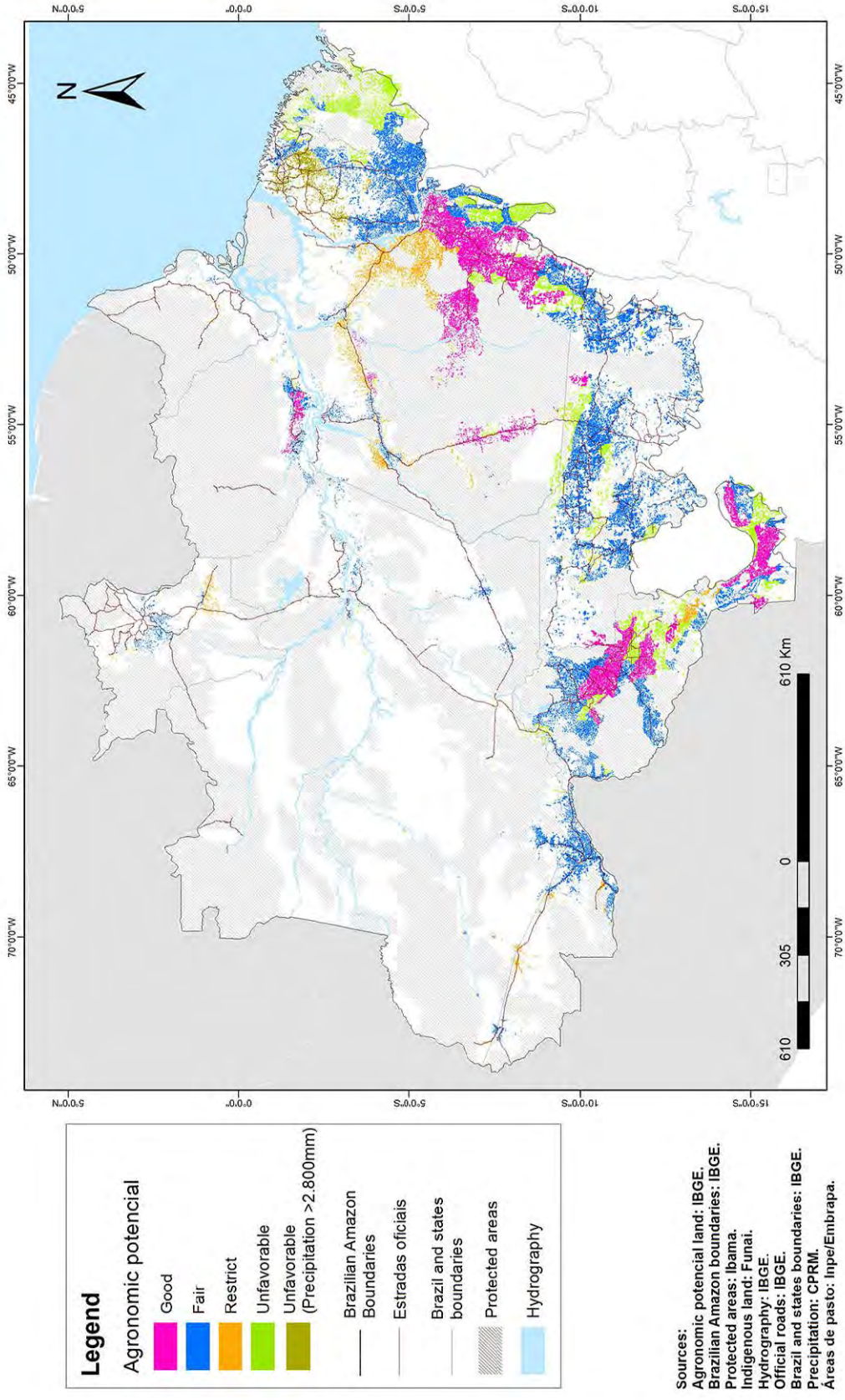
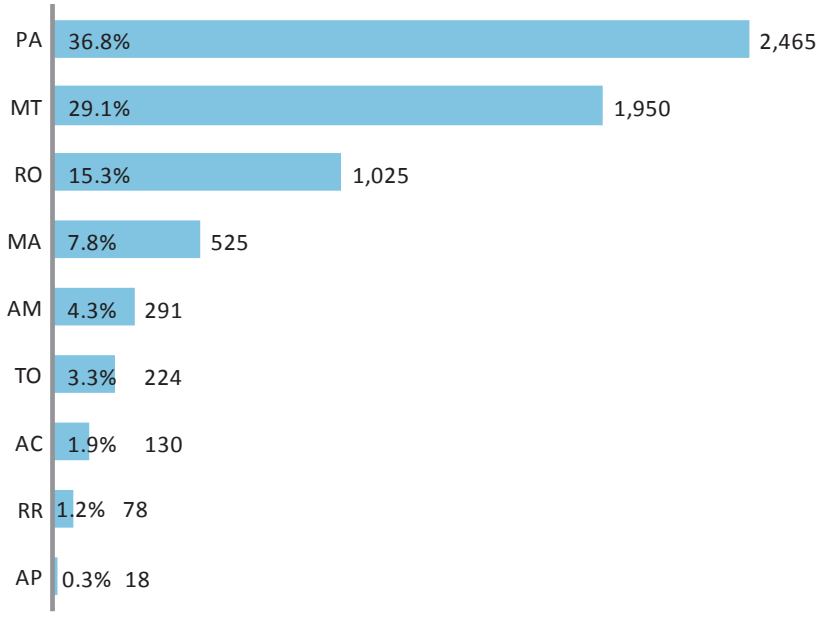


Figure 15. Agronomic potential of lands with pasture in the Amazon biome.

Figure 16. Distribution of the pasture area (% and thousands of hectares) with good and fair agronomic potential in 2007 in the Amazon biome, outside of Protected Areas.



On the other hand, if the additional demand were met by deforesting new areas and maintaining current average productivity it would be necessary to deforest about 12.7 million hectares up to 2022. That would be equivalent to annual deforestation of 1.27 million hectares per year up to 2022, or approximately 3.4 times the goal for deforestation stipulated by the Brazilian government up to 2020 (See Barreto & Araújo, 2012 over the goal). This contribution towards deforestation would affect the reputation of ranching even more negatively.

The scenario for increasing production through new deforestation would also involve costs. Considering a cost of about R$ 200 to R$ 400 per hectare to deforest and form new pastures, the investment would be around R$ 2.5 to R$ 5.1 billion up to 2022, without considering the cost of obtaining the environmental license. Without a license, the producers would be subject to the risk of embargoes and confiscation of cattle. Since the banks do not lend funds for deforestation, the producers themselves would have to come up with these funds.

If there is enormous potential for increasing production without deforesting, why does deforestation continue and average productivity remain so far below the potential? We will dedicate the last section of this work to analyzing these questions and explaining how to encourage adoption of best practices.

Challenges for increasing productivity and reducing deforestation

Average productivity for ranching is low and deforestation continues because there are inhibitors to investment and inefficiencies in fighting illegal and excessive deforestation. To establish policies that reduce deforestation and stimulate the best use of deforested lands in the Amazon it is necessary to understand those factors and how to treat them.

Eliminate barriers to investment in productivity

Establish stable and effective environmental and land title rules

Two recent cases in Pará illustrate how institutional conditions inhibit rural investments. The manager of an oil palm producing company[8] has been trying to invest in a partnership with small-scale producers in the eastern part of the State, but requires environmental and land title regularity for their properties. Because of the lack of regularity in those items the company could not invest in 88 out of 100 properties that were candidates for investment. In October 2012, several institutions presented technologies for increasing ranching productivity at an event in São Félix do Xingu in southern Pará. In response, one discouraged rancher declared *"I will not invest in a rented house"*[9] to refer to the fact that he lacked the title to the land he occupied.

The prevalence of environmental and land title irregularity for properties is the result of similar vicious cycles. On the one hand, the financial and transaction costs for complying with rules tend to be high because the rules are complex, the procedures for fulfilling them are bureaucratic and ineffective and the government agencies are insufficiently equipped for responding to demands from holders of the properties. On the other hand, inefficiency in enforcement and in applying penalties allows illegal operations to prosper (land appropriation and logging, deforestation etc.).

As the problems accumulate crises such as record rates of deforestation and violent disputes over land occur. In an attempt to ease a given crisis, governments try more drastic control measures, but without resolving bottlenecks to complying with rules. The continuing problems lead governments to try to regularize irregular situations in a case by case manner, usually influenced by pressures from rural sector groups, who have accumulated economic and political power. Groups from civil society and specialists criticize such attempts and the resulting impasse many times leads to decisions being put off (See analysis in Araújo & Barreto, 2012). On other occasions, precarious and

[8] Personal communication from Marcello Brito of the Agropalma company, in July, 2012.

[9] OThe use of this analogy by the producer is imprecise, because the squatters use public lands without paying any royalty or rent. However, the analogy is valid due to the fact that the land belongs to someone else.

partial solutions are established and the problem continues (new records of deforestation or more land conflicts).

Bases for lasting and effective solutions continue to be absent. For example, after 13 years of discussions for reforming the Forest Code, Congress produced a proposal that the President partly vetoed and partly regulated, via a decree. Leaders from the various sectors involved are still discussing potential changes to the law and even the possibility of challenging its constitutionality. To deal with the land title chaos the federal government created the Legal Land Program to regularize possessions on 67 million hectares occupied by about 300 thousand holdings in the Amazon. However, the program met only 1% of the goal established for 2010 (Brito and Barreto, 2011).

To encourage investments, environmental and land title policies must be stable and effective. Several measures would be necessary for meeting those objectives, but here we will note three. First, it is necessary to have a high-level government commitment to coordinate the negotiations, allocate resources and require implementation of the necessary measures. The second critical aspect is to establish lasting programs for supporting small-scale producers in complying with the laws, given that the situation of smallholders is often used to justify changing the rules. Even if the rules are simplified, these producers will still need technical and financial support. This finding has already been incorporated in the new Forest Code, which authorizes the Federal Executive Branch to create programs for support and incentives to environmental conservation with a priority focus on Family farmers (Brasil, 2012b). It is therefore now up to the federal government to prioritize resources and create support programs. The third is to make maximum use of the benefits of geoprocessing technologies. The use of satellite images and georeferenced maps could greatly reduce the work of registering, analyzing and monitoring of properties that is necessary for land title and environmental management. Use of such technologies, for example, might eliminate the field inspection that is currently obligatory before the granting of environmental licenses.

Expand research, extension and education

The development and adoption of best agricultural and ranching practices requires capacity building for personnel at several levels. We estimate that the additional production of meat projected up to 2022 would demand 39 thousand persons trained for operating on the ranches. That would demand the training of about 4 thousand persons per year beginning in 2013.

In order to advance, it is essential to replicate the successful experiences with rural extension in the Amazon. In Rondônia, the Fund for Supporting Dairy Ranching (Proleite) receives funds from the government and private sector (milk processing industry) and applies them in training labor (Milkpoint, 2010). In Acre, the Brazilian Agriculture and Ranching Research Company (Embrapa) aids in preparing technicians in the areas of pasture and animal husbandry that provide assistance to producers[10]. To do that, Embrapa utilizes public notices

[10] Personal communication from Judson Valentim, the general director of Embrapa/Acre, in 2012.

from the Personnel Improvement Coordination for higher education (Capes) and the National Council for Scientific and Technological Development (CNPq), directed towards preparing masters' and doctoral students in Brazil as a form of financing specialists who in the future will be references in local production. Maintenance of these technicians in the region is through the producers themselves, who pay for technical consulting.

Another opportunity for expanding technical preparation in the field is the National Program for Access to Technical Teaching and Employment (Pronatec), created by the federal government in 2011. Pronatec offered 23 thousand openings for agriculture and ranching and agroindustrial courses through the National Service for Rural Learning and hopes to advance to 50 thousand in 2013[11].

Install adequate infrastructure

Infrastructure is essential for enabling an increase in productivity through transportation of agricultural and ranching inputs and technical assistance and other services such as education and health. However, the infrastructure is precarious and some investment in infrastructure is inadequate. According to the National Department for Transportation Infrastructure (Brasil, n.d.), in the Amazon, only 40% of federal roads present good traffic conditions, while 27% show fair conditions and 12% are classified as precarious[12]. The other 21% are being worked on (4%), interdicted (1%) or information is lacking (16%). Besides the precariousness of federal roads, the extensive network of municipal and informal roads (opened by timber companies and ranchers) is generally precarious.

The problem is aggravated when the government invests or promises to invest in infrastructure without adequate planning. For example, the paving promised by the federal government for a stretch of the BR-319 highway that connects Manaus to Porto Velho at a cost of R$ 557 million, would generate a loss of R$ 316 million (Fleck, 2009) without counting the environmental losses associated with deforestation. The loss is explained by the low population density in that region.

To guide investments in infrastructure such a vast region, governments should use Ecological Economic Zoning (ZEE) and prioritize areas with greater potential for generating socioeconomic benefits. For example, benefits from investing in infrastructure would be higher in regions with better agronomic conditions and where there is a higher population density.

[11] Information from the Confederation for Agriculture e Ranching in Brazil (CNA). Available at : http://goo.gl/efj2t. Access on: 20 Dec. 2012.

[12] There are still thousands of kilometers of informal and municipal roads, many of them in terrible shape.

Control deforestation

Measures for increasing productivity would tend to increase the profitability of deforested areas and in the medium term could encourage new deforestation (Carpentier *et al*., 2000). Therefore, in order to promote rural growth in a sustainable manner, it would be necessary to reinforce the fight against deforestation. Besides improving environmental enforcement, which has been relatively successful (See analyses in Maia *et al*., 2011, Assunção *et al*., 2012, Barreto & Araújo, 2012), it will be necessary to consider other factors that stimulate deforestation and that have not yet been dealt with adequately.

Combat speculative deforestation

In the Amazon, there are vast forests that belong to the government. Speculators illegally take possession of those areas and use deforestation to signal that they are the lawful occupants (Brasil, 2002; Barreto *et al*., 2008). These occupants expect to profit in the future, either by selling the land or when they themselves can increase production in the area as infrastructure improves (Barreto *et al*., 2008; Margulis, 2003). Since occupation is not economically viable initially[13], the squatters tend to invest little in the area. This practice thus helps explain the approximately 10 million hectares of overgrown pastures in the region and the high frequency of use of labor analogous to slavery along the illegal deforestation fronts (See analysis of slave labor in Théry, 2010).

Several factors have facilitated this speculative appropriation of public lands. Although occupation of these lands is illegal, the Legislative, Executive and Judicial Branches have historically allowed the regularization of possession of public lands or made it difficult to bring them back under public control (Brasil, 2002; Barreto *et al*., 2008; Castilho, 2012). The rules created by the executive and legislative branches for regularization generally involve donation and sale of lands at prices below market value[14], which generates additional profit for the squatters.

Furthermore, the speculators use corruption and fraud to register documents of false lands with land registry offices, which creates a facade of legality that makes it difficult to take back lands (Brasil, 2002; Barreto *et al*., 2008; Brito & Barreto, 2011). Squatters can speculate without producing for many years, since it has been easy to defraud the ITR, which should be higher for unproductive areas (See next section).

The appropriation of public lands is so attractive that politicians and land occupants have taken legal measures to expand access to more public lands, including legislative proposals and court actions to reduce Protected Areas, complicate the recognition of Indigenous and *Quilombola* Lands; and expand the area for occu-

[13] Cattle ranching for raising calves is frequently used to occupy areas. According to Nogueira (2012), anan agronomic engineer and consultant, *in raising, calculations of accumulated assets and the peopling of new areas would cover the low operational return for the activity.*

[14] The Legal Land program of the federal government calls for donation of lands for properties of up to one fiscal module (which may reach up to 100 hectares depending on the municipality) and the sale below market price for properties of up to four fiscal modules (up to 400 hectares). Such measures encourage occupants to subdivide their lots. Additionally, Brito and Barreto (2011) show that the state land title regularization programs in Tocantins, Pará, Mato Grosso and Amazonas sell lands occupied for amounts below the market price. For example, the maximum amount charged by the Land Institute of Tocantins (ITERTINS) was 13 to 22 times lower than the market value for the cheapest lands in Tocantins in 2010.

pation in the ZEEs (Araújo and Barreto, 2010; Agência Brasil, 2012).

Speculators have also used violence against actions for de-occupying public lands (Barreto *et al*., 2008; Aranha, 2012). Violence also breaks out in disputes amongst the land occupants themselves, which turns some of the Amazon municipalities into some of the most violent areas in the country (See data in Waiselfisz, 2011).

Several approaches are needed for preventing and fighting speculation with public lands. To prevent new occupations it is urgent that the government concludes the allocation of public lands in the region. To do this it is essential to prioritize the rights established in the Federal Constitution (recognition of Indigenous Lands and *Quilombola* Peoples) and use approaches that reconcile development with conservation such as the destination of forests for public uses through the creation of Conservation Units (See details in Schneider *et al*., 2000; Maia *et al*., 2011; Brito and Barreto 2011).

At the same time, it is essential to extinguish the donation and sale of public lands below the market price, a proposal that is in harmony with the recommendation of the Parliamentary Inquiry Commission on occupation of lands in the Amazon (Brasil, 2002). Donation and sale below the market value, besides creating an economic incentive for occupation, are unfair to the rest of society, whose assets are privatized without due compensation. Therefore, land title regularization must always always be based on market prices for land.

To facilitate the retaking of lands occupied illegally, the National Justice Council (CNJ) must proceed with administrative cancellation of illegal titles registered in Land Registry Offices (See details in Brito & Barreto, 2011). The public authority must also use an integrated and cooperative approach against speculators in regions that are critical for deforestationfor deforestation, including environmental enforcement (deforestation, burning and logging), labor issues (slave labor), combating violence and fiscal crimes (tax evasion such as ITR and IRR and money laundering – See details in the following sections) and combating frauds and corruption (land registry offices and land agencies). Punishment in some major cases with this approach would serve to discourage occupation of public lands in the region[15]. The priority regions for this type of action, considering deforestation in regions with public lands, include the area the area along the BR-163 highway in southwestern Pará and along the Transamazon highway, between the municipalities of Uruará and Itaituba, also in Pará, and in southern Amazonas and northern Rondônia[16].

[15] An approach with integrated actions and a focus on exemplar cases was recommended by the World Bank (Gonçalves et al., 2011) to deal with organized crime involved in illegal timber harvesting that is associated with the appropriation of public lands.
[16] The map of federal tracts of land is available at: http://www.mda.gov.br/terralegal/, and the deforestation map is updated monthly by Imazon at his address: http://www.imazongeo.org.br/imazongeo.php.

Improve collection of the Tax on Rural Territorial Property

The ITR was created to discourage unproductive use of lands. However, Souza (2004), a technician with Federal Revenue, estimated that collection of the ITR in all of Brazil in 2002 (R$ 243 million) was only about 6% of the potential (R$ 4.29 billion). The ineffectiveness of the ITR was also confirmed by a federal attorney in São Paulo who recommended in 2004 that Federal Revenue take measures to improve collection in that State (Araújo, 2004).

To improve ITR collection it will be necessary to deal with several failings in the way it is charged. The ITR is charged based on declarations provided by the proprietor or possessor of the property regarding the value of the land without improvements, the degree of utilization of the land (% of the area that is utilized in relation to the total utilizable planted area), and other information. To calculate land utilization, the landholder discounts areas unsuitable for use and areas of environmental interest such the Legal Reserve (RL) and the Permanent Preservation Area (APP)[17]. To discourage speculation the ITR establishes higher rates for properties with a low degree of utilization. For example, for properties above 5 thousand hectares with a degree of utilization of up to 30%, the rate is 20%, while it is only 0.45% for a degree of utilization of above 80% (Brasil, 1996).

Owners of properties evade taxes by under declaring the land values (Brasil, 2002) and by declaring a higher degree of land utilization than actually occurs and higher proportion of exempt areas (unusable and of environmental interest). The failings in verification of this information occur at various agencies involved in the process. For example, the Brazilian Institute of the Environment and Renewable Natural Resources (Ibama) is responsible for verifying information about areas of environmental interest that the property holder declares to that institution before filing a tax declaration with Federal Revenue. However, Ibama does not demand the georeferenced map of the property during the declaration. Ibama thus needs to do sampling in the field to verify the existence of forests on the property instead of using satellite images.

To improve enforcement it is possible to integrate several types of available information. Federal Revenue has recently created an Internal System of Prices for Lands, which is supplied with land prices from each region and will serve for overseeing land prices.

There are two sources of georeferenced maps of rural properties that may be crossed with satellite images of vegetation cover to verify the existence of areas of environmental interest that are tax exempt. The first is the Rural Environmental Registry (CAR), in which holders of properties must register. Although incomplete, the CAR from Pará and Mato Grosso at the end of 2012 respectively had 68,927 and 17,840 properties registered[18], driven by agreements that the MPF made with some meat packing

[17] According to Ibama, besides the APP and RL, exemption from the ITR is provide for areas of: Natural Heritage Private Reserve (RPPN), Ecological Interest (AIE), Forest or Environmental Easement (Asfa), areas covered by Native Forest (AFN) and areas Flooded for Hydroelectric Projects (AUH). More information on exemption is available at: http://www.ibama.gov.br/servicos/ato-declaratorio-ambiental-ada.

[18] The number of properties registered may be obtained from the portals of the State Environmental Secretariats, respectively for Mato Grosso (http://monitoramento.sema.mt.gov.br/simlam/) and Pará (http://monitoramento.sema.pa.gov.br/simlam/).

plants (See description of the agreement in Barreto & Araújo, 2012).

In the case of the Amazon, the Legal Land program is a second source, because it has already mapped approximately 55 thousand properties on federal land tracts[19]. Some of those properties overlap maps already registered in CAR, but others are new records.

Combat the use of lands for illicit gains

According to specialists, the current IRR creates an incentive for the use of lands for illicit gains such as tax evasion and money laundering (Agência Estado, 2007). The incentive for crime results from the fact that the IRR is applied to only 20% of the revenue from rural activities by individuals[20], while the Income Tax for Individual Persons (IRPF) applies to almost the totality of income for salaried persons (Agência Estado, 2007). That difference encourages criminals to declare illicit revenue as being rural income and paying taxes related to only 20% of the illicit gain that then appears to be legal (rural income).

This potential for illicit gain creates a demand for rural properties beyond what would be necessary to meet the demand for agricultural and ranching products. Thus, the search for illegal gain results in a demand to deforest more than necessary (See revision on deforestation in the Amazon associated with money laundering in Fearnside, 2008)[21]. Besides, this practice induces inefficiency in production, because the lower the income derived from agricultural and ranching production, the greater the potential for illicit money laundering[22].

Illicit gain, for its part, tends to valorize land more than is normal, since it results in a greater income than agricultural and ranching production could provide. This artificial valuation impedes an honest and efficient rural producer from leasing or buying lands that are used for illicit purposes[23].

Besides the IRR differential, several factors facilitate the use of unproductive lands for achieving illicit gains. According to specialists, including a judge specialized in fighting money laundering, it is easy to obtain the documentation that makes it possible to simulate agricultural and ranching activities through fraud, corruption and connivance with industries such as meat packing plants (Agência Estado, 2007). On the other hand, the agencies that should be fighting this crime are unprepared and lack the necessary coordination and specialization.

In order to discourage the use of lands for illicit gains it would be necessary to adjust the IRR rules and strengthen the institutions in-

[19] Informação pessoal de Sérgio Lopes, Secretário Extraordinário de Regularização Fundiária na Amazônia Legal, em dezembro de 2012.

[20] Lei nº 8.023, de 12 de abril de 1990, Art. 5º. A opção do contribuinte, pessoa física, na composição da base de cálculo, o resultado da atividade rural, quando positivo, limitar-se-á a vinte por cento da receita bruta no ano-base.

[21] O uso da pecuária e do desmatamento para a lavagem de dinheiro tem sido reportado em vários países da América Latina. Ver exemplos em Haan De, 1996; Allen, 2012; Richani, 2012.

[22] Outra forma de lavagem é declarar o valor da produção abaixo do real e usar a diferença para legalizar recursos de origem ilícita.

[23] Richani (2012) avaliou que, na Colômbia, a lavagem de dinheiro de drogas e a redução de imposto sobre terras levou à expansão da pecuária em áreas impróprias para tal uso ao mesmo tempo que reduziu a produção de produtos agrícolas.

volved in fighting money laundering. One form of discouraging money laundering in rural areas would be for the Brazilian Congress to end the IRR differential for individuals, making it similar to other incomes[24].

Additionally, it is necessary to improve procedures for investigating and prosecuting money laundering. The integrated action suggested for action against speculation in critical areas is also valid against laundering. The actions of a federal judge in Mato Grosso do Sul offer lessons in this area. He works through a Specialized Court for Combating Organized Crime that, besides imprisoning those involved in drug trafficking and corruption, determined the confiscation of their goods that included 85 ranches that totaled 368 thousand hectares. Specialization allows the accumulation of knowledge in an area that is complex and relatively new in Brazil (the law against money laundering is from 1998). Furthermore, this and other experiences Brazil demonstrate that judges acting against organized crime should work in a collegial court system (shifts of judges) to keep them from individually becoming the targets of threats and violence from the accused (See Abreu and Milk, 2012).

Finally, efforts against money laundering may become more effective with the legal changes from July 2012, including: any source of illegal money has become subject to penalties (while in the past laundering was only considered for eight types of crimes, such as drug trafficking and kidnapping), the maximum fine went from R$ 200 thousand to R$ 20 million, and the confiscation of goods acquired with illicit money can be quicker by means of a court decision (Brasil, 2012c).

Focus on municipalities that are leaders in wastefulness

Part of the success in combating deforestation in recent years has resulted from the focus on critical municipalities. By concentrating on enforcement in municipalities that were responsible for 50% of recent deforestation, the government has optimized its actions. This same approach might be used to fight land speculation, in other words, to concentrate efforts on enforcing the ITR and tax evasion and money laundering laws.

To select the municipalities that are leaders in wastefulness one might use simple indicators such as the area with overgrown pasture in lands with good and fair agronomic potential. To exemplify this criterion, we crossed the map of overgrown pastures (overgrown + undergoing regeneration) from TerraClass with the agronomic potential map of the Brazilian Institute for Geography and Statistics (IBGE). We found that 46 municipalities in the Amazon biome concentrated 50% of these pastures in 2007, the equivalent to 6.7 million hectares. The first 20 municipalities on the list all have an average of one hundred thousand hectares of overgrown pastures. Municipalities with continuing high rates of deforestation headed this list; such as São Felix do Xingu, Novo Progresso and Altamira. Appendix V shows the list of municipalities that total 80% of the overgrown pastures in lands with good and fair agronomic potential. The list should ideally be updated at least every two years with the data derived from TerraClass.

[24] Neste caso, se o país deseja manter a tributação sobre a renda rural no mesmo nível atual, seria necessário apenas reduzir a alíquota do IRR sobre o total da renda.

APPENDIX

APPENDIX I
Estimate of the value of agricultural and ranching production

In this section we present the methods and data sources that we used to estimate the value of agricultural and ranching production. All of the monetary values (value of production, prices) were corrected for the year 2010 by applying the General Index of Prices – Internal Availability (IGP-DI) of the Fundação Getúlio Vargas (FGV) to the values current for each year.

Ranching

The value of bovine ranching production includes the following components: gross value for the sale of beef + sale of live cattle + sale of milk. Because IBGE does not estimate the value of beef sales, we estimate this value by multiplying the weight of cattle slaughtered (in *arrobas*) by the average price per *arroba* in each year (IEA, n.d.). To estimate the weight slaughtered in *arrobas*, we obtained from the IBGE the weight of cattle slaughtered in Amazon biome municipalities in kilograms and divided it by 15.

To estimate the current value of sales of live cattle we consulted data on the value of exported products from the Ministry of Development, Commerce and Industry (MDIC, n.d.). We estimated the average price of cattle considering the daily price averages for the *arroba* year by year, according to data from the Institute of Applied Economics (IEA) of São Paulo.

We utilized stocking in pastures (number of animals per hectare) as an indicator of ranching productivity. To estimate stocking, we divided estimates of the herd by an estimate of the pasture area for the States in the Legal Amazon and the three States that had 75had 75% of the herd in 2010: Mato Grosso, Rondônia and Pará.

The area in pasture was obtained in two ways. We obtained the data directly from IBGE from IBGE for the years of the Agriculture and Ranching Census (1995, 2006), which collected data from the pasture area. For the other years from 1995 to 2010 we estimated the pasture area considering the growth rate for deforestation, according to the Program for Calculating Deforestation in the Amazon (Prodes).

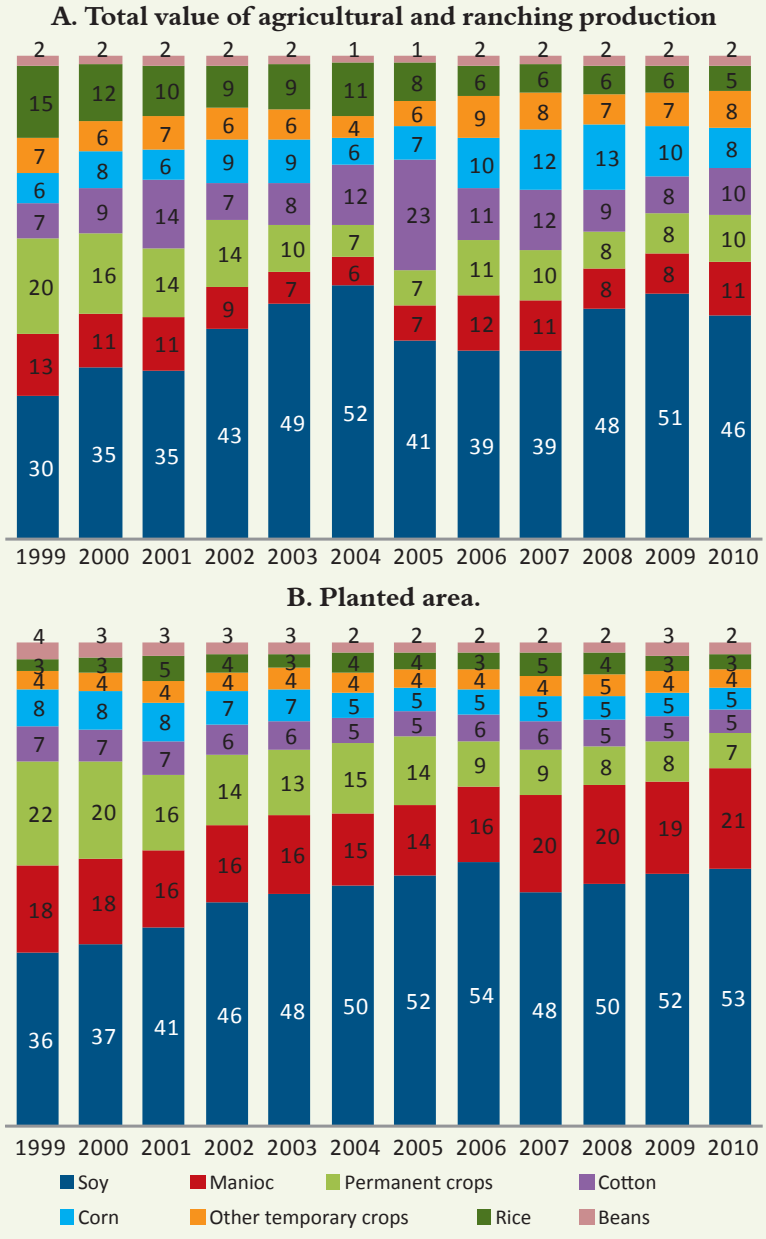
Agriculture

To discover the crops with the greatest potential for influencing variation in the value of production we estimated the proportion of participation of each crop on the value of production and on the planted area. We performed these analyses with data from IBGE. We obtained the current value of agricultural production directly from IBGE for all of the crops surveyed by this institute in the Amazon biome municipalities.

The most important crops were soy, corn, rice and manioc and perennial crops, since, according to IBGE (2012), they totaled 92% of the value of production and 66% of the planted area in 2010 (Figure 1). To estimate the average value of each agricultural product (R$/kg), we divided the value of production of each product by its quantity.

We estimated productivity rates for the main agricultural crops using yield data surveyed by IBGE from 1990 to 2010. The rates were calculated using 1990 as base 100, meaning that we calculated variations in productivity by dividing productivity for each year by productivity for the year 1990.

Figure 1. Percentage distribution of the planted area (A) and in the total value production (B), by crops, in the Amazon biome from 1999 to 2010.



Source for data: IBGE (n.d. (a)).

APPENDIX II
Techniques for increasing productivity for beef cattle ranching

Although average productivity for ranching in the Amazon has been increasing, it is still well below its potential. The data from IBGE (Figure 5) indicate an average stocking of 1.3 animals per hectare and field surveys show a productivity of about 80 kilograms per hectare per year (Homma *et al*., 2006; FNP, 2011). The use of best practices can result in a productivity of 240 to 720 kilograms per hectare per year according to studies (Maya 2003; Homma *et al*., 2006) and the specialists consulted (Moacyr Corsi, PHD in Agronomy and professor at the University of São Paulo, who has been providing assistance to ranches in the Paragominas (PA) region; and Joaquim E. G. Ribeiro, animal husbandry specialist, Director of Terra Nativa Gestão & Negócios Sustentáveis, which diagnosed the situation in nine regions in the eastern region of Pará.

Low productivity is associated with the following situations:

Overgrown pastures. These have a high occurrence of invasive plants, which reduces availability of forage for the cattle. In these situations, the cattle take up to four years to reach the ideal weight for slaughter. Based on data from Inpe/Embrapa (2011), IBGE (n.d.) and CPRM (n.d.) we estimated that around 25% of the pastures in regions with better agronomic potential were overgrown in 2007 (See in Appendix III). Our recent field observations have demonstrated that extensive pasture areas continue to have these characteristics. We found two main types of overgrown pastures. First, there are overgrown pastures that were not properly formed since the beginning, involving only deforestation and burning of vegetation (popularly known as stump pastures). In those areas, besides the grass, there is woody material from the felled trees (stumps, branches and larger trunks) and forest regeneration (Photo 1). Second, there are pastures in which the soil was well cleared after felling (remove the stumps and grading), but there is a high density of invasive plants because of overgrazing, and there has been a lack of control of invasive species and of soil fertilization (Photo 2).

Low degree of use of available grass. Researchers have demonstrated that failures in herd management lead to the use of 35% of the grass produced even in clean pastures (Corsi, 2007). See demonstration of underused pasture in a video from the Globo Rural program available at: http://bit.ly/ZUlJw9).

Low gestation rate. The gestation rate in cattle ranching with low-level technology is around 60 to 80 % (Homma *et al*., 2006) and means that a large number of cows occupy space over a long period without producing new calves. The low gestation rate is associated with deficiencies in feeding and other items of

Photo 1. Overgrown pasture resulting from poor formation in eastern Pará. Photograph: Paulo Barreto.

Photo 2. Overgrown pasture resulting from insufficient fertilization and overgrazing after land clearing in eastern Pará. Photograph: Paulo Barreto.

animal health. Furthermore, the lack of control over operations makes producers inefficient in identifying cows that should be discarded because they are unproductive.

Inadequate practices in animal management. The lack of adequate facilities and personnel training leads to inadequate management resulting in discomfort, diseases, damages and even unnecessary deaths of animals.

Data from studies and specialists indicate the following approaches and techniques for improving ranching productivity.

According to the specialists heard (Joaquim E. G. Ribeiro and Moacyr Corsi), the highest potential for increasing productivity in the region is in ranching based on feeding in the pasture. To do this it is necessary to increase pasture stocking and weight gain per head/day. That would imply increasing forage supply and creating conditions for the cattle to effectively consume the available grass. To increase the forage supply it is possible to improve overgrown pastures and replace fertility for those that have already been cleared. This improvement includes preparing the soil (acidity correction through liming and fertilizing) and planting of appropriate grass. The improvement costs would be higher in areas with stumps, since these would need to be removed. In pasture improvement, it is also possible to plant grass intercropped with legumes (such as forage peanut) that help with natural soil fertilization, as has been done on some ranches in Acre assisted by Embrapa (Embrapa, 2010).

The principal technique for increasing grass consumption is to rotate cattle among several pastures. To do that, pastures must be subdivided and each plot should contain a water trough and a trough for salt (feed supplement). The ranch hands should take the cattle to a pasture in which the grass is at the ideal size for consumption and should remove them as soon as the most nutritious part of the grass is consumed. After removal of the cattle, the pasture lies fallow until it recovers. In one study by Costa *et al.*, (2006), pasture division and correct rotation of cattle by themselves increased productivity from 74 to 262 kilograms per hectare per year. Because of the higher use of pastures in the rotational system it is necessary to replace soil fertility frequently. See the video from the Globo Rural program with an example of preparing an area in Paragominas at: http://bit.ly/ZUlJw9.

Besides improving feeding, in order to increase productivity techniques for animal well-being need to be introduced for handing the cattle in order to reduce mortality and damage to animals and increase weight (Sant'Anna & da Costa, 2009). Such techniques involve, among other things, construction or improvement of corrals and training of ranch hands in order to facilitate treatment of the animals[25]. In fact, training of employees is essential for them to perform all of the methods for increasing productivity.

Improved feeding and management of the animals makes it possible to raise the gestation rate to 80 to 95% (Homma *et al*., 2003).

[25] See didactic materials at: http://bit.ly/RwlP8h, and examples of application in Globo Rural programs at: http://bit.ly/WqefZZ e in http://bit.ly/ZUlJw9.

The profitability of intensive ranching for finishing

In order to assess the profitability of intensifying ranching we contracted a consultant who produced a diagnostic and productive potential for nine ranches in eastern Pará. Based on the technical indicators surveyed by the consultant, we estimated the costs, revenue and return on investment with the current situation and with adoption of best practices. We estimated that the investment for intensification is R$ 1,575 per hectare considering installation of fences to divide pastures, water tanks and fertilizers (Table 1). Considering revenue with a productivity of 300 kilograms per hectare per year (equivalent to 15 *arrobas*), the annual gross income would be approximately R$ 1,620 per hectare considering the price of R$ 81 per *arroba* of cattle. The internal rate of return on the investment would be 20% for a period of 10 years, including costs of training for adoption of best practices. This return is compatible with the 17% found by Maya (2003), in São Paulo, and with the 19% found by Homma *et al*. (2006) in simulations for conditions in Pará. However, for individual investment decisions, profitability must be estimated for each property taking into account specific conditions of infrastructure, pasture and soil situation, distance to market and costs for dealing with possible environmental liabilities such as recovery of RL and APP.

Table 1. Average investment for increasing productivity in ranching for weaning and finishing on nine ranches in eastern Pará.

Item	Average value (R$/hectare)
Fence	260
Improving and fertilizing pastures	1,065
Installation of water tanks	250
Total	**1,575**

APPENDIX III

Pasture with potential for ranching intensification in the amazon biome

To estimate the area of pasture with the potential for increasing productivity we considered legal and agronomic aspects. First, we excluded pastures from the Protected Areas (Figure 1) in which raising of large animals is forbidden (Indigenous Lands and all Conservation Units, with the exception of Environmental Protection Areas (APAs). To do that, we crossed the TerraClass pasture map (about 40 million hectares) with the Protected Areas map. The pastures in these areas totaled 963 thousand hectares in 2007. Next, we crossed the map of the remaining pastures with the IBGE (n.d.) agronomic potential map and the rainfall map (Figure 2). As areas with potential for intensification we considered only areas with good and fair agronomic potential according to the IBGE and with annual rainfall below 2,800 millimeters. According to the analysis by Chomitz & Thomas (2001), stocking rates in pastures in areas with rainfall above 2,800 millimeters were low, probably because they were more susceptible to the development of diseases and pests and because of the rapid loss of soil nutrients. Thus, we found an area of approximately 28 million hectares with potential for intensification. Table 1 shows the distribution of the potential for intensification by State, as well as the discarded areas.

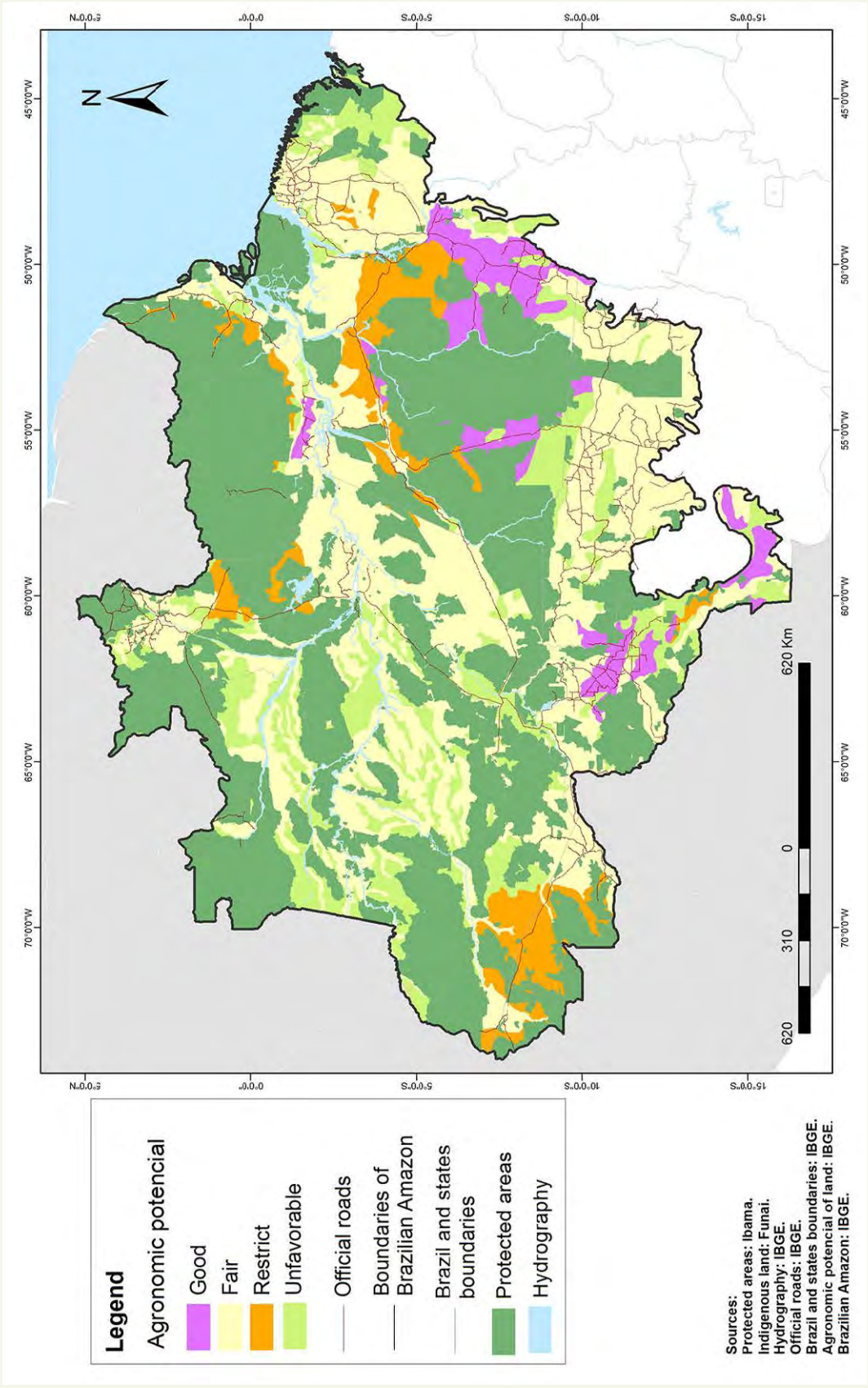


Figure 1. Protected Areas and agronomic potential of lands in the Amazon biome.

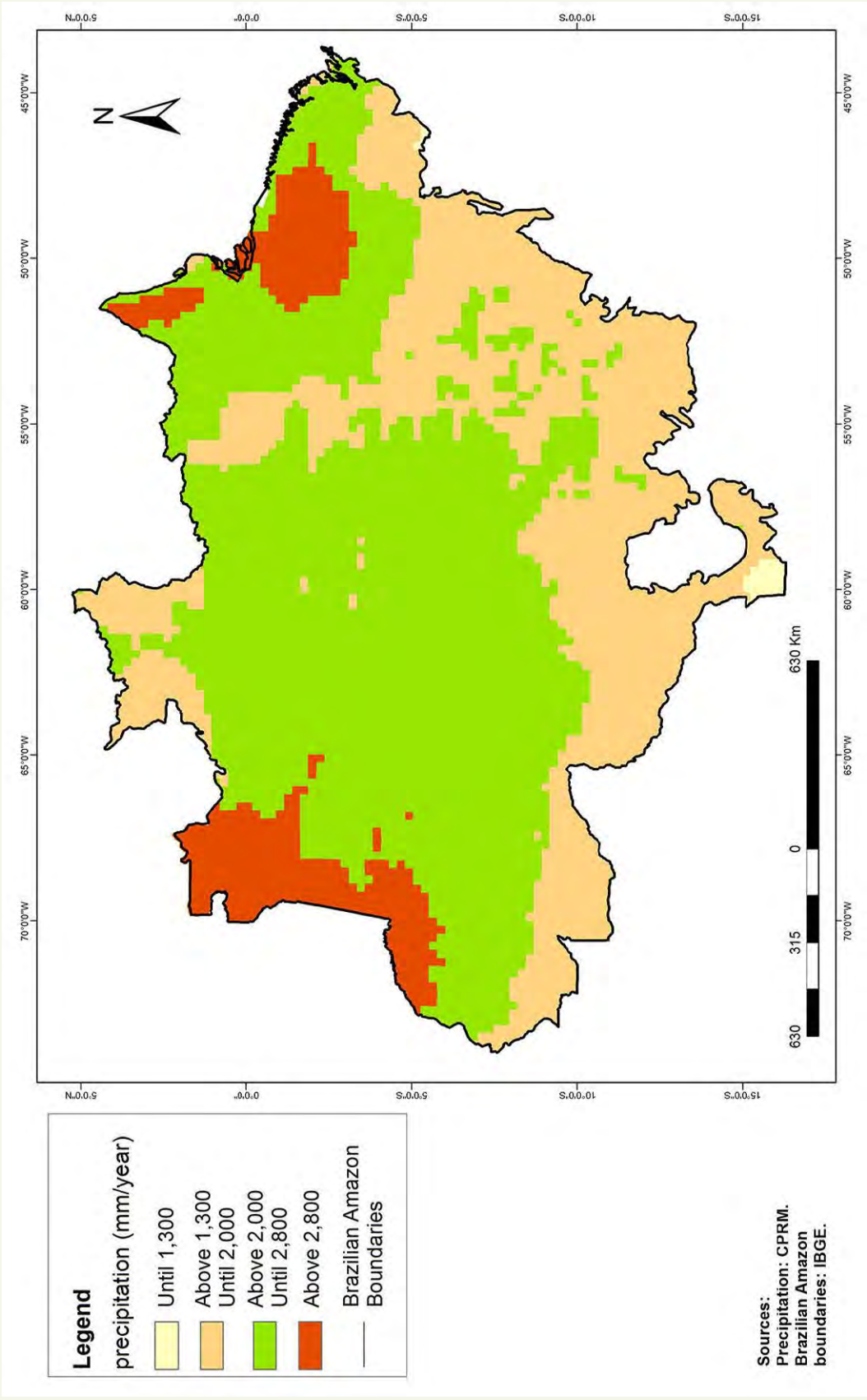


Figure 2. Precipitation in the Amazon biome.

Table 1. Distribution of the pasture area in States of the Amazon biome with potential for intensifying ranching (areas with good and fair agronomic potential and with rainfall below 2,800 millimeters) and outside of Protected Areas[26].

States	Total of pastures outside of Protected Areas	Distribution of agronomic potential				
		Restricted and unfavorable	Good	Fair	Good and fair	% of good and fair
PA	12.88	3.61	5.45	3.82	9.27	33.3
MT	11.14	1.98	1.59	7.57	9.16	32.9
RO	7.28	1.98	2.29	3.01	5.30	19.0
MA	2.99	1.54		1.45	1.45	5.2
AC	1.08	0.15		0.93	0.93	3.3
AM	0.92	0.13		0.79	0.79	2.8
TO	1.55	0.85		0.71	0.71	2.5
RR	0.40	0.17		0.24	0.24	0.8
AP	0.10	0.07		0.03	0.03	0.1
Total	**38.36**	**10.49**	**9.34**	**18.54**	**27.87**	**100.0**

[26] Includes the category of Conservation Unit APA.

APPENDIX IV
The area necessary for meeting demand for beef in 2022

In this section we present the calculations of the area necessary for meeting the additional demand for beef projected for 2022 in the Amazon considering a scenario of adopting more productive techniques and another in newly deforested areas maintaining the productivity found in 2010.

The Ministry of Agriculture has projected that from 2011/2012 to 2022 consumption of meat produced in Brazil would increase by 25.9%. To estimate the increase in relation to 2010 (the last year for which we had complete production data) we added a year of projected growth (2.1%, which was the projected average annual growth). Thus, the rate of growth would be 28% from 2010 to 2022. We multiplied this growth rate by the volume produced in 2010 (2,748,779 tons) to obtain the additional volume that it would be necessary to produce in 2022 to meet the projected consumption (769,658 tons).

Scenario with an increase in productivity

To estimate the area necessary to produce the additional volume in 2022 in the scenario with increased productivity we performed two estimates. First, we estimated the area necessary to fatten the herd that would be slaughtered. Next, we estimated the area necessary for producing the calves that would replace the herd for fattening; meaning, the area for the mother cows and calves. The technical indicators used for estimating gains in productivity are summarized in Table 1.

Table 1. Technical indicators for ranching with an increase in productivity.

Items	Indicators
Productivity (kg equivalent carcass/hectare/year)	300
Stocking of pasture (Animal Unit/hectare)	3
% of adult herd slaughtered annually	90
Gestation rate (% of cows that produce one calf per year)	80

To estimate the area for fattening we divided the additional demand projected for 2022 (777,904 tons) by the additional productivity in area of intensified pasture. Additional productivity is the difference between productivity in an intensified pasture minus productivity before intensification, meaning 0.22 ton per hectare per year (0.3-0.08). Thus, dividing 777,904 tons by 0.22/tons per hectare per year we reach 3,535,929 hectares.

To estimate the area necessary for raising we first estimate the herd of calves necessary for fattening. To do that, we first divide the total weight demanded (777,904 tons) by the average weight of the carcass of each animal (0.209 ton) and are given a herd of 3,722,031 to be slaughtered. To estimate the herd of calves necessary, we consider that only 90% of the calves would be slaughtered every year. Thus, dividing 3,722,031 by 0.9 we obtain the herd of calves to be produced: 4,135,590.

To estimate the numbers of cows necessary to produce this number of calves, we consider that the gestation rate would be 80%. Thus, the number of cows would be 5,169,487 (4,135,590/0.8). In summary, there would need to be a herd of 9,305,077 animals (4,135,590 calves + 5,169,487 cows).

To estimate the area necessary for this herd we convert the number of animals into a standard unit (Animal Unit – UA, equivalent to 450 kilograms) that is used to measure stocking in pastures (number of animals per hectare). For conversion, we multiply the herd by the average weight of each animal (336 kilograms) and then divide by 450 kilograms [(9,305,077 animals X 336 kilograms)/450 kilograms]. Thus, the herd of cows and calves in UA would be 6,947,791.

To estimate the area that the herd of cows and calves would occupy we consider that the number of animals per hectare in an area with high productivity would be 3 UAs per hectare in comparison with 0.8 UA per hectare before intensification. Intensification would thus increase stocking by 2.2 UAs per hectare. Therefore, to estimate the area with the necessary high productivity we divide the herd by 2.2 UA per hectare and reach 3,158,087 hectares. Thus, the area necessary to meet the additional demand in 2022 should be 6,694,016 hectares: 3,535,929 for the herd for finishing and 3,158,087 for the herd for raising and weaning.

Scenario maintaining productivity at 2010 level

To estimate the area for the scenario maintaining productivity we multiply the estimated area of pasture in 2010 (42,504,629 hectares) by the percentage of increasing demand up to 2022 (28%).

We estimate the pasture area in 2010 by adding the pasture estimated by TerraClass in 2007 (40,451,504) to an estimate of the pasture area formed from 2008 to 2010. To estimate the area of pasture formed since 2008, we assumed that 75% of the deforested area (estimated by Inpe) was transformed into pasture (2,053,125). Thus, the area of additional pasture was estimated at 12,751,388.

APPENDIX V

List of municipalities with largest areas underutilized for ranching

We present below a list of municipalities totaled 80% of overgrown pastures areas in lands with good and fair agronomic potential in the Amazon biome in 2007 outside of Protected Areas (See methodology in Appendix III).

STATE	MUNICIPALITY	GOOD	FAIR	TOTAL	% OF TOTAL	% CUMULATIVE
PA	SAO FELIX DO XINGU	158,945	24,561	183,505	3	3
MT	ARIPUANA	20,900	157,379	178,279	3	5
MT	JUARA	-	129,550	129,550	2	7
PA	SANTA MARIA DAS BARREIRAS	114,126	13,369	127,495	2	9
RO	PORTO VELHO	-	125,459	125,459	2	11
PA	NOVO PROGRESSO	118,191	-	118,191	2	13
MA	AÇAILÂNDIA		103,379	103,379	2	14
MT	PONTES E LACERDA	80,258	17,113	97,371	1	16
PA	ALTAMIRA	94,036	-	94,036	1	17
PA	CONCEIÇÃO DO ARAGUAIA	88,790	-	88,790	1	19
PA	CUMARU DO NORTE	87,394	1,238	88,632	1	20
PA	GOIANÉSIA DO PARÁ	-	81,427	81,427	1	21
PA	MONTE ALEGRE	34,480	45,303	79,783	1	22
PA	SANTANA DO ARAGUAIA	19,980	59,589	79,569	1	23
PA	FLORESTA DO ARAGUAIA	74,132	-	74,132	1	25
RO	MACHADINHO D'OESTE	-	73,447	73,447	1	26
PA	RONDON DO PARÁ	-	72,071	72,071	1	27
PA	XINGUARA	64,486	6,072	70,558	1	28
PA	PICARRA	36,611	32,584	69,195	1	29
MA	BOM JESUS DAS SELVAS		67,444	67,444	1	30
MT	MARCELÂNDIA	-	66,820	66,820	1	31
MT	TAPURAH	-	64,191	64,191	1	32
MT	VILA BELA DA SANTÍSSIMA TRINDADE	19,889	42,102	61,992	1	33
RO	NOVA MAMORÉ	-	61,351	61,351	1	34
PA	RIO MARIA	60,959	-	60,959	1	35
MT	SAO FELIX DO ARAGUAIA	-	57,831	57,831	1	35

STATE	MUNICIPALITY	GOOD	FAIR	TOTAL	% OF TOTAL	% CUMULATIVE
MT	PORTO DOS GAÚCHOS	-	57,807	57,807	1	36
MA	SANTA LUZIA		56,000	56,000	1	37
MT	JUÍNA	-	54,184	54,184	1	38
PA	DOM ELISEU	-	53,748	53,748	1	39
AM	LÁBREA		53,250	53,250	1	40
MT	NOVA BANDEIRANTES	-	53,171	53,171	1	40
MA	BURITICUPU		51,940	51,940	1	41
MA	BOM JARDIM		51,929	51,929	1	42
MT	BRASNORTE	-	51,691	51,691	1	43
MT	NOVA MARINGÁ	-	49,231	49,231	1	43
RO	JI-PARANÁ	28,082	20,504	48,586	1	44
PA	PARAGOMINAS	-	48,292	48,292	1	45
RO	JARU	45,222	2,562	47,785	1	46
MT	PARANATINGA	-	45,303	45,303	1	46
PA	ÁGUA AZUL DO NORTE	43,736	-	43,736	1	47
MT	GAÚCHA DO NORTE	-	43,438	43,438	1	48
RO	CUJUBIM	-	43,315	43,315	1	48
PA	REDENÇÃO	43,152	-	43,152	1	49
MT	COTRIGUAÇU	-	41,681	41,681	1	49
RO	CANDEIAS DO JAMARI	-	41,248	41,248	1	50
PA	ALENQUER	33,340	7,750	41,090	1	51
PA	ULIANÓPOLIS	-	40,926	40,926	1	51
MT	ALTO BOA VISTA	-	40,672	40,672	1	52
MT	CONFRESA	-	40,387	40,387	1	52
MT	ITAÚBA	-	40,033	40,033	1	53
MA	CENTRO NOVO DO MARANHÃO		38,757	38,757	1	54
RO	VALE DO ANARI	-	37,730	37,730	1	54
RO	CACOAL	37,290	-	37,290	1	55
MT	APIACÁS	-	36,594	36,594	1	55
MT	TABAPORÃ	-	35,895	35,895	1	56
MT	NOVA UBIRATÃ	-	35,828	35,828	1	56
PA	BREU BRANCO	-	35,258	35,258	1	57
MT	PEIXOTO DE AZEVEDO	7,600	27,483	35,083	1	57
RO	THEOBROMA	7,049	27,849	34,898	1	58
TO	ARAGUAÍNA	-	34,701	34,701	1	58
RO	COSTA MARQUES	-	33,934	33,934	1	59
PA	CAPITÃO POÇO	-	33,648	33,648	1	59
RO	ARIQUEMES	16,232	17,356	33,588	1	60

STATE	MUNICIPALITY	GOOD	FAIR	TOTAL	% OF TOTAL	% CUMULATIVE
PA	ITAITUBA	7,777	25,596	33,373	0	60
MT	CASTANHEIRA	-	33,108	33,108	0	61
PA	JACUNDÁ	-	31,816	31,816	0	61
RO	SAO FRANCISCO DO GUAPORÉ	-	31,713	31,713	0	62
AM	BOCA DO ACRE		31,490	31,490	0	62
AC	RIO BRANCO		31,255	31,255	0	63
MT	ALTA FLORESTA	-	29,688	29,688	0	63
MT	FELIZ NATAL	-	29,029	29,029	0	64
RO	OURO PRETO DO OESTE	20,086	8,862	28,948	0	64
MT	VILA RICA	90	28,118	28,209	0	65
MT	QUERÊNCIA	-	28,180	28,180	0	65
MT	NOVA MONTE VERDE	-	27,601	27,601	0	65
MT	NOVA LACERDA	7,597	19,230	26,827	0	66
PA	ÓBIDOS	13,139	13,039	26,178	0	66
PA	ORIXIMINÁ	10,582	14,366	24,948	0	67
PA	TOME-AÇU	-	24,921	24,921	0	67
RO	GOVERNADOR JORGE TEIXEIRA	23,998	248	24,247	0	67
PA	RURÓPOLIS	-	24,193	24,193	0	68
PA	AURORA DO PARÁ	-	24,056	24,056	0	68
PA	SANTARÉM	-	23,991	23,991	0	68
PA	SAPUCAIA	23,587	-	23,587	0	69
PA	SAO DOMINGOS DO CAPIM	-	23,126	23,126	0	69
MT	TERRA NOVA DO NORTE	-	23,054	23,054	0	69
PA	GARRAFÃO DO NORTE	-	22,498	22,498	0	70
PA	IPIXUNA DO PARÁ	-	22,462	22,462	0	70
PA	MOJÚ	-	22,005	22,005	0	70
PA	PLACAS	772	21,082	21,853	0	71
MT	SAO JOSE DO XINGÚ	-	21,770	21,770	0	71
TO	PIRAQUÊ	-	21,059	21,059	0	71
AM	MANICORÉ		20,906	20,906	0	72
PA	NOVA ESPERANÇA DO PIRIÁ	-	20,797	20,797	0	72
MA	AMARANTE DO MARANHÃO		20,510	20,510	0	72
TO	ARAPOEMA	-	20,339	20,339	0	73

STATE	MUNICIPALITY	GOOD	FAIR	TOTAL	% OF TOTAL	% CUMULATIVE
RO	GUAJARÁ-MIRIM	-	20,195	20,195	0	73
RO	VALE DO PARAÍSO	8,695	11,016	19,711	0	73
PA	IRITUIA	-	19,327	19,327	0	73
TO	PAU D'ARCO	-	19,191	19,191	0	74
MT	CANARANA	-	18,788	18,788	0	74
RO	SAO MIGUEL DO GUAPORÉ	2,481	16,140	18,622	0	74
RO	BURITIS	-	18,404	18,404	0	75
MT	NOVA OLÍMPIA	758	17,549	18,307	0	75
RR	CANTA		17,945	17,945	0	75
AM	APUÍ		17,922	17,922	0	75
MT	BARRA DO BUGRES	1,657	16,021	17,678	0	76
PA	CURIONÓPOLIS	17,620	-	17,620	0	76
MT	SANTA TEREZINHA	7,300	10,256	17,556	0	76
RR	MUCAJAÍ		17,509	17,509	0	76
MT	TANGARÁ DA SERRA	11,833	5,441	17,274	0	77
PA	CASTANHAL	-	16,846	16,846	0	77
TO	BERNARDO SAYÃO	-	16,565	16,565	0	77
RO	ESPIGÃO D'OESTE	15,703	592	16,295	0	77
RO	PIMENTEIRAS DO OESTE	55	16,142	16,196	0	78
AC	BUJARI		16,147	16,147	0	78
PA	TUCUMÃ	16,139	-	16,139	0	78
AM	ITACOATIARA		16,120	16,120	0	78
TO	BANDEIRANTES DO TOCANTINS	-	16,118	16,118	0	79
AC	PLÁCIDO DE CASTRO		16,109	16,109	0	79
MA	ITINGA DO MARANHÃO		15,567	15,567	0	79
RO	CAMPO NOVO DE RONDÔNIA	3,840	11,560	15,400	0	79
RO	JAMARI	-	15,112	15,112	0	80
AM	CAREIRO		14,744	14,744	0	80
TO	RIACHINHO	-	14,732	14,732	0	80
RO	ALTA FLORESTA D'OESTE	9,296	5,391	14,687	0	80
PA	PAU D'ARCO	14,106	-	14,106	0	80
	Outros 310 municípios	261,906	1,048,069	1,309,976	20	100
TOTAL		**1,813,897**	**4,892,001**	**6.705.898**		

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It is possible to combat deforestation of the Amazon and promote the growth of the rural economy in the region. That tendency has been occurring since 2007 and may become consolidated over the next few years. The critical factor in increasing production without deforesting is to increase productivity, especially for ranching, the main use made of deforested areas. We estimate that it would be possible to supply the increased demand for beef projected up to 2022 by increasing productivity by around only 24% of pasture with agronomic potential for intensification existing in 2007. Thus, it would be possible without deforestation to increase the value of agricultural ranching production by around R$ 4 billion by 2022 – a 16% increase in the value of agriculture and ranching in 2010. In order for agricultural and ranching production to grow only in already deforested areas the public sector needs to correct failings in policies that discourage investment in those areas and others that encourage deforestation.

Execution

Imazon

Funding

Climate and Land Use Alliance

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