INCREASING AGRICULTURAL OUTPUT WHILE AVOIDING DEFORESTATION – A CASE STUDY FOR MATO GROSSO, BRAZIL

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THE INTERNATIONAL INSTITUTE FOR SUSTAINABILITY

IN PARTNERSHIP WITH:

INSTITUTO CENTRO DE VIDA

AGROSUISSE

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CHAPTER 1 - Introduction

Over millennia, agricultural practices have produced food and fodder for human population. Between 1940 and late 1970s the ‘Green Revolution’ allowed to avoid Malthusian’s gloomy forecasts that the Earth would not be able to support its growing human population. ‘Green Revolution’ cased on a range of scientific research and management solutions, such as development of high-yield varieties of cereal grains or expansion of irrigation infrastructure, doubled global grain production, greatly reducing food shortages (Tilman et al., 2001) and is believed to have saved millions of people from starvation. Notwithstanding, food insecurity is currently a major global problem with millions still hungry throughout the planet (due to both food accessibility and affordability) and the problem may escalate due to increasing population.

On the other hand, the conversion of natural environments into managed ones contributed to major environmental problems, such as pollution, land degradation and biodiversity loss. Further, land use and land use change combined contribute 31% of anthropogenic greenhouse gas emissions (IPCC, 2007). Agriculture has historically been the greatest force of land transformation (Ramankutty et al. 2007), with population growth and per capita consumption driving global land use change (Tilman et al. 2001). Global cropland area expanded from 3-4 million km^2 in 1700 to 15-18 million km^2 in 1990, mostly at the expense of forests (Goldewijk and Ramankutty, 2004). Similarly, Gibbs et al. (2010) showed that throughout the tropics, between 1980 and 2000 more than 80% of new agricultural land resulted from deforestation (Gibbs et al. 2010).

According to future projections (Bruinsma, 2009) demand for new agricultural land fuelled by demand for food, fodder and timber will continue over the next four decades at least, driven by population and per capita consumption growth. Over the next decades, business as usual, extensive agriculture therefore has the potential to cause irreversible environmental impacts, especially in tropical forest-countries.

The sustainable intensification of production in current agricultural lands has been suggested as a key solution to the conflict between expanding agricultural production and conserving natural ecosystems (Smith et al., 2010; Phalan et al., 2011). It has been shown (e.g. Smith et al., 2010; Herrero et al., 2010) that it is possible to increase agricultural efficiency and mitigate greenhouse gases through resource conservation and improvements in land management, which lead to increased yields without further deforestation. Importantly, in addition to be technically feasible, to regenerate degraded lands and improve supply chain efficiency, sustainable intensification can result in positive returns to landowners, smallholders, processors, traders and ultimately governments through increased tax returns and multiplier effects on the economy. On the other hand, it has been demonstrated (Lambin and Meyfroid, 2011) that increased productivity does not necessarily lead to land sparing. In many cases, the opposite is true, with increased deforestation following increases in productivity. This is mainly due to the 'rebound-effect', a classic economic effect where increased productivity makes an activity more attractive, leading to an increase in demand for its inputs (in this case, land). Further, some approaches to agricultural intensification by increasing use of on-farm inputs may increase greenhouse gas emissions from use of fertilizers and machinery, and hence be may not be sustainable over the long term. Moreover, increasing agricultural productivity should be associated will all elements of the supply chain and linked to market demand. Otherwise, sudden increases in productivity could lead to price crashes, reduced production and generate unemployment.

In order to prevent deforestation a number of stakeholders should be involved, including private sector, NGOs and government. Also, upfront investment is required to assist changes in agricultural practice that will lead in the future to productivity increase. However, even if subsidies are provided, private sector should be provided with risk reduction mechanism. Unless risk barriers are reduced or eliminated, a shift towards a more productive agriculture may be heavily constrained.

The purpose of this study is to inform debates associated to Reducing Emissions from Deforestation and Forest Degradation (REDD+) and sustainable supply chains strategies about the implementation gap and practical on-the-ground solutions for conciliating agriculture productivity increase and avoided deforestation. It focuses both at the producer level, investigating financial requirements, and at a broader implementation level, discussing possible financing and deliverable mechanisms.

Chapter 2 - Context setting

The State of Mato Grosso, located in the Centre-West Region of Brazil, has a total area of 903 thousand square kilometres, composed of three main biomes: the Amazon forest, the Cerrado (savannah) and the Pantanal wetlands (Figure 2.1). Its population totals 3.0 million people, with an urbanization rate of 82%.

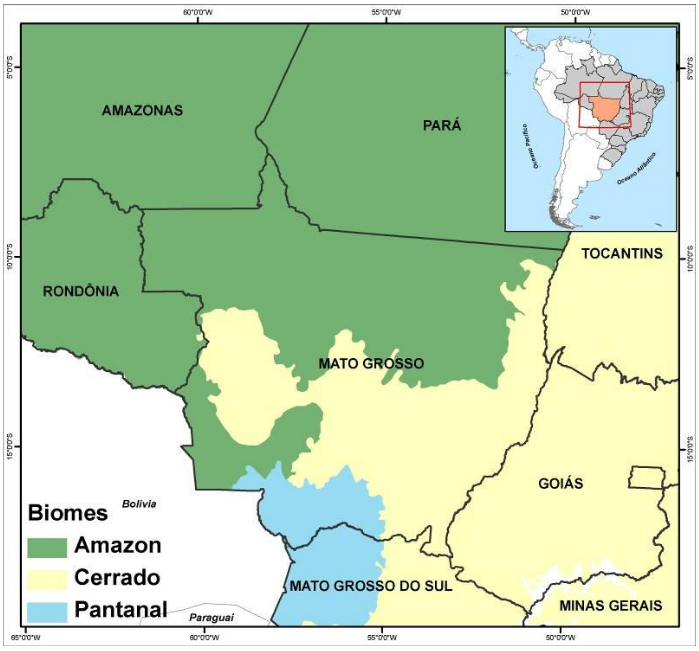


Figure 2.1- Mato Grosso State, Brazil

Source: IBGE

Current profile of soya and beef production

During the last two decades Mato Grosso became Brazil's largest producer of grains and livestock, though with very different profiles in terms of productivity:

- **Soya** production has grown at an average 9.5% per year since 1990 and reached 18.8 million tons in 2010 (27% of Brazil's production and approximately 7% of the world's total production); it occupies 6.2 million hectares, with stabilized average yields of 3.0 tons per hectare, slightly higher than the Brazilian average (Table 4.4). Corn and cotton crops, most often planted in alternating or in double cropping systems with soya, have also grown steadily since 1990: Mato Grosso's corn production has increased at an average 14% per year and reached 8.2 million tons in 2010 (15% of Brazil's total), while cotton production rose from 0 to 0.6 million tons, representing 49% of Brazil's production (IBGE, 2011a), and is expected to exceed 1 million tons in 2012 (IMEA, 2012). The total planted area of seasonal crops (including soya, corn, cotton, rice, sugar cane and sorghum) in Mato Grosso was 9.2 million hectares in 2010 (IBGE, 2011a); considering that 30-32% of this area is under double cropping system, the total area occupied by seasonal crops in the state is approximately 7 million hectares.

Table 2.1 - Mato Grosso and Brazil soya indicators, 2010

Indicator	Unit	Mato Grosso	Brazil	Mato Grosso / Brazil
Planted Area	Million ha	6.2	23.3	27%
Production	Million tons	18.8	68.8	27%
Productivity	$Tons.yr^{-1}.ha^{-1}$	3.0	2.9	

Sources: IBGE (2011a). Prepared by ICV

- As for **livestock**, cattle herd grew by 7.5% annually from 1990 to 2005, when it reached 26 million heads; it remained stable during 2005-2008 but started rising again in 2009 and reached 28.8 million heads in 2010 (IBGE, 2011b). This herd occupies approximately 25.8 million hectares (IMEA, 2011, from Acrimat/Sinoptica 2008 – unpublished) in the state, with an average pasture stocking of 1.1 head per hectare. Slaughter amounts to 4.3 million heads (IMEA, 2011, from INDEA, unpublished) and production totals 1.1 million tons carcass weight per year, meaning an overall productivity of 42 kilograms carcass weight per hectare of pasture. Mato Grosso's cattle herd, pasture area and production account for 14%, 13% and 12% of Brazil's, respectively. Its overall productivity is slightly lower than the national average, due to a lower average off-take rate and despite a higher pasture stocking and average carcass weight (Table 2.2). Livestock producers have invested in feedlot in the last few years and the capacity of the 222 existing units in 2010 adds up to 0.8 million heads, though still representing a small portion of the total herd (IMEA, 2010a).

Table 2.2 - Mato Grosso and Brazil livestock indicators, 2010

Indicator	Unit	Mato Grosso	Brazil	Mato Grosso / Brazil
Area of pasture	Million ha	25.8	205	13%
Cattle herd	Million heads	28.8	209	14%
Pasture stocking	$Head.ha^{-1}$	1.1	1.0	
Slaughter	Million heads	4.3	43.8	10%
Off-take	Percent of herd	15[1]	20	
Production	Million tons cw	1.1	9.2	12%
Carcass weight	Kg per head	250	210	
Productivity	$Kg.yr^{-1}.ha^{-1}$	42	45	

Sources: IBGE (2011b), IMEA (2011) and INDEA, MAPA (2011), Gouvello et al (2010). Prepared by ICV

Besides seasonal crops and livestock, forestry also represents a significant land use category in Mato Grosso. Log consumption from native forests amounted to 4 million cubic meters in

[1] This low average off-take rate is due to the fact that ranchers in the last 4 years have held more females, with an off-take rate dropping to 8.2%, while it was higher and increasing for males, at 26.5%.

2009, 28% of the total consumption in the Brazilian Amazon (Pereira et al, 2010). However, forest management plans in the state still occupy only 2.3 million hectares in 2010, approximately 6% of the total area of remaining forests in private properties, where this activity can be legally carried out. Firewood and charcoal are also produced from native forests, with a volume of 2.2 million cubic meters in 2010 (IBGE, 2011d). Planted forest, with an extension of approximately 0.2 million hectares (Arefloresta), supplied a total of 0.6 million cubic meters of firewood, coal and logs in 2010 (IBGE, 2011e).

Land tenure structure is highly concentrated in both seasonal crops and livestock activities in Mato Grosso. In farms dedicated to seasonal crops, 87% of the area is concentrated in approximately 2,200 properties larger than 1,000 hectares, which represent less than 14% of the total number of this group of farms. In cattle ranches, 78% of the area lies in approximately 8,600 ranches larger than 1,000 hectares that represent less than 8% of the total number of cattle ranches (IBGE, 2009).

Current profile of soya and beef supply chain to consumption

Most of Brazil's soya production is for exports, although a growing part of it is processed in the domestic industry. In 2011, 46% of the production was exported in grain and 52% was processed in Brazil to produce meal for animal feeding (42%) and oil for the food industry or biodiesel (10%), while the remaining 7% was stocked or directed to other uses. Approximately 44% of the processed meal and oil were exported and 56% were consumed on the domestic market (ABIOVE, CONAB).

Since 2010 China became Brazil's #1 buyer of soya products, with a participation of 46% of the total value of Brazilian exports of soybean, meal and oil, vs. 33% for the EU. China consumes above all soybeans, while the EU imports mainly meal (MDIC). The soya trading industry is highly concentrated and four companies (Amaggi, Cargill, Bunge and ADM) hold most of the market in Mato Grosso.

As for beef, the domestic market accounts for most of the Brazilian production (79% in 2010), with an average *per capita* consumption of 37 Kg cwe (25.2 Kg of meat) per year. Exports in 2010 represented 1.9 million tons cw, being 71% fresh beef, 17% processed and 11% others (MDIC, ABIEC, ABRAFRIGO). The main buyers of Brazil's fresh beef are Russia, Iran and Egypt, while the EU is the main buyer for processed meat (ABIEC).

The beef supply chain is also highly concentrated with only 3 companies (JBS, Marfrig and Frialto) holding 15 of the 18 major slaughterhouses in Mato Grosso. The total number of slaughterhouses in the state is 55, with a total industrial capacity of 40.5 heads/ day, which at full capacity represents 12.1 million heads/year. This capacity was used at only 33% in 2010, as the industry was starting to recover from a financial crisis it went through during 2008-09.

Agricultural production targets

Both seasonal crops and livestock production are expected to grow significantly during the next decade:

- According to IMEA's projections (IMEA, 2010a) **soya** yields will increase by 1.5% per year and planted area by 2.5% per year by 2020, leading total planted area to increase by 1.7 million hectares and production to increase by 8.9 million tons over the period. This projected area growth is consistent with MAPA's projection (MAPA, 2011), which forecasts an additional 1.8 million hectares of soya in Mato Grosso by 2020. However, MAPA foresees stable yields during this period. Considering that demand will continue to be strong, the main limitation to area growth is linked to transports infrastructure and costs. IMEA considers that if the main infrastructure projects are carried out, area growth could reach 2.5 million hectares, and if not, it could be limited to 1 million hectares. The most recent figures and short-term projections indicate that the current trend of soya area growth is higher than IMEA's higher scenario, which makes it more plausible than the lower or even the intermediary one. Area growth in other crops should be mostly linked to soya expansion, thus we consider that projected growth of soya area is equivalent to projected growth of seasonal crops area as a whole.

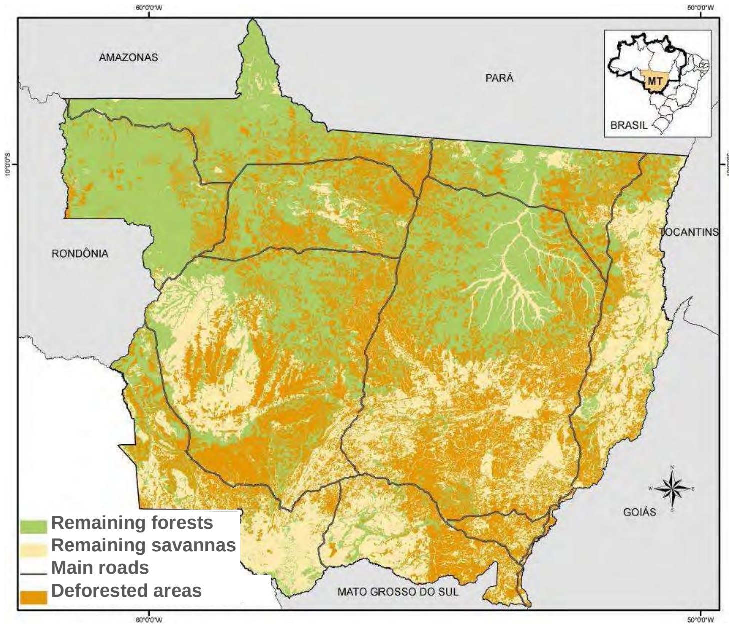
- As for **livestock**, also according to IMEA's projections (IMEA, 2010a) cattle herd is expected to grow at an average 2% per year in the next decade, due to improvements in pasture management resulting in increased stocking capacity. It would then reach 35 million heads in 2020, without change in the total area of pastures. Besides this, the average off-take rate is expected to grow at an average 4% per year, due to the increase of feedlots and to the improvement of pasture, reproductive and feeding management. Thus slaughter and overall production would grow by 6.9% per year, meaning a 95% percent increase over the period, on the same area of pasture. The corresponding increase in production would amount to 1 million tons cw, which represents half of the total increase in beef production projected by MAPA for Brazil by 2020. The Mato Grosso projections can be considered optimistic, especially considering that during the last five years stocking increased by 1.5% per year (vs. 2% in the projection) and take-off rate for males grew at an average 2.9% per year, while it dropped for females (vs. a 4% average in the projection).
- Agriculture (soya crops) **expansion** should occur onto pasture areas. According to an estimate by IMEA, approximately 35% of the existing pastures in Mato Grosso, representing 9.1 million hectares, are located on latosoils and thus are supposed to be suitable for agriculture (IMEA, 2010b). One third of the total potential areas lie in the northeast region of the state, where soya expansion depends basically upon already planned investments in transport infrastructure (road paving and/or railroad). The potential area for soya expansion on pastures largely exceeds the 1.7-1.8 million hectares projected expansion of this crop's planted area in the next decade. However, this means that cattle ranching will have to grow on less area, not the same area, as it did during the last few years.

Status of forest and deforestation

Originally, forests in Mato Grosso occupied 526,000 square kilometres while savannahs occupied 377,000 square kilometres. By 2010, approximately 204,000 square kilometres of forests and 157,000 square kilometres of savannahs had been deforested, which represents 39% and 42% of their original areas, respectively (

Figure 4.4.2).

Figure 2.2 – Deforested areas in Mato Grosso



Sources: Prodes/ Inpe, SEMA-MT. Prepared by ICV.

For many years Mato Grosso has been the leading deforester among the Amazon states. During the peak period of deforestation from 1996 to 2005, the state accounted for 39% of Amazon deforestation and lost 7,700 square kilometres of forests per year, an annual rate of 1.5% of the original forest area. Deforestation rates reduced since then and went down to 871 square kilometres in 2010, when Mato Grosso accounted for 12% of Amazon deforestation. In 2011 deforestation increased again to 1,126 square kilometres, due to a few large clearings for soya plantations in the centre-north region of the state (Prodes/INPE).

Mato Grosso was also the leading state in Brazil for deforestation of savannahs during 2002-2008, representing 21% of the total. During this period it lost 3,000 square kilometres of savannahs per year, an annual rate of 0.8% of the original area of savannahs. This rate also reduced strongly since 2005 and went down to 769 square kilometres in 2010 (MMA-IBAMA). At this time still no data is available for 2011.

Climate change and deforestation reduction targets

The Brazilian Government has developed and successfully implemented since 2004 a Plan to prevent and control deforestation in the Amazon (PPCDAM). The set of measures taken, including the creation of 25 million hectares in new reserves and ratification of 10 million hectares of indigenous lands, the intensification of law enforcement operations, the creation of a list of critical municipalities and the imposition of economic restrictions and sanctions on illegal deforesters, are believed to have contributed significantly to the deforestation reduction that has occurred since 2005.

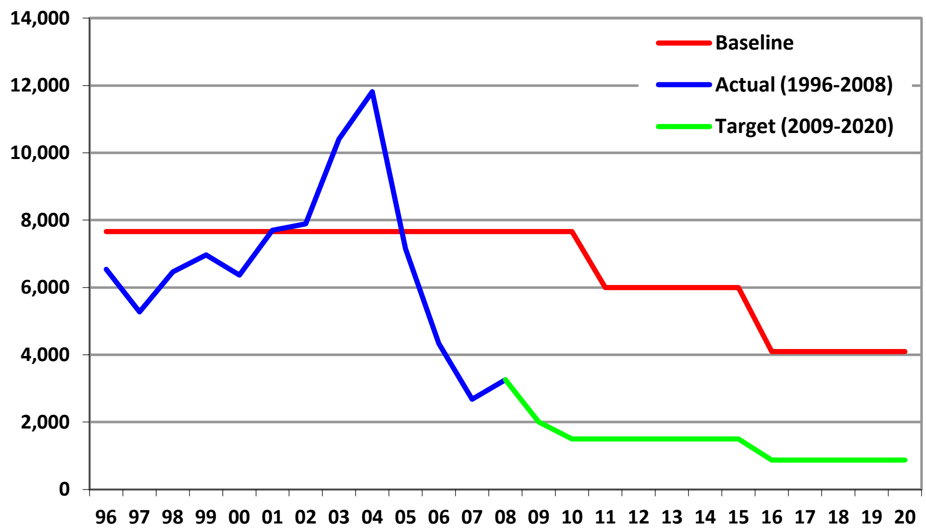
However, the original plan did not include quantitative targets for deforestation reduction, nor was it explicitly linked to a climate change mitigation strategy. In 2009-2010 Brazil established its National Policy on Climate Change (PNMC) and adopted a voluntary goal to reduce GHG emissions: to reduce total emissions by 36 to 39% by 2020 compared to a business-as-usual scenario, meaning an overall stabilization at the current levels. This goal encompasses a target to reduce Amazon deforestation rates by 80% by 2020 compared to the 1996-2005 average, and a target to reduce Cerrado (savannah) deforestation by 40% by 2020 compared to the 1999-2008 average[2] (Brasil, 2010), as well as targets for other sectors, including agriculture. Thus, the PPCDAM and its counterpart for savannahs, the PPCerrado, as well as the ABC Plan for agriculture, now constitute NAMAs (Nationally Appropriate Mitigation Actions) as to the international climate change negotiations.

Additionally, Brazil also created in 2008 the Amazon Fund, a financing mechanism for deforestation reduction projects whose ceiling is related to the country's results in terms of deforestation reduction. By February 2012 the Amazon Fund had been granted R$ 860 million and had approved 26 projects totalling R$ 265 million.

Following the national policies, Mato Grosso launched in November 2009 its own Plan to prevent and control deforestation and fires and adopted a target to curb deforestation in its forest area by 89% by 2020 compared to 1996-2005 (Mato Grosso, 2009). The state still has no target for savannah deforestation reduction.

Mato Grosso's Plan to prevent and control deforestation and fires is composed of an integrated set of programs organized in three areas: Land-use planning, Monitoring and control, and Incentive to sustainable activities and economic instruments. Although many actions of the Plan were not implemented yet, there has been progress one important aspect: the environmental registry of rural properties, a necessary step for the environmental compliance of these properties and a condition for adequate law enforcement. The registry is now covering 48% of the area of rural properties in the state (ICV analysis, SEMA-MT data).

Figure 2.3 – Deforestation reduction target - Mato Grosso's forest area, 2006-2020 (km²)



Source: Mato Grosso's state Plan to prevent and control deforestation and fires (PPCDQ-MT)

Status of REDD+ policy development

While specific and explicit REDD+ policy has not yet had significant developments at the national level, besides the PNMC, PPCDAM and Amazon Fund mentioned above, a few Amazon

[2] The target for cerrado might be revised to a 60% reduction by 2020 vs. the 1999-2008 average.

states – especially Acre, Amazonas and Mato Grosso – have developed their own frameworks and legislation for REDD+.

REDD+ policy development in Mato Grosso has been led by the State Environmental Agency (SEMA-MT) and by the Mato Grosso State REDD Working Group (MT REDD WG), a technical, open working group established in 2010 within the Mato Grosso State Forum on Climate Change. SEMA-MT has manage the state's participation to the Governor's Climate and Forests Task Force (GCF), where it shares experience with other states in Brazil and abroad on REDD+ development, while the MT REDD WG has worked on the development of a state REDD+ draft law.

The initial version of the draft law (MT REDD WG, 2010) that creates the State REDD+ System went through a participatory construction process that included a wide public consultation, which resulted in many contributions and changes. The MT REDD WG is currently finishing the final draft of the law project that will then go through the regular State legislative process.

The proposed State REDD+ System intends to create a practical nested approach. It establishes emissions reference levels, a monitoring system, a registry of emission reductions and a security reserve at the State level, as well as a state fund for REDD readiness actions and a public-private financial mechanism for project financing. These instruments are linked to the project or local level through sector, thematic or regional programs, still to be developed. The priority sector programs to be developed are for the forestry, agriculture and livestock, smallholder communities and indigenous people sectors.

Besides the REDD+ draft law, Mato Grosso also has a draft law for an overarching Climate Change Policy, also developed by the Climate Change Forum, which is expected to go through the legislative process this year.

Other relevant policies and programmes

Brazil's **Low Carbon Agriculture (ABC) Plan**, created in 2010 by the federal government, intends to reduce agriculture emissions in countrywide by 134-163 million tons of CO_2 by 2020 promoting a set of low-carbon techniques (

Table 2.3).

Table 2.3 - ABC Plan's targets

Action	Area (million hectares)		Emissions reduction target (tCO_2-e)
	Current	Additional	
1. Expand use of no-till	25	8	16-20
2. Restore degraded pasturelands	40	15	83-104
3. Promote integrated crop-livestock-forest systems	2	4	18-22
4. Increase area of commercial planted forests	6	3	-
5. Promote Biological Nitrogen Fixation techniques	11	5.5	10
6. Treatment and energy use of animal manure	-	4.4 million cubic meters	6.9
Total			133-166

Source: MAPA (2010)

The plan lists a series of actions to be developed in order to achieve these targets, encompassing research, capacity building and financing, among others. The total estimated cost for the plan's implementation is R$ 197 billion, out of which the major part (R$ 157 billion) is for rural credit (Brasil, 2011).

The plan's main action to date was the creation, in 2010, of a new subsidized financing program, the ABC Program, that received a R$ 2 billion allocation for the first year and R$ 3.15 billion for the second year[3]. The program offers loans with low interest rates (5.5% per year) and extended term (5 to up to 15 years depending on the type of project) for investments in low carbon agriculture activities. Besides the actions directly linked to the ABC Plan's targets, the program also funds the regularization of properties to the environmental legislation, especially the restoration of legal reserves and areas of permanent preservation (APPs). The access to this credit was nearly zero in the first year but exceeded R$ 0.5 billion in the second year – however still representing only 0.7% of the total rural credit.

In order to support the implementation of the ABC Plan, State action plans should be created in 13 priority states. Among them, by the end of 2011 three states had already established a Management Committee and developed their action plans, including Mato Grosso. The Mato Grosso action plan consists in 45 proposed activities, organized around 7 expected results, directly related to the national plan's targets. However, these action plans have no budget of their own, which is a critical limitation to their potential effectiveness.

[3] This amount represents 15% of credit for investment allocation and 3% of the total rural credit allocation for the 2011-2012 crop year.

Chapter 3 - Economic analysis for changes at producer level

3.1) Description and Assumptions

Farm sizes

In order to investigate the effect of scale on cattle ranching economic performance, we selected three farm sizes of 290, 1406 and 2558 hectares of pasture. All three farm sizes were modelled adopting an initial stocking rate of 1.05 animal units per hectare, equal to the base carrying capacity.

Table 3.1 – Farm sizes

	Small	Medium	Large
Total Area (ha)	290	1,406	2,558
Initial Herd	303	1,483	2,817

Systems:

i)Business as Usual (BAU)

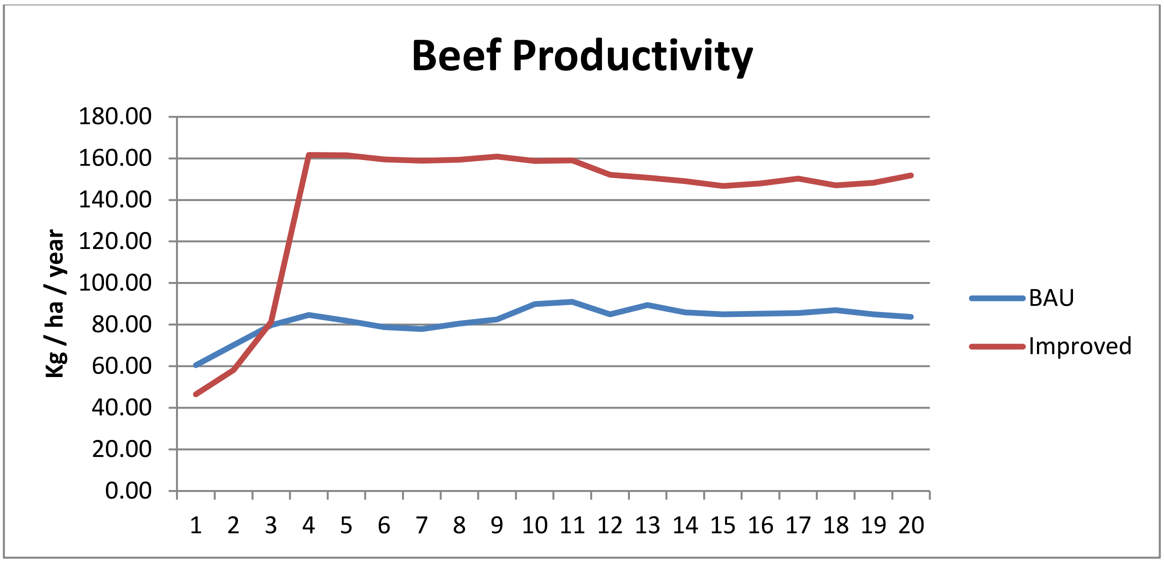
Represents the baseline of the farm, keeping the general management based on conventional production practices. The BAU scenario adopted here can be considered optimistic, as it assumes farmers will not degrade their pasture areas (by keeping stocking rates at the carrying capacity of the farm and implementing annual pasture maintenance on 10% of the pasture area) and are complying with labour laws. In addition, their productivity is higher than the average productivity of the state. It also includes a timid program for increasing pasture productivity, following the state baseline rate.

Ii) Improved Scenario – Assumes the adoption of a program that increases pasture productivity at a faster rate, by implementing EMBRAPA's good practice guidance (EMBRAPA, 2006). These include a more ambitious program of increasing pastureland productivity by introducing intensive rotated pasture system (PRI, from "Pastejo Rotacionado Intensivo"). PRI includes the improvement of pasture condition and the subdivision of pastures with electric fences. In the scenario modelled here, this leads to a doubling of the base carrying capacity in three years. The Improved Scenario also includes a minor improvement in fertility rate and weight gains. These gains are on the lower bound of EMBRAPA's projections, so it is likely that gains would be higher if the system is properly implemented. We assume the investments lead to improvements in results for 10 years, after which they are repeated.

Table 3.2 – Selected Productivity Parameters for BAU and Improved Scenarios

Parameter		System	
		BAU	Improved
Pasture Productivity (AU/Ha)	Initial	1,05	1,05
	Final	1,33	2,10
	Average	1,28	2,00
Birth Rate (% / Year)		85	87
Animal Weight (@ /Head)	Bull	20	20
	Pregnant cows	15	15
	Non-pregnant cows	12	13
	Female Calf	6	6
	Heifer	11	12
	Male Calf	7	8
	Male Heifer	12	13
	Fattened Cattle	18	19
Farm Productivity (Kg/Ha/Y)		**82**	**154**

Figure 3.1. – Beef productivity over time in BAU and Improved Scenarios (Large Farm)



iii)Silvipastoral Systems

Silvipastoral systems involve the joint management of pastoral and silvicultural activities. From the farmer perspective, they contribute to increase the income per hectare and reduce the risk of the farm operation by diversifying unrelated income sources. From the macro point of view, silvipastoral systems contribute to alleviate the demand for additional land by providing more products from the same unit of area. Silvipastoral systems increase animal wellbeing by providing shade. There are some evidence this improved animal comfort can increase milk quality. Some Silvipastoral systems, such as the Intensive Silvipastoral System (SSPi) being implemented by CIPAV in Colombia can substantially increase pasture productivity. In this scenario, however, we simulate a simpler silvipastoral system consisting of the planting of 350 eucalyptus trees per hectare. We do not include any productivity gain for the beef production.

Table 3.3 – Silvipastoral System Variables

Variable							
Planting (cost in R$)	Productivity (m3/ha/y)	Replanting (R$)	Labour Costs (R$/man/day)	Maintenance Labour Requirements (man-days)	Harvesting Labour Requirements (man-days)	Last year of pruning	Price of wood (R$/m3)
3500	20	350	50	2	6	4	50

iv)Leasing

An increasingly common practice in Mato Grosso is the leasing of part of cattle farms for soybean plantations. Such practice is constrained by demand for soybean lands, topography, infrastructure and suitability. For the cattle ranchers such practice is attractive due to higher income. One hectare can be leased for 20% of the soybean produced in that hectare (we used a value of R$ 320/ha/y). Cattle ranchers still use the fraction leased during the winter months for grazing. In this scenario, we assume that the cattle rancher of medium and large farms will lease half of their farms and adopt the improved system in the remaining area, guaranteeing that the total beef production will remain at least the same as in the BAU scenario.

We modelled the performance of all three farms sizes in the “Business as Usual”, “Improved” and “Improved + Silvipastoral” systems. For the medium and large farms we also modelled the “Improved + Leasing” scenario.

3.2) Results

Our results highlight three important aspects of the economics of cattle ranching. First, the business as usual system presents negative returns in all three farm sizes. Net Present Values (calculated for 20 years using a 6.75% annual discount rate) vary between (R$ 1950) and (R$ 262) and tend to stay in the negative during all years of the simulated 20 years cycle (Fig 2.1). Multiple explanations have been presented for the persistence of cattle ranching activities under apparent negative results. These include i)land speculation, where cattle ranching is a means to secure land ownership with an aim to sell the land when the cropland frontier advance; ii)money laundering; iii)non-compliance with labour and environmental legislation, which could lower costs in reality (e.g. in the BAU system modelled, all farmers collect all labour taxes, which add to a considerable expense); iv)”irrational” behaviour, where losses in the cattle ranching operation are masked by high gains in other operations of the same farm (such as timber extraction) and tolerated for the pleasure or status gained; v)extractivism model, where stocking rates higher than carrying capacity are used for a short period of time, followed by degradation and possible abandonment of the land.

The second aspect highlighted is a strong scale factor. Across all scenarios, larger farms lead to significantly better results. For instance, in the improved scenario the IRR varies from 8% (small) to 24% (medium) to 31% (large) as the scale of operations is increased. This effect is due to strong economies of scale in several individual aspects of the operation, and to the dilution of fixed costs over a larger area.

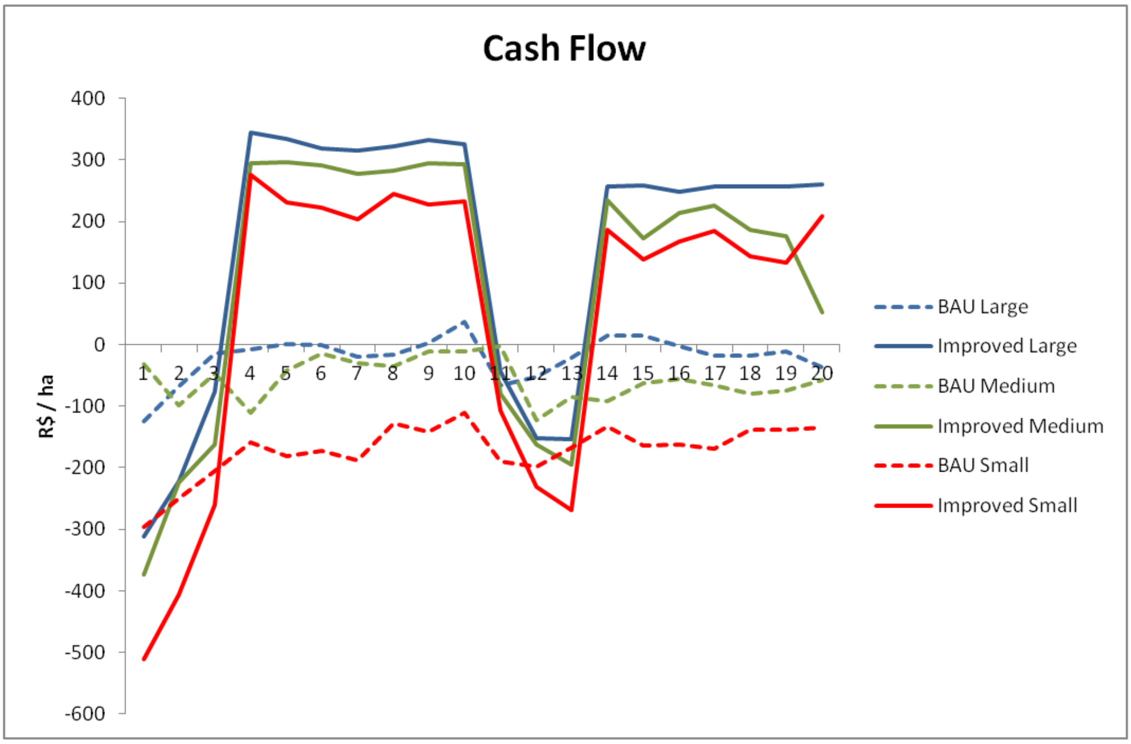
Thirdly, we have found that the investing in improving productivity leads to very significant gains in cattle ranching operations. In all farm sizes, the implementation of the Improved System turns a negative BAU result into a positive one. In large farms, for example, implementing the improved system transform a negative NPV of R$ 262 per hectare into a positive NPV of R$ 1336 per hectare, providing 170% ROI.

Table 3.4 - Performance Indicators

Farm Size	System	Constant Price				10 % Meat Price Premium			
		EBITDA	ROI	NPV	IRR	EBITDA	ROI	NPV	IRR
Small	BAU	-1580	-	-1950	-	-1292	-377%	-1635	-
	Improved	1989	104%	74	8%	2501	139%	704	20%
	Improved+Silvipastoral	10474	104%	359	7%	10986	110%	990	9%
Medium	BAU	-226	-	-572	-	69	20%	-278	-
	Improved	2778	147%	884	24%	3287	174%	1394	34%
	Improved+Silvipastoral	11408	111%	1135	9%	11925	116%	1652	10%
	Improved + Lease	1515	192%	727	39%	1783	226%	994	56%
Large	BAU	116	31%	-262	-	403	107%	25	9%
	Improved	3234	170%	1336	31%	3747	197%	1849	41%
	Improved+Silvipastoral	11705	116%	1621	10%	12217	121%	2134	11%
	Improved + Lease	1689	215%	902	45%	1949	248%	1162	62%

An important aspect visible in the cash-flow graph (Fig. 3.2) is the need for finance. In order to make the transition from the BAU to the improved scenario, farmers need to invest a considerable value upfront. As can be seen clearly for the medium and large farms, results for the first three years are worse than in the BAU scenario. The same occur over years 11 to 13 when pasture improvement investments need to be repeated.

Figure 3.2 – Cash Flow for 20 years cycle



The results also help to explain why the practice of leasing pasturelands for soybean expansion is becoming more common. Results in the Lease scenario are the most attractive ones, suggesting cattle farmers would continue to choose this option when available. This option also presents a practical alternative or at least complement to regular financing, as the income from soybean can be used to partially finance pasture improvements.

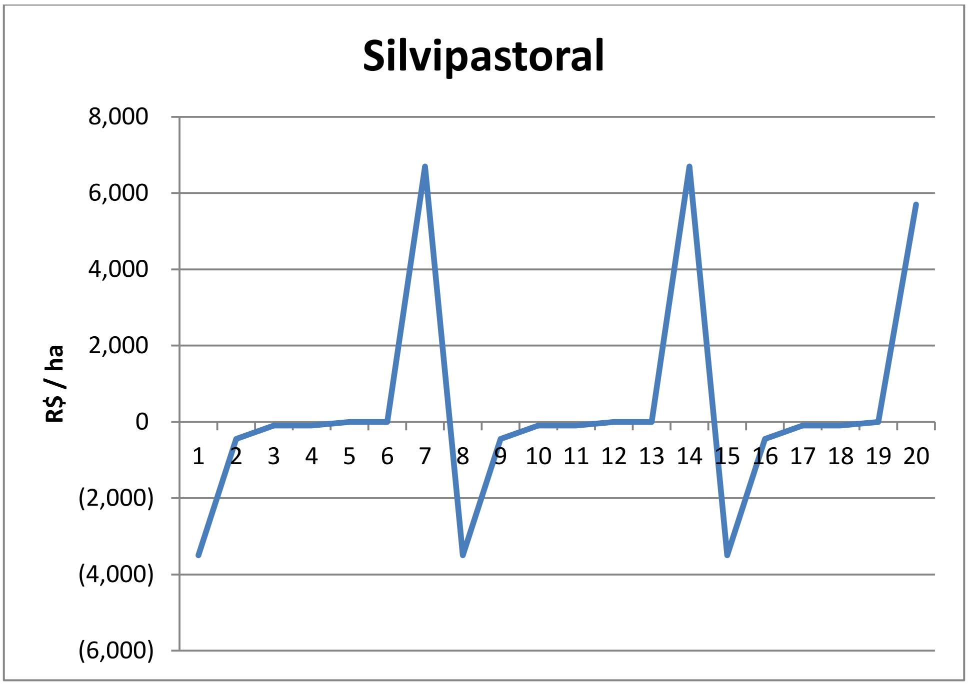
A potential price premium for beef produced from improved systems would represent a strong incentive for the adoption of this system (Table 3.4). Questions remain if this incentive could be offered at large scale, but they might be of great importance in the early stages, for example to finance demonstration projects.

The implementation of Silvipastoral systems greatly increases the NPV per hectare in all cases. As the investment demanded are considerably high and offer a modest rate of return, however, the performance of investment related indicators is worse than in systems without this complement. Silvipastoral systems seem to be of special interest to small farm owners. The importance of Silvipastoral systems as hedge against price fluctuations will be discussed below.

Table 3.5 – Silvipastoral Results

Silvipastoral Results			
EBITDA	ROI	NPV	IRR
8,470	109%	675	8%

Figure 3.3 – Silvipastoral Cash-flow



3.3) Risks Analysis

The potential risks associated with the alternative scenario would be the following ones:

i) Production risk – also called agricultural risks, it is related to variations in the expected productivity levels and input parameters that are not fully known in practices that are not widespread yet. So the financial analysis will adopt different parameter levels.

ii)Market risk – (i) Meat: although Brazil is the second major meat producer, it 25% share in the export market is not enough to set prices in the international market. All projection, including FAO (2011), consider that despite the high prices the market will continuous to prosper due to difficulties in several countries, including Brazil, to rebuild herds. However, if OECD economic crisis end up also affecting emerging economies, demand-driven factors may lead the market to stagnation; (ii) Soy: Brazil is also the second major soy producer but soy is a commodity more sensitive to supply and demand fluctuations, resulting in significant movements in prices. However, according to FAO (2011), oilseeds in general will benefit from the worldwide expansion of biodiesel; and (iii) Wood: Brazil has only a dominant position in the international market of the pulp and cellulose. Other wood and wood-related markets the country has no expressive participation although with a great potential due to climate and land conditions (SAE, 2011). International wood market is uncertainty considering wood fast substitution. However, expectations in the domestic are high for with the actual implementation of the forest code and biodiesel programs. So the financial analysis will adopt different output price levels also and a sensitivity analysis for the prices of the major cost items.

iii)Disease risk – One of the major barriers for the export of meat in Brazil is the foot and mouth disease (FMD). The combat to this disease has been very diligent in the last ten years with the National Program to Eradicate and Prevent FMD (Programa Nacional de Erradicação e Prevenção da Febre Aftosa – PNEFA) under the coordination of the Ministry of the Agricuture (MAPA)[4]. PNEFA has been already successful to eradicate the disease from most of the country, including the states of Goiás, Mato Grosso, Mato Grosso do Sul and the south of Pará that were infected until 2005. The Program seems to have reached its maturity with regular financial flow of resources, stable extension services and increased farm's awareness. However, the disease control effectiveness has showed sensitive to rapid increases in the herd size; as it happens in 2005 when the disease was reintroduced in Paraná and Mato Grosso do Sul. It is also recognized that extension services have failed to reach small farmers in remote areas, as it is the case of the Amazon region that is still remains mostly as a PMD infected area. This risk should be addressed in the delivery mechanisms by avoiding no free PMD areas and in free PMD areas enforcing PMD control practices as requisite to financing.

iv)Adoption risk - the adoption of new technologies and practices may generate inertia since it may require high upfront payments while the return from savings coming over several years. If so, low-income framers may lack of access to capital to make the investments. Even for major farmers, adoption costs include the losses of network externalities or qualitative attributes associated with the substituted technology and costs of learning how to manage the new practice and changing internal structures, cultures and strategies. (Ekins et al., 2011). This risk should be addressed in the delivery mechanisms with strong extension incentives.

v)Default risk – Agricultural activities usually face high default on loans and lack of collateral. Rural insurance mechanisms have been developed elsewhere but in Brazil are still incipient and the sector is often bailed out. However, the National Program in Rural Insurance that gives subsidies to farmers in order to contract out insurance at the finance system has attempted to reserve this trend and has a promising increase in coverage (MAPA, 2011). This risk should be addressed in the delivery mechanisms that enable insurance subsidies.

vi)Regulatory risks – (i) Forest Code: the current changes in discussion through the National Congress will certainly reduce land restrictions but they can also increase the enforcement of the lax ones to be approved. The final outcome of the current revision of the Code is not yet decided but it is possible to construct potential scenarios for APP and legal reserve restrictions. So the good practices considered in the scenarios of the financial analysis will consider distinct scenarios for land restrictions and its implementation scale; (ii) Land law: there are recent

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4 http://www.agricultura.gov.br/arq_editor/file/Aniamal/programa%20nacional%20sanidade%20aftosa/evolucao%20geografica.pdf

restrictions on foreigners ownership on rural land in Brazil applying also to Brazilian companies held by foreign investors, such as, previous approval by the Brazilian Agriculture State Department (INCRA), rural land owned by foreigners in any Brazilian municipality may not exceed 25% of the municipality's total rural land area and foreigners of the same nationality cannot own rural land representing more than 40% of the total rural land area in the municipality. This risk should be addressed in the delivery mechanisms by considering leasing procedures whenever is possible; and (iii) The National Policy on Climate Change is not specific on regulation principles for REDD mechanisms so the country has no clear regulatory framework for REDD (Seroa da Motta, 2011). Several law bill initiatives are already in discussion in the National Congress but it seems that the federal government is not willing to speed up the approval of any framework on REDD before this mechanism is better designed within the UNFCC. So REDD market in Brazil will have to move in the short-term on voluntary and bilateral basis what pushes downwards REDD prices. In medium and long term, say, from 2020 on, a well established market regulated by the UNFCC and also restricted control in GHG emission from global agreements will make REDD more attractive pushing up prices. If so the carbon price that breaks even the financial analysis should be analyzed in accordance to these possible temporal outcomes.

Table 3.6 Risk Summary

Risks	**Expected Level**
Production	Low-Moderate
Market	
Meat	Low
Soy	Moderate
Wood	Low
Disease	Low-Moderate
Adoption	Moderate-High
Default	High
Regulatory	
Forest Code	Low-Moderate
Land Law	High
Climate Law	Low-Moderate

Sensitivity Analysis for Market Risks

We simulated how each system would respond to both a decrease of 10% in beef prices and an increase of 10% in production and investment costs. As can be seen in Table 3.7, both changes would have a significant impact in returns. The Improved system would cover the discount rate (6.75%) only for the large farms. NPV values would be negative both for small and medium scale farms.

The importance of Silvipastoral systems as a hedge against market fluctuations is clearly demonstrated in Table 2.7. For both small and medium scale farms, the Silvipastoral systems would help farmers stay at or very close their breakeven situations.

Table 3.7 – Sensitivity Analysis for Market Risks

Farm Size	System	10% drop Beef Price				10% Increase Costs			
		EBITDA	ROI	NPV	IRR	EBITDA	ROI	NPV	IRR
Small	BAU	-2156	-629%	-2498	-	-2314	-614%	-2691	-
	Improved	965	54%	-832	-	1164	59%	-813	-
	Improved+Silvipastoral	9450	95%	-546	6%	9649	88%	-1347	4%
Medium	BAU	-815	-235%	-1162	-	-837	-220%	-1219	-
	Improved	1758	93%	-135	4%	2036	98%	-46	6%
	Improved+Silvipastoral	10373	101%	100	7%	10667	94%	-633	5%
	Improved + Lease	981	124%	192	15%	974	112%	107	11%
Large	BAU	116	31%	-262	-	-445	-107%	-860	-
	Improved	2209	116%	311	12%	2532	121%	444	14%
	Improved+Silvipastoral	10679	106%	596	8%	11003	99%	-89	7%
	Improved + Lease	1169	148%	381	21%	1179	136%	314	18%

3.4. Financing gap to go from BAU to Alternative

The investments required to move from the BAU to the improved scenario are summarized on Table 3.8. The values are nearly constant per farm size, as we took the conservative assumption of not estimating economies of scale in the pasture improvement and division item. As this item has been budget by EMBRAPA for a 300 hectare farm, it is likely that the values presented here are conservative toward the medium and large farms. Animal acquisitions costs were modelled and project planning costs assumed to be 5% of the financing costs for the first cycle. In the second cycle the pasture investments are repeated as we assume the investments have a lifetime of 10 years.

Table 3.8 – Financing Gap from BAU to Improved (20 years cycle)

		Small Farm		Medium Farm		Large Farm	
		Per ha (R$)	Total (R$ 1000)	Per ha (R$)	Total (R$ 1000)	Per ha (R$)	Total (R$ 1000)
First Cycle (Years 1-3)	Pasture Improvement and Division	1,135	329	1,135	1,596	1,135	2,949
	Animals Acquisition	335	97	334	469	338	877
	Project Planning	74	21	73	103	74	191
	Sub-Total	1,544	448	1,542	2,168	1,546	4,017
Second Cycle (Years 11-13)	Pasture Improvement and Division	1,135	329	1,135	1,596	1,135	2,949
	Sub-Total	1,135	329	1,135	1,596	1,135	2,949
TOTAL		**2,679**	**777**	**2,677**	**3,764**	**2,681**	**6,966**

Chapter 4 - Delivery Mechanism

Conciliating the expansion of agriculture with the conservation and possibly restoration of forests in the agricultural frontier is a complex task that requires a host of complementary activities. In this chapter we present the components that should be part of such initiative at a statewide level. We then present some initial insights for a mechanism that could address the core challenge described here (directly linking increase in agricultural productivity to forest cover). Ideally, this would be part of a concerted statewide effort including the activities described in the first part. In the absence of those, however, it could be adopted at a project by project scale.

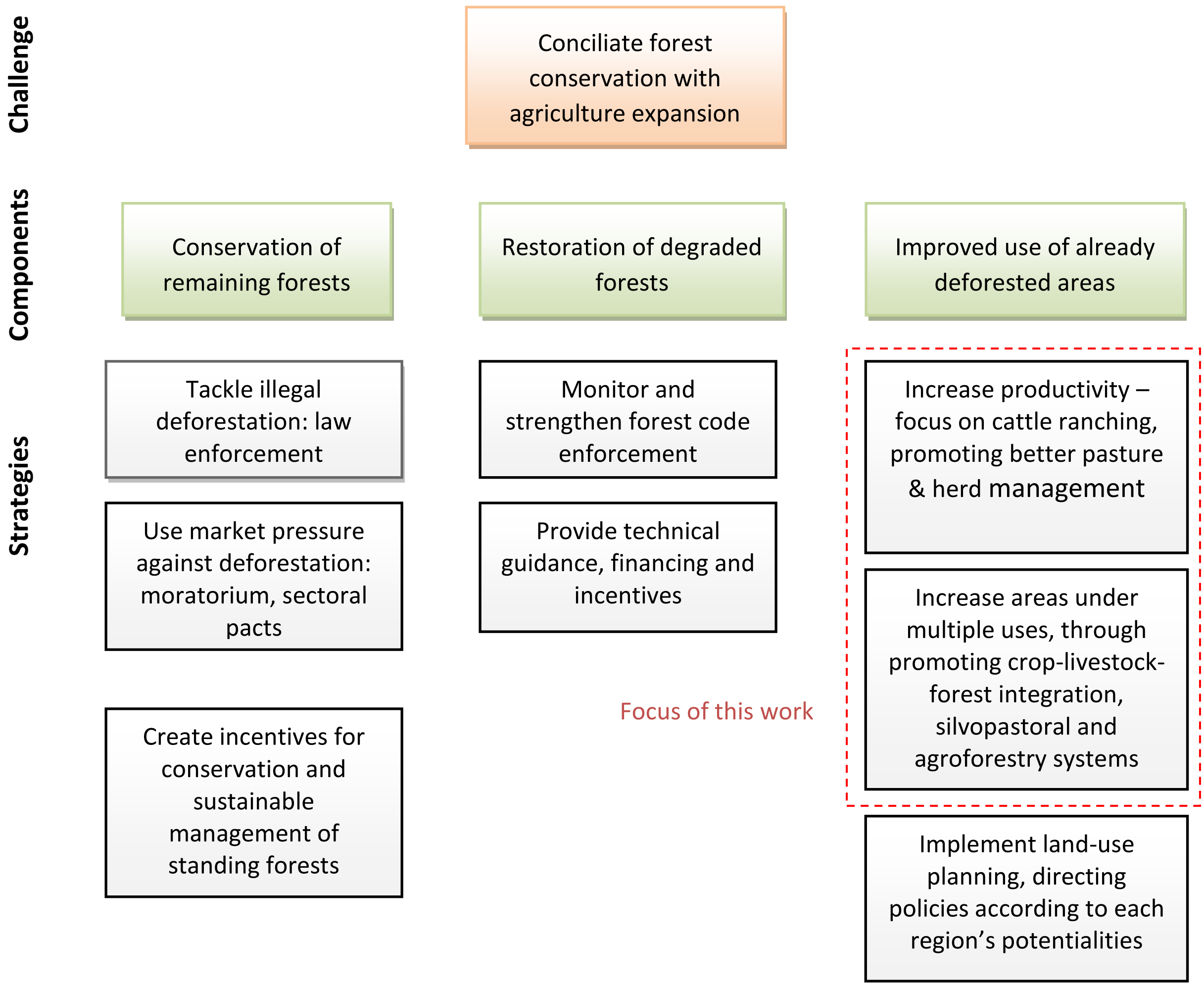
4.1. Components of a comprehensive REDD+ and agriculture initiative

The land-use challenge that has to be faced – to conserve and augment forest areas while strongly increasing agricultural output – requires an integrated approach with three basic components:

1) Conservation of remaining forests, through tackling illegal deforestation, decreasing the benefits from deforestation and increasing the value of standing forests;
2) Restoration of degraded forests, through promoting the restoration of APPs and Legal Reserves; and
3) Improved use of already deforested areas, through increasing productivity – with a focus on cattle ranching, where most potential productivity increases lie, as well as increasing areas under multiple uses and implementing land-use planning.

In this work we focused on specific strategies related to the third component.

Figure 4.4 – Components of a comprehensive REDD+ and agriculture initiative



Source : authors

4.2. Financing mechanism options

The main financing option available for restoration of degraded forests and productivity increases and implementation of multiple uses in cattle ranching operations is the subsidized loan of the ABC Program (and other existing programs). However, this mechanism has limitations due to: i) the lack of capacity of local public extension agents and private service providers to build adequate projects, both on the technical and financial aspects; ii) the reimbursement period required by the program, especially for pasture reform, that according to sector representatives should be extended to 12 years instead of 8 years; iii) the high costs of inputs, especially for pasture reform in regions that are distant from lime stone-pits, which lowers potential return on investment; iv) the lack of existing models of improved pasture and herd management showing positive results to producers ; and v) the risk of default perceived as high by the producers, especially considering their current financial situation. These limitations need to be addressed for the financing mechanism to work at the necessary scale and time.

The Table 4.4 below discusses the applicability of the different financing mechanism options available.

Table 4.4 – Financing mechanism options

Option	Applicability	Discussion
Regular capital	Medium	Most producers use preferably their own capital for investment. However, the cattle ranching sector is composed of family businesses without access to capital investment from third parties, and the capital availability of the own businesses to invest in productivity increases and environmental compliance is limited.
Grants	Low-Medium	The scale of the necessary changes in productive systems greatly exceeds the capacity of grants. However, these might be important to support pilots.
Loans	High	The ABC Program and other subsidized credit programs provide financing for the restoration of degraded forests for environmental compliance and for productivity increases and implementation of multiple uses in cattle ranching operations, although some limitations have hindered the program's implementation.
Provision of inputs	Medium	The direct provision of inputs can be important to compensate for the high costs of inputs, especially for pasture reform and management. Preferably, it should be used in the initial stages of a program, coupled with the provision of free extension services, following successful experiences already implemented in other regions/contexts.
Provision of free extension services	Medium	The provision of free extension services can be fundamental at an initial stage, in order to compensate for the lack of technical capacity on restoration of degraded forests, on pasture and herd management for productivity increase and on implementation of multiple uses in cattle ranching operations. It should be coupled with the provision of inputs in pilot areas.
Risk guarantees	Medium	A risk guarantee provision for the loans would be important for a larger number of producers to embrace the program, since the risk (both technical and financial) is considered a major limitation for them to take the loans of the ABC Program. This risk guarantee could be in the form of a risk pooling among loan takers, intermediated by the state or by the slaughterhouse companies.

Guarantees of purchase	Low	Guarantees of purchase do not seem to be an adequate approach for beef production, since the market is not so volatile as for other agriculture commodities and producers can decide when to sell their herds.
Differentiated pricing	Low	The changes necessary in the cattle ranching sector are for the mainstream production and it seems unlikely that differentiated pricing could apply to that.
Certification schemes	Medium	Certification is important to encourage investments and reward the best producers, and could play a major role. However producers currently consider the return on investment of certification low.
Link to companies' commitments	Medium	Buyer companies' commitments – such as the "legal beef" commitment already signed by Mato Grosso's main slaughterhouse companies – are a fundamental strategy to minimize deforestation pressure. It is still unclear if and how they could be applicable to promote changes in non-compulsory management practices. In any case, the involvement of the companies in the program could be decisive, e.g. for the risk guarantee.
Direct incentives (payments for performance)	High	Direct payments for performance can be applied in this case – preferably in a second stage after the pilot projects with direct provision of inputs and free extension services are in place. They can be linked to results in the implementation of given practices, or to an overall productivity improvement indicator. See item 3.4 below.

Source: authors

4.3. General elements required to close implementation gap

The main elements necessary to close the implementation gap include shaping, managing and monitoring the State REDD+ and low carbon agriculture program, implementing a network of demonstration projects in the major cattle ranching poles throughout the State, providing facilitated access to the ABC program, strengthening public and private extension services, and performing strategic research on the program's themes. The initial cost of this program was estimated to approximately R$ 22 million during the first five years, not including research needs, monitoring and verification, and the operational costs of extension services (Table 4.5).

Besides these elements, it will also be necessary to implement the State REDD+ System, since the proposed program is part of this system. This will require an emissions measurement, reporting and verification system and a registry of emissions reductions, among other necessary structures. The corresponding costs were not yet estimated, and will be additional to the funds already requested by SEMA-MT to the Amazon Fund (R$ 65 million) to support the implementation of the State Plan to control deforestation.

Table 4.5 – Closing the implementation gap: needs, actions and costs

Need	Actions	Actors	Cost estimate (R$ '000)	Financing options
Shape state REDD+ and low carbon agriculture program	Define program rules, design incentives, develop and monitor action plan	State Government, Farmers Associations, NGOs, Research institutions	600 (y1) + 430/yr (y2-20)	Grants, State REDD+ fund
Network of demonstration projects in 10 cattle ranching poles throughout the State	Set up network of demonstration projects of pasture and herd management and multiple use systems, providing: projects development; inputs for implementation; and extension services.	Farmers Associations, NGOs, Research institutions	For each pole (10 projects each): 1,300 (y1-2) + 900 (y3-5)	Grants
Facilitate access to Low-Carbon Agriculture Finance	Capacity building for project developers (10 courses in the cattle ranching poles)	Implementing financial institutions, Farmers Associations, Slaughterhouse companies	200 (y1-2)	Own resources
	Set up risk management (risk pooling) mechanism		To be estimated	?
Provide extension services	Strengthen public extension services	State agriculture agency	Training: 400 (y1-2) Operational costs: aprox. 15,000 /yr	ABC Plan Public budget
	Capacity-building for private service providers (10 courses in the cattle ranching poles)	Farmers Associations, Research institutions, NGOs	400 (y1-2) + 100 /yr	Grants, ABC Plan; Extension costs supported by producers
Research	Carry out applied research on technical, financial and social aspects of improved pasture and herd management, multiple use systems, and forest restoration	Research institutions, NGOs	To be estimated	Grants, Public research finance
Monitoring	Implement independent monitoring and verification of the program, exploring	State Government (responsibility)	To be estimated	

	collaboration with existing taxation, inspection and traceability systems	

Source: interviews, MAPA (2011), authors

4.4. Proposed mechanism of incentives linking agricultural performance more directly to forest cover

In additional to the general steps outlined above (which should spur significant positive behaviour change), a complementary system linking direct performance-based changes to forest cover could be implemented. It could be sub-program under a general REDD+ initiative, or in the absence of such initiative, an independent program

The “Land-Neutral Agriculture Expansion” (LNAE) mechanism[5]

In a context of land-scarcity, the expansion of one additional unit of area of a given land-use can be understood to generate pressure over natural ecosystems proportional to the production displaced by the expansion. At a jurisdictional level (for example, the State of Mato Grosso), it is possible to identify the sector or product that demanded additional land and relate this additional demand to the deforestation that occurred in the same period. In the state, it has been well documented that most soybean expansion occurred into pasturelands, whereas most newly deforested areas were occupied by pasturelands. This “indirect deforestation” has been suggested as the main flaw of the soybean moratorium.

Here we reproduce the concept of “Land-Neutral Agriculture Expansion” (Strassburg, 2012) to allow farmers to demonstrate that their agricultural expansion has not caused any direct or indirect impact over natural environments. In a context of incentives related to avoided deforestation, this mechanism would allow the ones who implement to claim avoided deforestation credits. In the absence of such mechanism, it can still be used to demonstrate commitment to sustainability goals, be it in order to gain access to specific markets or to meet their or their partners’ sustainability commitments.

The LNAE mechanism consists of a series of coordinated steps to link concerted efforts of expanding agriculture into a certain area and mitigating or compensating the displacement of the original production in the area. Such efforts can be understood as a closed system with zero land leakage. This closed system would merit a very robust claim on avoiding deforestation proportional to the land leakage that would have occurred in its absence.

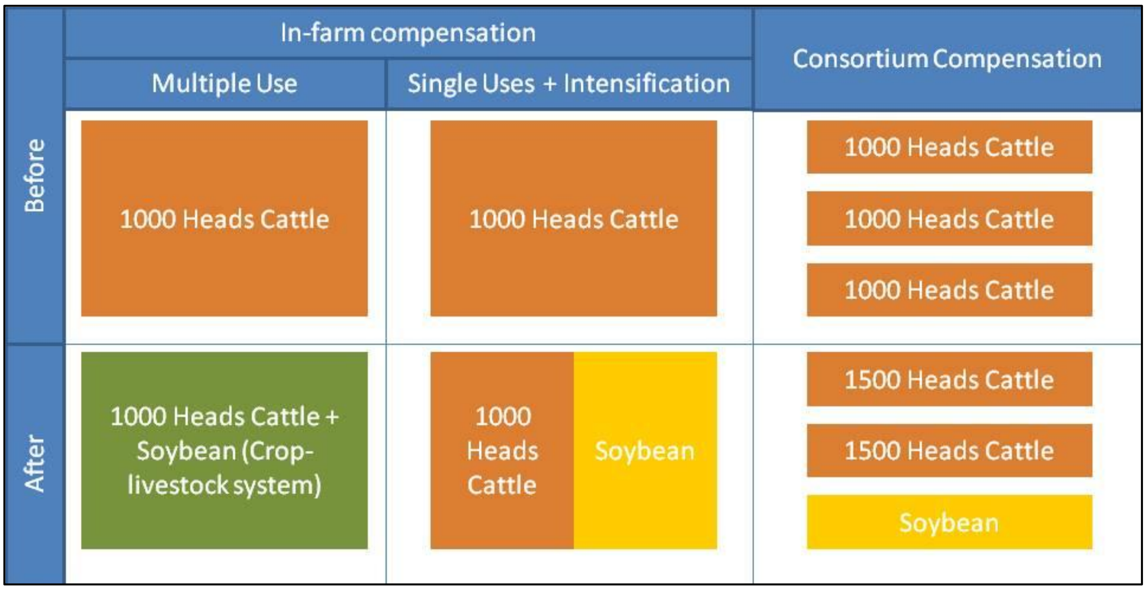
[5] The International Institute for Sustainability retains the intellectual property rights over the Land Neutral Agricultural Mechanism and associated concepts and processes. IIS welcome further correspondence with colleagues and interested parties about the concept moving forward on research and implementation. For further detail, correspondence with Dr. Bernardo Strassburg is encouraged: b.strassburg@iis-rio.org).

The LNAE mechanism could be implemented following three main routes, or a combination of them. In the first route, the displacement of the original production in the target area for agricultural expansion is mitigated via the adoption of multiple land use system. In this option, the original production (e.g. beef) shares the same area with the new production (e.g. soybean) and no displacement occurs.

In the second route, the farm targeted for the agricultural expansion is divided in two areas. In one occurs the expansion of the new production (e.g. soybean), whereas in the other occurs the intensification of the original production (e.g. cattle ranching). If the production in the second area is equal to the original production of the farm, the displacement is mitigated and no leakage occurs.

In the third route, a consortium is formed with one or more additional farms capable of compensating for the production displaced by the expansion in the target farm. If the total production of the original product (e.g. beef) in the farms of the consortium is the same as before the expansion of the new product (e.g. soybean), the displacement is mitigated and no land leakage occurs. Figure 4.2 presents the three routes of LNAE mechanism in a context of soybean expansion into cattle ranching farms.

Figure 4.2 - The “Land-Neutral Agriculture Expansion” (LNAE) mechanism options



Source: Strassburg (2012)

It is important for the credibility of the mechanism that its implementation is independently verified. A similar approach could be implemented entirely by the public sector. The LNAE mechanism can be implemented by a partnership between public, private and NGOs (Strassburg, 2012). If direct (e.g. REDD+ incentives) or indirect (e.g. access to markets) financial benefits are associated with such mechanism, it would naturally generate a space for private, for profit institutions to facilitate the process, possibly including extension services and financing intermediation to cattle farmers.

4.5. Stakeholder map

Many stakeholders with complementary potential contributions should be involved in the initiative. The stakeholder groups with key potential roles identified include Government institutions of the Federal, State and local levels, NGOs and research institutions, farmers' organizations, financial institutions, other private sector stakeholders and donor agencies (Table).

Table 4.3 – Key stakeholders and potential role in implementation (preliminary)

Stakeholder group	Key players	Potential role
Federal Government	MAPA	Participate to program/ policy design; Mobilize funds from the ABC Plan
State Government	SEMA-MT	Participate to program/ policy design, especially on environmental aspects and questions related to REDD+
	SEDRAF-MT Empaer Indea	Participate to program/ policy design; Participate to the strengthening of extension services; Participate to the monitoring of the program.
Municipal Government	Municipalities	Participate to pilot projects in cattle ranching poles and local program implementation
NGOs and Research institutions	Environmental NGOs	Participate to program/ policy design; Manage pilots in cattle ranching poles; Mobilize grants for program design and implementation of pilots
	Embrapa	Participate to capacity building; Lead research
	Universities	Participate to capacity building and development and implementation of pilots in livestock poles
Farmers organizations	Famato, Aprosoja, CNA and Acrimat IMEA SENAR	Participate to program/ policy design; Mobilize farmers to engage in the program; Participate to program coordination; Provide expertise on sector economics; Monitor program implementation; Participate to the implementation of capacity-building actions
	Local Farmers Unions	Mobilize farmers to engage in the program; Participate to pilot projects in cattle ranching poles and local program implementation
Financial institutions	ABC program implementing banks	Provide capacity-building for farm-level project development; Adapt financing rules to the conditions of the ranchers sector.
Other private sector	Slaughterhouse companies	Develop and implement responsible sourcing policies; Participate to risk management mechanism.

	Technical assistance service providers	Recipient and multiplier of capacity-building actions, assist farmers on cattle ranching productivity improvement, multiple production systems and environmental compliance
Donor agencies	Int'al cooperation	Fund program design and implementation of pilot projects
	Foundations	

Source: authors

Chapter 5 - Public returns and risks

The figures presented in this chapter represent a preliminary estimate of the environmental and social impacts of the proposed implementation of the LNAE Mechanism in Mato Grosso. A proper estimate of these impacts would demand the development of an appropriate methodology to calculate them.

The key assumptions considered in this estimate relate to i) the area under production for livestock and soya in a business-as-usual scenario; and ii) the proportion of successful uptake of alternative production methods:

- As for the area under production for livestock, we assume IMEA's projection that cattle herd will grow at an average 2% per year in the next decade. We consider that pasture stocking will grow at an average 2.25% per year, a conservative assumption that represents a 50% increase over the last 5 years' average. As a result, the total pasture area would be slightly reduced in 2020 (Table 4.1). With a plausible 3% annual growth in off-take rate, this allows beef production to increase by 64% over 2010-2020. We also assume that the soya planted area will grow according to IMEA's high scenario presented above. Consequently, the total area of agriculture and pasture will grow 0.8 million hectares by 2015 and 1.9 million hectares by 2020, which implies average deforestation rates of 1.650 Km^2 per year during 2010-2015 (consistent with actual rates observed in 2010 and 2011) and 2.100 Km^2 per year during 2015-2020 (Table 4.1).
- As for the proportion of successful uptake of alternative production methods, we assume that during the first 5 years the proposed mechanism could reach 100,000 hectares of soy expansion and that during the following 5 years it could reach 500,000 hectares of soy expansion. This would represent 24% of the total expansion of soya area projected for the whole period. Since the alternative production methods in cattle ranching generate an 88% productivity increase besides what would already occur in the BAU scenario, they would have to be applied to 114,000 hectares of pastures during the first 5 years and 568,000 hectares during the next 5 years to compensate the above mentioned areas of soya expansion. This would represent approximately 3% of the total area of pastures in the state.

Table 5.6 – Assumptions related to area and production for livestock and soya

Indicator	Unit	2010	Annual growth	BAU 2015	BAU 2020
Cattle herd	Million heads	28.8	2.0% [a]	31.8	35.1
Pasture stocking	$Head.ha^{-1}$	1.12	2.25% [b]	1.25	1.39
Pasture area	Million ha	25.8	-0,2% [c]	25.5	25.2
Soya planted area	Million ha	6.2	3.4% [a]	7.3	8.7

Indicator	Unit	2010	Annual growth	BAU 2015	BAU 2020
Net Area Increase	Million ha	NA		0.8	1.9

Sources: IBGE, 2011a e 2011b; [a] IMEA, 2010 ; [b] conservative assumption, 50% above 2005-2010 average; [c] calculated, based on cattle herd and pasture stocking

5.1 Climate impacts

Area of avoided deforestation

In the proposed mechanism, we consider that all productivity increases in cattle ranching compared to the BAU scenario directly generate avoided deforestation, since they are explicitly linked to areas of soya expansion, which thus become "land-neutral". The system is closed and there is no possibility of leakage. Moreover, since the alternative methods require investment and generate higher income than the conventional ones, the risk of non-permanence is low, especially when compared to a "payment for no deforestation" approach. This is why we consider the productivity increases as fully additional.

The implementation of improved, alternative production methods in a given ranch are expected to increase productivity by 88% above the BAU scenario. For this reason, for each 1 hectare of improved productivity, we consider 0.88 hectare of avoided deforestation. Inversely, in order to compensate for 1 hectare of soya expansion, 1.14 hectare of cattle ranching increased productivity is necessary.

Based on these assumptions, the total projected area of avoided deforestation corresponds to the area of soya expansion made "land-neutral". We consider here 100,000 hectares in 5 years and an additional 500,000 hectares in the following 5 years.

Avoided GHG emissions

In order to calculate avoided GHG emissions, we consider the loss of typical stocks of 119 tons of carbon per hectare in forests located in northern Mato Grosso, compared to carbon stocks of 8 tons of carbon per hectare in pastures, both extracted from the II National Inventory of GHG emissions (MCT, 2010). As a result, each hectare of avoided deforestation represents 407 tCO_2 and the total projected avoided GHG emissions from this initiative amount to 40.7 million tCO_2 during the first 5 years and 203.5 million tCO_2 during the following 5 years.

Hectares of reforestation/afforestation

The proposed approach produces two types of additional areas of reforestation/ afforestation: i) the restoration of degraded forests in legally protected areas, which is required for properties to take part to the project; and ii) the implementation of silvipastoral systems in part of the areas of pastures, which is recommended by Embrapa.

As for the restoration of legally protected areas, the Brazilian Forest Code establishes two categories of protected areas within private properties: Areas of Permanent Preservation (APPs), mostly riparian forests, which must be left intact, and Legal Reserves, a percentage of the total area of each property (80% in the Amazon region) where forests can be managed but not cleared. However, the Forest Code is currently under discussion and there is a high uncertainty regarding to what extent the restoration of these areas will actually be required from landowners, and if is, whether the landowners will or not comply with this requirement independent of their participation to this initiative. In view of this fact, at this stage we do not consider the potential of restoration of legally protected forest areas.

As for the implementation of silvipastoral systems, we assume that it will represent 20% of the cattle ranching areas under intervention, which represents 22,800 hectares during the first 5 years and 114,000 hectares during the following 5 years.

Carbon sequestration

For carbon sequestration in native forest restoration, we would consider an annual average increment of 5.1 tons of carbon per hectare, based on the Brazilian Initial Communication on carbon storage in aboveground live biomass, corrected with a root-shoot ratio to include belowground live biomass.

For carbon sequestration in silvipastoral systems, we consider the average carbon stock in an area managed with 7-year cycles. Considering an annual average increment of 6.58 tons of carbon (24.12 tons of CO_2) per hectare, including above and below ground live biomass, based the Reference report on commercial forestry of the I National Inventory of GHG emissions, the average carbon stock is 19.7 $tC.ha^{-1}$, which corresponds to the sequestration of 72.4 $tCO2.ha^{-1}$. Thus the total carbon sequestration in silvipastoral systems is estimated to 54.3 $tCO2.ha^{-1}$, which means a total of 1.6 million tCO_2 during the first 5 years and 8.3 million tCO_2 during the following 5 years.

Avoided GHG emissions/carbon sequestration of agricultural practices

Improved practices in cattle ranching, especially the restoration of degraded pastures, generate positive climate benefits in terms of increase of soil carbon stocks and of avoided CH_4 emissions from cattle.

In terms of area, we assume that 10% of the pastures under intervention are degraded and will be recovered through the implementation of improved practices. The corresponding area represents 11,400 hectares during the first 5 years and 57,000 hectares during the following 5 years.

In terms of climate benefits, the increase in soil carbon stocks is estimated to 9,5 $tC.ha^{-1}$ (at the end of 20 years), applying the CDM "Tool for estimation of change in soil organic carbon stocks due to the implementation of Afforestation and Reforestation CDM project activities" (version 1). As for the reduction in CH_4 emissions, it is estimated to 4.67 kg CH_4 per year per head of cattle, based on Gouvello, Soares Filho & Nassar (2010), which represents (in 10 years) 1.2 tCO_2e per hectare at the average BAU stocking. Thus the total avoided GHG emissions and carbon sequestration from improved cattle ranching practices is estimated to 1.1 million tCO_2e during the first 5 years and 5.5 million tCO_2 during the following 5 years.

5.2 Other social or environmental impacts

This section examines the environmental impacts of adoption of *pastejo rotacionado intensivo* (PRI) – intensive rotational pasture - the main approach suggested to increase productivity in Chapter 3.

1. *Impacts of the alternative production technique on land degradation, soil erosion and soil fertility.*

A transition to intensive rotational systems has been shown to improve a range of environmental and economical aspects of agriculture. Well managed PRI may reduce land degradation and reverse soil erosion (Drewry, 2006). Shifting the livestock systematically at desirable intervals to different subunits of fenced subdivisions enables managed control over the height of fodder, which prevents overgrazing. Moreover, grazed soil is always covered, which diminishes erosion. A number of studies from tropical countries demonstrated advantages of adopting PRI as a more sustainable pasture management (WWF, 2009). Is has been shown that rotational systems increase livestock product yield per unit of land area.

For example, Eaton et al. (2011) showed that in a 17-month study, mean cattle weights and pregnancy rates were 15% and 22% higher, respectively, for the herd using the rotational system in Brazilian Pantanal. The potential stocking rates of the rotational system were 2 to 6 times higher than rates typical of continuously grazed areas. Increasing stocking rates were shown to have a potential for minimizing pressures on natural resources in Pantanal (Eaton et al., 2011).

On the other hand, a number of authors (Martınez and Zinck, 2004; Hamza and Anderson, 2005) highlighted potential impacts of trampling, and consequent soil compaction. Compaction of the topsoil through the pressure exerted by the hooves of increased number of livestock per unit area has been shown to negatively impact soil physical conditions, such as increase of bulk density and penetration resistance, decrease of soil porosity and infiltration rates. This in turn, decreases soil physical fertility through reduced nutrient recycling and mineralisation, decreasing storage and supply of water, reduces activities of micro-organisms, impedes root growth and promotes erosion. For example, studies of Mwendera and Saleem (1997), and Donkor et al. (2002) demonstrated effects of different grazing intensities on surface runoff leading to greater losses of nutrients and sediment, soil loss and infiltration. Notably, finetextured soils (clay rich) were more susceptible to trampling effects than coarse-textured soils. Increased soil bulk density and consequent impedance to root penetration and a reduction in aeration may negatively affect legumes productivity and growth, and thus nitrogen fixation in pasture (see below). Environmental impacts associated with soil compaction tend to be most prominent in areas where animals congregate, for instance around field gateways and along fence lines (McDowell, 2008). Soil moisture is a critical factor determining soil compaction under trampling. A gradual process of the compression of a saturated soil by squeezing out water may lead to adverse consequences of soil consolidation (Drewry, 2006). Therefore, as a component of well managed PRI systems, grazing should be prevented on wet soils, especially widespread in Brazil clay-rich acrisols (argissolos). Along with PRI adopted here, it is assumed that every 10 years a pasture will undergo general reestablishment, which will also include deep sub-surface tillage to combat possible compaction.

2. *Pollution impacts and eutrophication*

Soil fertility and nutrient availability is fundamental to fodder production in PRI. Provided that PRI systems are seeded with atmospheric nitrogen-fixing legumes, there is no need for additional commercial nitrogen fertilization. In addition, pasture soils are generally well supplied with nitrogen, on account of relatively high concentrations of soil organic matter (McDowell, 2008). A constant input of soil organic matter and recycling of nutrients is provided by dung and urine, in addition to decay of leaves and stems, root exudates and the turnover of root biomass. Therefore, although grazers remove biomass from the pasture system, these losses are compensated by the manure. Such a nutrient recycling can be well managed and controlled within rotational grazing systems. Utilizing legumes avoids the peaks of high concentrations of nitrogen in soil, which normally follows applications of fertilizer, thereby nitrogen leaching to environment from N-fertilized pastures can be avoided. However, various studies demonstrated the importance of nitrogen from urine compared to nitrogen from fertilizers in contributing to NO_3 leaching (McDowell, 2008; Eriksen et al., 2010). Leaching from agricultural soils has a significant contribution to nitrate pollution of ground and surface waters, while urine typically contributes 70-90% of total leached nitrogen (Monaghan *et al.*, 2007). Because urine patches are the main source of nitrate leaching from grazed pastures and losses are related to stocking rate, attention should be paid to diminish possible nitrate leaching from PRI. In PRI this can be achieved by adopting drainage and processing of manure, as well as composting systems. For some edaphoclimatic conditions, an option to mitigate NO_3 losses is to reduce the length of the grazing season (Erikson, 2010) yet this would require a high environmental consciousness of farmers.

The adoption of PRI involves application of phosphates fertilizers. Similarly to nitrogen, a plant-growth limiting phosphorus is one of the macronutrients, crucial for the formation of phosphate containing nucleic acids, ATP and membrane lipids. However, possible P leakage from PRI should be carefully controlled and managed, on account of the risk of diffuse pollution of surface waters. Because concentrations of phosphorus in unpolluted waters are generally low, relatively small P discharge can cause eutrophication. Significant loses of P may be due to detachment in compaction-affected soils and incidental loses through run-off after the application of fertilizer, if heavy rain falls soon after (surface or subsurface flow through fissures and drains). Possible loses in PRI systems can be therefore controlled by good pasture management, careful application of relevant gradual-release source of phosphate and by soil analysis for exact concentrations of P in soil, prior to fertilizer application.

With respect to weed control, in general, PRI systems have low weed occurrence due to high competition with well-established forage species (usually multiple species which further contributes to minimize weeds). Also, in PRI, higher stock densities contribute to increased browsing of broadleaf weeds, while weeds that are useless as livestock feed (for example thistles) are exposed to more physical damage by trampling. Therefore, it is assumed that well managed PRI will not receive any pesticide input and thus pesticide-origin pollution is not envisaged. In case extensive weed cover occurs, the system will be managed with mechanical means. In fact, a routine yearly pasture-maintenance of PRI considered here, assumes trimming of the remaining weeds (which may compete with a neighbourhood fodder species), while every ten years it is assumed the pasture will be tilled for both weed and sub-surface compaction control. If extensive uncontrollable weed occurs, the pasture will be re-established with new seeds. A part of weed control is also an appropriate every-day pasture management. For example, overgrazing should be prevented yet undergrazing is also undesirable as animals are likely to graze selectively, allowing less desirable plants to outcompete fodder, which may require more frequent mowing to keep thistle and other undesirable plants from going to seed and spreading further.

If soil acidity occurs, it is assumed that PRI will be supplemented with liming. In addition to a variety of positive effects of increasing soil pH by adding *calcario*, in tropical countries liming has been reported to significantly reduce aggregate stability, increase clay dispersion, improve soil texture and soil microbial activity, and diminish infiltration rates by increasing water holding capacity (Haynes and Naidu, 1998). In aluminium-rich Brazilian soils, addition of lime has a crucial role in liberating phosphorus from stable forms of aluminium phosphate. An important constraint for a wider access to liming in Brazil is a need for a farmer to travel over large distance to obtain lime. In excess, liming can result is excessive soil cementing, soil cracking and can be harmful to fodder.

3. Impacts of the alternative production technique on water and riparian areas

Theoretically, riparian areas at farms in Brazil are protected by ´Permanent Protection Areas´ (APPs), wherein a strip of land (minimum 30 meter and depends on the river size) should remain with native vegetation. In reality, however, not all farms meet APPs requirements. In PRI suggested here, we assume that riparian areas along with APPs are unavailable to grazing and are separated from the grazing plot by fence. Water pollution from infiltrating N, P, pathogens and urine leaching is prevented by well managed pasture. The consequences of animal grazing on riparian areas may otherwise involve: trampling and overgrazing of stream banks, loss of stream bank stability, reducing resistance by removing protective vegetation and loosening soil and soil runoff, runoff high in nutrients from animal waste and sediment, soil erosion, declining water quality due to siltation and pollution, aquatic and riparian wildlife (Belsky, 1999), with detrimental effects increasing with increasing inclination.

4. Impacts of introduction of silvopastoral systems

Transition of extensive pastoralism to agroforestry may result in a range of socio-economical benefits (Tilman et al., 2002), such as maintaining agricultural productivity and supplementary farm outputs, enhancing the supply of diverse market products, and contributing to risk reduction due to provision with alternative products and higher incomes. Agroforestry has been shown to enhance rural livelihoods by preventing and reversing soil degradation, increase biodiversity and provision of environmental services (German, 2006).

On the other hand, transition to agroforestry when not properly planned and executed may result in possible lower yields thus incomes although large-scale farmers may be able to forego short-term returns. Pinto et al. (2005) showed that on account of diminished light available to crops, and competition for water and nutrients, which increases with proximity to trees of mature eucalyptus, trees negatively affected sugarcane growth and yield. Although shade from trees provides benefits for the cattle reducing the risk of heat stress, animals congregate heavily in the shade which may lead to nutrient loading and runoff, uneven grazing, soil compaction and soil erosion. This can be prevented by planting taller trees. In addition, water-demanding trees may negatively impact the farms, which rely heavily on springs and rivers for drinking and irrigation water (German et al. 2006).

5. Social impacts of the alternative production technique

Due to refinement and increase complexity of pasture management when transferring to PRI, is it possible that the system will require more workers, and thus create new jobs in the farms adopting it. It is possible, however, that aggregate jobs per unit of output (e.g. tones of beef) might decrease due to higher efficiency. If we assume a constant total output in both BAU and Alternative scenarios, this would lead to an overall reduction in jobs in the Alternative scenario. Further research should clarify the overall and regional impacts and targeted policies could address any negative consequences.

Successful functioning of PRI is a function of complex and sometimes variable factors, including soil properties, climatic and weather conditions, biological characteristics of the grass species, pasture and cattle rotation. In the PRI systems assumed in this study, the pasture requires to undergo maintenance every year, whereas every ten year the pasture needs to be re-established. Therefore, PRI to work properly requires to be well managed. In fact, some authors (Briske et al., 2011) highlighted social aspects as critical, above all other impacts of the introduction of PRI). The capacity of farmers to detect, learn, and adapt to change within complex PRI is a key component of successfully functioning pasture. Transition to agroforestry also requires additional financial and labour investments from the farmers, providing training, extension, markets, marketing organizations, access to roads and relevant policy.

Chapter 6 - Private Returns and Risks

In this chapter we briefly discuss the potential returns and risks for the private sector related to a potential initiative to apply the "Land Neutral Agricultural Expansion" mechanism to the soybean expansion in the state of Mato Grosso.

6.1 Private returns

<u>Soya producers and supply chain</u>

For the soya producers and associated supply chain, taking part in a LNAE initiative would reduce the risk of market barriers, especially from the highly and increasingly demanding European market. There is increasing pressure for the Round Table on Responsible Soy to adopt indirect deforestation criterion. Also, the commitment from the Netherlands' market to buy only RTRS soya by 2015 send a strong signal of potential market barriers. A LNAE initiative would allow soybean farmers to prove a zero impact on natural environments arising from future expansion at a relatively low cost. We estimate the costs of fully neutralizing the expansion of one hectare of soybean at around 2.5% of the value of the soybean produced in the first five years after expansion.

For the soy supply chain, the benefits include but go beyond the access to markets. Guaranteeing a future "land-neutral" expansion would bring considerable corporate social responsibility and reputational benefits in a period where the tensions arising from growing environmental problems is likely to grow substantially.

<u>Cattle ranchers and beef supply chain</u>

The cattle sector could benefit in diverse ways from both the improved practices at producer level and a potential LNAE initiative.

For ranchers, the analysis in Chapter 3 has shown that adopting improved practices would bring substantial positive financial returns. The availability of subsidized credit (in particular the ABC programme) introduces a key element, making the necessary investments increasingly attractive. Further, adopting improved practices brings a potential differentiation in the market, considering that both the major slaughterhouses and supermarket chains are increasingly demanding deforestation-free and best-practices certified products. This is particularly true for "first-movers". A LNAE initiative could benefit ranchers from improved access to credit and extension services, in addition to potential gains related to carbon mitigation incentives.

For slaughterhouses and supermarket chains, the widespread adoption of improved practices by ranchers, as could be catalyzed by a LNAE initiative, would bring increased security of supply of higher quality and potentially traceable and certified products. This would entail the same reputational benefits as discussed for the soy supply chain.

6.2 Private risks

No significant risks were detected for the involvement of soybean traders in a potential initiative to reduce or eliminate their direct and indirect impact on deforestation. For the cattle sector, the production, financial, market and regulatory risks and mitigation measures were discussed in Chapter 3.

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