INSTITUTO INTERNACIONAL PARA SUSTENTABILIDADE

IIS

The Business Case for a more sustainable cattle ranching

International Institute for Sustainability

Estrada Dona Castorina, 124 – Jardim Botânico
CEP 22460-320 – Rio de Janeiro/RJ – Tel: 21 3875 6218
www.iis-rio.org

Bernardo Baeta Neves Strassburg (Coordinator)
Executive Director

Agnieszka Latawiec
Research Director

Coauthors
Alvaro Iribarrem (IIS), Ana Castro (IIS), Daniel Silva (IIS), Felipe Barros (IIS), Helena Alves-Pinto (IIS), Jerônimo Sansevero (UFRRJ), Kemel Kalif (IIS), Luisa Lemgruber (IIS), Márcio Rangel (IIS), Mariela Figueredo (IIS), Rafael Feltran-Barbieri (IIS), Renato Crouzeilles (IIS).

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Executive Summary

Among the agricultural activities, livestock carries the greatest potential to reconcile production, ecosystem conservation and mitigation of greenhouse gases emissions. However, actually livestock production in the Amazon has proven to be inefficient, with an average productivity of 15@ per equivalent carcass (PAA, 2015), 1@ less than the national average and half of the American. It occupies 76% of open areas, but it is still responsible for about 73% of new deforestation activities, and for 30% of Brazil´s CO2 emissions. Even with all this use of resources, it generates 8.7% of the regional GDP and it is among the sectors with the highest indexes on informal labour and land irregularity, especially concerning the lack of rural property ownership and low adherence to the Forest Code.

It is true that in the last decade important steps were taken to achieve greater legal safety and legal compliance. Ranchers and refrigerators committed with the Public Ministry and society to initiate the environmental regularization and to fight the degrading work. Just as important are Embrapa´s efforts in disseminating Good Agricultural Practices, and the development of socioenvironmental patterns through volunteer initiatives involving the whole value chain, such as promoted by the Brazilian Roundtable on Sustainable Livestock, the GTPS. The Rural Environmental Registration is another positive point.

However, the vertical progresses in production have been more modest. The Amazon annual rate of productivity growth in the last 12 years was about 2,04% p.y, figuring among the lowest in agriculture. The state of Mato Grosso, where the carcass average weight is higher than the amazon average, around 16,5@, is, on the other hand, at a stationary stage of productivity growth, close to 0,4% p.y.

But, the potential growth is huge. Favourable climatic and soil conditions to densify fodder biomass, associated with investments directed to pasture improvements, genetic enhancement, animal sanity and management, could elevate productivity three times.

The intensification brings multiple advantages. It raises the producers' incomes, contributes with GDP´s increase, being able to soften price fluctuation to the consumers by promoting positive offer shifts. Comparatively, it generates more rural jobs than wide systems, also driving direct and indirect jobs to the rest of the productive chain due to the greater volume produced and, from the environmental point of view, it affects less because it demands less land and reduces herd slaughtering time.

So, why not to intensify? Even though aspects such as the producers' resistance to innovation and the need for technical orientation must be taken into consideration, the greatest barrier is the high initial investment. In this sense, the rural credit may play a fundamental role if

conformed to good practices. The main benefits are the equity exoneration through cheapening of the initial investment, which may be prohibitive if conformed to market interest rates. It is necessary to clarify that intensifying may represent an additional expense of 50% to 70% over the conventional pasture reform, approaching values close to the soybean production.

However, it is worth it. The model developed here demonstrates that by intensifying even only 20% of the total pasture area, the net value may be incremented in R$1.940/ha, substantially increasing the probability of business profit, going from 1% up to 85%, depending on the property´s size. These results do not just confirm the economic viability of improved livestock production, but also provide greater competitiveness in relation to alternative soil uses, or even investments in the financial market. It is important to stress that it may create a win-win relationship with the creditor in the case of financing use, because it reduces the default risk.

The strategy for a transition for a more sustainable livestock must not be restricted to intensification. The implementation of systems for integrated production is noteworthy. Though poorly disseminated in the recent past, the crop-livestock and crop-livestock-forest integrations have grown rapidly, being currently adopted in about 3,5 million hectares throughout Brazil, 700 thousand only in Mato Grosso. Besides presenting the necessary technical viability for diversification of agriculture production, it is an alternative option for the recovery of degraded areas and for land saving and agrochemical inputs that, ultimately, represent the great environmental bias of intensification.

These advantages have been recognized not only by agriculture research and consulting organisms, but also by the State, through the National Politics Law ILPF (Law 12.805/2013) and specifically by the Low Carbon Agriculture credit line (ABC). However, there are still many restrictions for the integration to become widespread as a productive practice. One of the main restrictions derives from the lack of knowledge of its economic performance. Although being virtually unanimous among researchers, the economic viability of the integration is still based on experiments or case studies.

Our model intends to fill this gap, going beyond the simple performance evaluation and assessing the business risk. This analysis is justified because although integrated diversification has been seen as a strategy to decrease uncertainty – precisely by decentralizing investments, incomes and costs of specialized activities – there has not yet been an instrument that could simulate the vital risk-return relationship, combined with intensification and restoration, in the long term.

After 10,000 simulations based on the most common models of intensification, crop-livestock integration (CLI) and restoration, our results show that in fact, in Business as Usual (BAU) scenarios, extensive farms up to 804 ha are economic unfeasible. Intensification of 20% of pasture area, however, reduces by 41% the minimum economic feasible area, showing that economic responses are very sensible to technical improvements. Integrated systems have lower performance than intensification, but still reduces minimum feasible are to 649 ha, saving 155 ha compared to BAU scenario. CLI demands more investments than conventional intensification, but is an important strategy to pasture reform since it provides higher working capital. The production-conservation trade-off can be ameliorated since passive restoration (20% of total area) is combined with both integrated production or intensification, with marginal costs of restoration declining as farms scales increase, showing that productivity gains and conservation efforts can be convergent.

But, for this highly favourable scenario, from the gates to the inside, to be consolidated as a new path to a more sustainable livestock production, it must not do without command and control actions with potential to minimize the possible "rebound effect", in other words, the increase of social and environmental impacts that may initiate from the great attractiveness of improved livestock production. As it becomes more profitable, it is always plausible that the horizontal expansion occurs parallel to the productivity gains, mainly in a situation of growing demand. This is how formal regulation – public sphere – and informal regulation – volunteer actions of adequacy of the productivity chain, as it already occurs – are crucial to design the new path, from the gates to the outside.

1. Introduction

1.1. Contextualization

Farming is responsible for 25% of the Gross Domestic Product (GDP) and some 37% of the jobs in Brazil. However, it is in times of crises that it shows its strategic relevance. While the economy has flagged a retraction of approximately 2%, agriculture must grow between 2,0 and 2,5%, being the only sector capable of softening the strengthening of the negative GDP in 2015. It should be noted that more than one third of all the soy and sugar cane in the world are planted in Brazilian soil and that the country figures as the biggest producer among a dozen of other agriculture commodities. Moreover, in the last decade alone our cattle herd has grown more than 40 million cattle heads, the equivalent to 3 Uruguay, increasing the meat production in 25%. This strength has historically sustained the trade balance and, recently, has avoided an even greater deficit.

As primary sector by excellence, it is, on the other hand, substantial in natural resources. It is estimated that the Brazilian agriculture absorbs up to 83% of the water available for use, an index way above the worlds average, next to 76%. It is the final demander of 20% of the energy, but it is responsible for at least 27% of the Greenhouse Gases Emissions (GGE), not considering the agroindustry stage, for which values were not stipulated, and another 15% due to deforestation. This places the sector as the main reason for biodiversity loss and degradation of natural resources and environmental services, paradoxically to its big dependency on those goods and services.

In this scenario, livestock production is particularly striking. Not only because it is the major source of emission and deforestation inside its own sector, but especially because it has shown a delay to leave this condition. About 70% of the Brazilian agricultural area is composed of pasture, or 196 millions of hectares, of which 75% is at some degradation stage.

In 2014, the credit's investments in breeding pastures were of about R $ 3.38 billion, which represents only 15% of livestock investment, and 2.03% of the total rural credit. The insistence of an extensive system still favours the comprehensive land use instead of the management packs that properly combine the use of the natural support capacity and capital investment, has led to an average yield of about 5 kilos/hectare/year.

The situation is even worse in the Amazon forest. In 2014 the credit for investment on pasture improvement was about 13% of the total invested. Therefore, below the national average. Having about 60 million cattle heads nowadays, which represents 29% of the Brazilian herd, it raises 24% of the investment credit, an amount that is more diluted than in the rest of the country, and strongly directed to animal purchase, and not to activity improvement. More than that, recent studies show that, even though the stocking rate has grown 33% in the last decade, the carcass productivity decreased 4%. Despite the growing demand and the high prices of the @ anticipating the slaughter, a phenomenon valid for all the others biomes, in the others, the carcass weight increased an average of 1,5%, making it possible to argue that the early herd in the other Brazilian regions have had a bigger yield than in the Amazon. Moreover, this biome was the only one in which the horizontal pasture expansion occurred at a faster pace than the productivity gain, becoming deficient in the Land Saving *versus* deforestation (Feltran-Barbieri *et al*., 2015).

This wide system, which is not restricted to the Amazon, but more persistent in it, is justified by a series of factors: (1) the colonization stimulated from the 1960´s on by the programs for national integration which sought rapid territorial lands occupation instead of implementation of intensive and planned systems. (2) The abundance of land available until today, and therefore with relatively low prices, favouring the perpetuation of land loan restraint over technology. (3) The predominance of policies for subsidized credit not directed to intensification. (4) Legal inefficiency for the land hold and land fraud control, allowing the illegal and speculative occupation, and (5) low opportunity cost, given that more profitable soil use, as soybean production, are rare and densified in specific regions.

Connected to these, other factors that are unlinked to extensive systems have driven livestock production in the region, such as favourable climate to pasture growing, allowing a production with relatively lower costs than with similar conditions in the *Pantanal (Brazilian Wetlands) or Cerrado (Brazilian Savannas),* for example. The battle against foot-and-mouth disease, the infrastructure, the cheapening of basic feedstock and the vertiginous growth of refrigeration facilities are also important stimuli.

However, the extensive system and its consequences have found an increasing resistance especially from the gate out. Illegal deforestation (Santos et al., 2007), Greenhouse effect gases (Bustamante et al., 2014), low use of formal labour, degrading labour conditions (CPT, 2013), high levels of clandestine agro industry (Walker et al, 2013) and of land conflicts (Barreto et al., 2008) are socioenvironmental externalities increasingly fought.

An emblematic case which was widely spread on the media occurred in June 2009, when the Federal Public Ministry and the Environment and Natural Resources Brazilian Institute (IBAMA) initiated actions against 21 farms (20 for not accomplishing the environmental legislation and one for being located inside indigenous land) and 13 refrigerators that had acquired cattle from those farms in Pará and Mato Grosso. After that, the Public ministry recommended that 69 companies who were costumers of those fridges stopped acquiring their products to avoid judicial processes. The Public Ministry´s action was strengthened by a Greenpeace campaign, which demonstrated the illegality of the feedstock sources through the whole chain. Representatives of fridges and cattle breeders signed a TAC with the Federal Public Ministry, committing to initiate the environmental and land regularization.

The case unleashed an attitude change in the sector, which organized several initiatives, among them the most disseminated was the Sustainable Livestock Work Group formation (GTPS), which gathers the country´s largest fridges, producers' representatives, raw materials and services suppliers, big retailers, the three major rural financing banks and civil society organizations. The GTPS has the clear objective of searching for the development of patterns and good socioenvironmental practices involving the whole chain of cattle value.

From the gate in, the great economic challenge is to increase productivity. This is the key to promote a greater profitability for the producer, to decrease business risk, to elevate the values added to the chains and to release the pressure from new deforestation. This is mainly about intensification and implementation of integrated systems.

Mato Grosso must be especially sensitive to these strategies. Although the state already has an agricultural performance above the Amazon average, it has passed through a decade of relative productivity stagnation, the growth being a result of the production´s horizontal expansion. Regarding soy, sugar cane and cotton, for example, the productivity growth in the last decade was always at least half of the national average, and in 2014 these culture earnings in the rest of the country practically reached MT´s average, sometimes even surpassing it. In livestock farming, the situation is less unfavourable. The state's stocking rates vary a lot according to the region but, in general, they grow next to national averages, while the carcass weight is slightly above.

Even so, they are a lot below the biophysics potential. Today in MT there is about 3.5 million ha of pasture in a high level of degradation, and another 17 million ha of common pasture, sustaining a total close to 28 million cattle heads, when it could support 60 million (Strassburg et al. 2014). But such a radical change would not be necessary. The 20% intensification of today's available area could raise the herd in 37%, leading to a little more than 38 million heads, which is equivalent to say that 7.7 million additional ha to accommodate this same herd with no intensification would be saved. This is the first advantage: production increase with low impact on natural vegetation, mitigating deforestation. In MT the agriculture-environment conflict is latent, it being the second state in deforestation in Brazil, figuring 3,7 million ha in the last decade, leading Cerrado´s deforestation rank, with 1,9 million ha in the same period. For this reason, it is the state with the higher deficit in Permanent Preserved Area (APP) and Legal Reserve (RL).

Intensification brings benefits beyond the environment. For the producer, it is an opportunity to increase profit and promote business competitiveness. However, there are many challenges to overcome: it is necessary to encourage technical assistance capacitation; it is necessary to enlarge investments in technology. However, a previous step, equally important, is to anticipate economic performance that might elapse from management and operational change of an extensive system to combine intensification, and alternative actions such as the crop-livestock system.

The moment is favourable for this evaluation. The Low Carbon Agriculture (ABC) credit line was the one that presented a greater relative increase in the last five years, with expectations to make R$ 4,5 billion available until the end of 2015. At the same time, established in 2013, the ILPF´s National Politic Law (Lei 12.805/2013) is the public recognition of the need of integrated systems as a strategy for production growth with mitigation of impact in new areas, while MT´s state decree 2.151/2014 institutes exemption for SEMA´s request to clean and reform pasture areas, decreasing bureaucratic procedures that frequently prevented the pasture improvements.

In this scenario, this document intends to draw a complete panorama of the economic performance and optimization of the land use in livestock farms, and the impacts of intensification strategies, crop-pasture integration with restoration opportunities and forest code adequacy, without which it is not possible to achieve legality, nor natural resources resilience, so dear to the activity. Therefore, it aims at offering an instrument for decision-making support of producers towards an improved livestock, but also, to foment public policies sensitive to the theme. The instrument offered here is the Bio economic Model, developed as a system capable of conjugating economic and environmental analysis, applicable at farm levels, whose impacts might reverberate through the whole value chain.

1.2. Project Development

In 2012, the Instituto Centro de Vida (ICV) signed a partnership with Embrapa to promote the adoption of its Good Practices in Agriculture (BPA) program in the Alta Floresta region, in Mato Grosso. In the same year, the International Institute for Sustainability (IIS) joined this partnership to help with the economic analysis. The project involves several civil society organizations, industries, retail and unions.

The Project named "Low Carbon Integrated Livestock" focused on 14 farms, ten in the municipality of Alta Floresta and four in Cotriguaçu, aiming for the implementation of good practices focusing on productivity growth through the implementation of intensified pasture areas. BPA has the objective of assuring to consumer markets that the products acquired from livestock have been obtained in accordance with a minimum quality standard, promoting field's sustainable practices, improving its economic, social and environmental performances.

During two years of execution of the project, the farms taking part obtained a productivity up to 15,6 arrobas/hectare/year, while the region's average is 4,7 arrobas/hectares/year. In the intensified areas in the farms, productivity reached up to 27,3 arrobas/hectare/year. Besides that, the total time for animal slaughtering was reduced from 44 to 36 months (males) and from 34 to 26 months (females) (ICV, 2014). IIS analysed the economic performance of those farms concluding that the net financial gains resulting from intensification could achieve more than double than traditional systems.

Continuing the Project called "Low Carbon Integrated Livestock", in the year 2014 the Programa Novo Campo was launched, increasing the number of farms adopting BPA. The program relies on the support of Vale Fund, Gordon & Betty Moore Foundation, the Sustainable Work Group for Sustainable Livestock (GTPS) and Norwegian Agency for Development Cooperation (Norad). To support the New Field and disseminate good practices beyond the Program, IIS has been improving its Bioeconomic Model as a tool for analysis and support for management and financial decisions of rural producers. This report presents in detail the results of economic-environmental performance modelling of several beef cattle production models as well as systems integrated to it.

2. Methodological Procedures

2.1. Bioeconomic Model

Bio economic models are employed for analysis that combine land use and financial resources management, and its transition to alternative or complementary activities, helping agents in their decision-making. They are especially useful when applied to elaborate business plans in the agricultural sector because it is particularly in this sector that natural resources, climatic and biological factors may impact more directly the risk and business feedback. (Flichman & Allen, 2013).

The model developed here applies essentially to farming production whose initial condition is that of a livestock property, for animal breeding, fattening or for the complete cycle, with typical technical indexes for extensive systems for different scales. From this initial condition, unfold simulations for intensification, integration of crop-pasture and forest restoration as strategies for productivity, financial and environmental adequacy gains.

Therefore, it is structured in 3 interconnected parts, from which 2 refer to biological structure (herd and land use) and a financial-economic one. In the first module, the main variables are size, herd composition and price indexes for produced arroba. In the second, the distribution of the different classes for land use. The economy module highlights the investments, operational and financial costs. The model works according to the input-output logic, that is, the user provides entry data for each module and the model optimizes land assignments, returning indexes of economic performance based on the cash flow projected. Those indicators may be calculated for any period during the execution of the project, with a standard duration of 20 years, allowing for partial evaluation and monitoring of the development of activities performance (Figure 1). For the final evaluation, viable risks or probabilities of profit and internal rate of return (IRR) are provided.

It is important to stress that for parameter settings and calibration of the modules, we used real data collected in fields in the micro region of Alta Floresta (Low Carbon Integrated Livestock Project), in different production scales, levels of investment and productivity. Below, the contents and the function of each module are detailed. The whole model was developed by R Software, free and widely used worldwide. Complete R script developed reached 18,000 rows in 3 modules.

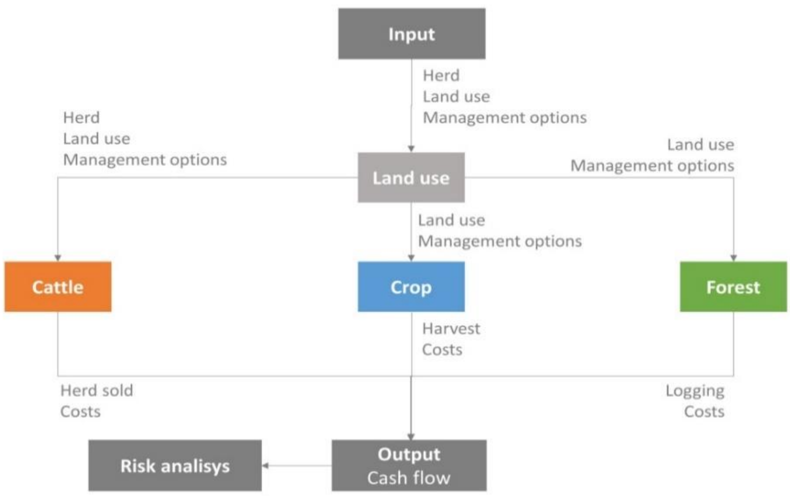

Figure 1. The model scheme

2.1.1. Bioeconomic model inputs

Cattle Herd Module

The cattle herd module gathers the main attributes referring to the cattle squad, composed by the initial number of animals per category (bull, pregnant mother, empty mother, heifers, calves, fattening cattle), average category weight (arroba/head), average price for arroba for each category (reais/arroba), drop rate, mortality rate, pregnancy initial rate and optimal bull/cow relationship. Those variables determinate not only the age arrangement and the initial herd composition, but indicate the structure of fixed assets in livestock, defined in the control panel.

Table 1: Stocking rates used

	Stocking Rate (heads/ha)
Degraded Pasture	0.5
Conventional Pasture	1.6
Intensified Pasture	4

Module Land Use

In this module, the land use has as starting condition the existence of only 3 categories: pasture areas, agriculture areas and native vegetation area. For the first, degraded, normal and intensified pastures are distinguished, to which different support capacity values are attributed (UA/hectare), adjusted by the presence of technical assistance. Figure 1 shows the stocking rates considered. In the initial distribution of pasture areas, we estimate 10% of degraded and 90% of normal areas. For agriculture, we consider soy and corn areas in conventional plantation, that is, off the integrated system. For native vegetation, only the area of initial vegetation cover is contemplated, without distinction in relation to type or successional stage.

As soon as the model is activated, the initial land uses are automatically rearranged by ranking and optimized for productive and restoration activities, also depending of the initial attributes selected for the herd and financial modules. The relocation and optimization, in turn, feedback these other modules, resulting in constant interaction.

For such optimization, some restrictions are predefined: (1) the index of normal pasture degradation is 5% per year, justified by the natural loss of vigour. To revert this condition, some annual investments for reforms are necessary, only afterwards returning to the typical capacity indexes for normal pasture. (2) The very degraded pasture has its support capacity reduced to 6% per year when not managed. (3) When there is vegetation deficit for Forest Code compliance, restoration follows the annual flat rate of 5%, obeying RPA´s stablished deadline of 20 years for adjustment. (4) The implementation of crop-agriculture integration occurs primarily in areas occupied by degraded pasture, followed by areas with agriculture, never replacing intensified pasture or confining.

Crop Module (Crop-livestock Integrated System)

The model results presented here considered soybeans as crop option, and focused on crop-livestock integration. The production cost of integration is increasing in the first four years and includes soybean costs and pasture formation: R $ 3.723 / ha in the first year ; R $ 3.313 in the second year ; R $ 3.015 in the third year ; R $ 2.829 from the fourth year. Soybean productivity is growing in Brazilian soy bags (1 bag = 60kg) per hectare. 38 bags in the first year; 42 bags in the second year ; 48 bags in the third year ; and 52 bags from the fourth year. The crop occupies the area during the rainy season and is replaced by grassland in the dry season, increasing the herd stocking capacity. On the other hand, the occupation of pastures in the dry season protects the soil compaction.

Forest Module

The forest module considered the cost of passive restoration of R$ 2,400 per hectare. This amount covers the costs of fencing the area. We consider restoration of 20% of the productive area, subtracting priority areas of degraded pasture. According to the Forest Code in Brazil, the restoration can be done over 20 years, or 5% of the forest passive area per year. We applied this 20 year-timeframe to restoration implementation.

Economic-Financial Module

It is a monthly cash flow containing investments, costs and revenues from the other modules. The initial investment covers the squad, cattle installations, such as stables and fences, machines and equipment. As the goal is to evaluate the productive system, usually land value is not considered. On pasture intensification, the additional investment of R$2.400,00/hectare is applied, distributed among reform (R$1.000,00) and improvement of soil and forage plants (R$1.400,00).

For options of crop-livestock integration (ILP) and forest restoration (RF), additional investments were not included, which is justified by the premise that, in the case of ILP, there is no soy specialized machinery available, thus everything is accounted as rental costs. The same premise was used to evaluate RF, which as a rule does not have goals of economic use, thus not consisting of business, but only of environmental adequacy. The premises were inspired by the local reality.

Livestock costs were divided between fixed and variables, that is: (a) fixed costs include depreciation, regular and intensified pasture maintenance. Variable costs cover sanitary management, mineralization and reproductive management. In ILP´s occurrence, they are considered costs of soy production intercropped with pasture, as well as variable costs per additional arroba produced in the integrated system, while in RF´s implementation, the land and environmental regularization duty is deducted. The land value may be added to the cost item as opportunity cost if it is eventually intended to evaluate the land gains, a common practice in agricultural borders of Mato Grosso. Table 2 shows the detailed description of those items:

Table 2: Description of the expenses considered in the Bio Economic Model

Costs	Unitary Value	Unit
Reproduction Management Cost	100.00	R$/head
Depreciation (per year)	500.00	R$/year
Regular Pasture Maintenance	150.00	R$/ha
Intensified Pasture Maintenance	450.00	R$/ha
Pasture Reform Investment	1,000.00	R$/ha
Pasture Intensification Investment	1,400.00	R$/ha
Bull Purchase Price	5,000.00	R$/head
Income Tax	20%	
Health Management	21.00	R$/head
Mineralizarion	45.00	R$/head
Minimum Wage	800.00	R$

Chart 1: Assumptions of Modeling

A)

Total Pasture Area (ha)	300	500	1.000	4.000
Initial % of degraded pasture area	10%	10%	10%	10%
Initial % of regular pasture area	90%	90%	90%	90%
% of regular pasture degradation (p. y.)	5%	5%	5%	5%

Initial Stocking Rate (UA/ha)	1.54	1.54	1.54	1.54
Initial Infrastructure Investment (R$/ha)	2,000.00	2,000.00	2,000.00	2,000.00
Rural Credit – Conditions when hired:				
Grace Period (years)	4	4	4	4
Interest Rate (p.y)	5,0%	5,0%	5,0%	5,0%
Amortization – total annual installment	8	8	8	8
Financed Investment Percentage	0 or 100%	0 or 100%	0 or 100%	0 or 100%
Annual investment in pasture formation (R$/hectare)	1,000.00	1,000.00	1,000.00	1,000.00
Intensification Investment (R$/hectare)	1,400.00	1,400.00	1,400.00	1,400.00
% of reformed degraded area for regular pasture in 20 years	33%	33%	33%	33%
Years of pasture investment – to achieve 20% of intensified area	5	5	5	5
Discount Practices Rate	6%	6%	6%	6%
Total area for APP restoration (in ha)	0	0	0	0
Total area for RL restoration (in ha)	0	0	0	0

B)

Animal Category	**Retail Price (R$/arroba)**
Bull	200.00
Pregnant Mother	100.00
Non Pregnant Mother	100.00
Heifer	120.00
Female Steer	120.00
Calf	160.00
Male Steer	120.00
Cattle for Fattening	115.00

C)

Initial Herd Composition	**%**
Bull	2%
Pregnant Mother	35%
Non Pregnant Mother	10%
Heifer	3%
Female Steer	24%
Calf	3%
Male Steer	11%
Cattle for Fattening	10%

D)

Animal Category	Unit Retail Price	Weight in arroba/head when sold	Drop Rate	Mortality Rate
Bull (purchase)	5,000.00	25	20%	1%
Pregnant Mother	1,.500,00	15	0%	2%
Non Pregnant Mother	1,400.00	14	67%	1%
Heifer	720.00	6	20%	5%
Female Steer	1,200.00	10	10%	1%
Calf	960.00	6	30%	5%
Male Steer	1,440.00	12	0%	1%
Cattle/Fattening	1,840.00	16	100%	1%
Bull (Sale)	2,500.00	25	-	-

Chart 2) Structures and main variables of Livestock Bioeconomic Model)

Initial configuration	Impacted variables	Results
Herd	**Current maximum capacity rate (heads/ha)**	**Revenues**
Herd Composition		
Herd prices by Animal Category		**Costs**
Disposal and mortality rate	**Pasture quality combination**	
Maximum Capacity Rate		**NPV**
Land use		
Total area of Rural Propriety	**Pasture support capacity at different levels**	**IRR**
Pasture area		
Pasture mix quality	**Birth rate**	**NPV/hectare**
Degree of Annual Pasture (normal for degraded)		
Required area for environmental adequacy	**Mortality rate**	**Stocking rate variation**
Zero Deforestation		
Economic-Financial		**Productivity (arroba/ha/year)**
Initial investment (R$/hectare)		
Fixed and Variable costs		
Rural Credit – investments to be made (total or partial) – interest rates, grace period and amortization		
Time horizon of 20 years		
Inflation – with or without analysis consideration		
Discount rate		
Maintenance of support capacity for normal pastures		
Reproductive managing		
Technical assistance		
Increased pasture support capacity		
Pasture Reform		

Pasture intensification		

2.1.2 Output data on the bio economic model

As previously stated, the great innovation of the bioeconomic model is that results necessarily arise from the biophysical and financial interaction. However, by the end of automation, each module offers its own display, so that one may diagnose how each one of them has been affected by data interaction and feedbacks. This is how the “Herd” module presents the final composition, by category and weight, while the “Land use” module offers allocation and distribution of different productive activities and of natural cover by the end of the project. In both cases, one may not only diagnose the evolution on biophysical changes, but it also allows assets fixed in squads and at the farm to be evaluated.

The financial module presents the economic-financial performance through the average indexes IRR and NPV, total and relative (NPV/ha), as well as its probabilities of viability (NPV>0) and IRR>TMA, to separate activities and as a whole, allowing the comparison of results against alternative investments. The general structure of the model’s operation and its main variable are summarized according to the example shown in **Table 1**.

2.1.3 Considered Scenarios

Although there is a wide range of possibilities for productive arrangements, 72 scenarios were considered here to simulate herd management performance, land use and technological changes as an effort to favour situations usually found in Mato Grosso State. Those different scenarios combine the systems calf, recalf/fattening and the complete cycle with 4 scales for initial pasture areas, considering typical sizes for Mato Grosso State according to IBGE, and specialized activities such as confinement, integrated agriculture-pasture and forest restoration. Moreover, we considered the possibility of financial boost through rural credit, compared to the use of individual resources in the investment, justified by implicit subsidy to financing coming from the National Rural Credit System through rates of negative real interest, which become the exoneration factor.

Additionally, scenarios in which there was no investment in herd or pasture were also considered, as well as specialized activities, but there are ATER (Technical Assistance and Rural Extension) hiring. The premise in this case is that assistance helps to improve management of livestock business information, causing a positive impact on full capacity rates even though cost standards remain constant. Examples of improved management are the better control of costs and incomes and a more efficient use of available resources, such as the improvement on animal well-being and on pasture management, picket resizing in order to avoid over and sub pasture, fountain rearrangement, segregation of herd by age and gender.

However, it is not simple to measure this impact, and it depends on a series of factors such as quality on services provided, frequency of visits and the producer’s engagement to adopt the guidelines. To estimate ATER´s elasticity of herd´s size, that is, how the presence of ATER increments full capacity rate, a spatial regression with herd, number of regular technical assistants and other variables of control available in the 2006 agricultural census was structured and applied to all of Mato Grosso´s municipalities.

2.1.4 Specialized Activities

Specialized activities are understood as those having technical-agronomic specificities and may constitute the productive arrangement being subsidiary or complementary to the main and typical livestock activities, such as the confinement or the crop-livestock integration, or yet, activities for property adequacy through Forest Restoration.

2.1.4.1 Forest Restoration

The Forest Code, Brazil´s main environmental law, which protects and regulates the forest use in private rural areas (Calmon et al. 2011) was changed in May 2012 after a long debate involving politicians, environmentalists, private companies and the agribusiness sector. The most controversial topics approved include: amnesty of fines for those who have illegally deforested before 2008; partial legalization of illegally deforested areas before 2008; reduction of the Permanent Preservation Area (APP) along water courses and the inclusion of APP when counting the Legal Reservation portion (LR). The table below summarizes the specificities of APP and RL to be implemented. The obligation of forest restoration on properties in which existing native vegetation do not reach RL´s minimum quota, as well as the Rural Environmental Registry (CAR), were included.

Table 3. Main rules of the new Brazilian Forest Code. Forest area to be preserved as Legal Reserve and Permanent Preservation Areas, depending on the extension of rural property. In Brazil, the fiscal module varies from 5 to 100 hectares.

Fiscal Module	PPA in Riparian Area (meters)	Legal Reserve
Less than 1	5	Not mandatory
1 to 2	8	
2 to 4	15	
4 to 10	20	20% to 80% of the property, depending on the Biome
Over 10	30	

The same law determines that the restoration must be completed in 20 years starting on May 2012. Among the expected penalties for failing to comply the restoration, besides fines, there are the embargoes for the areas and obstruction of credit from the official system. However, beyond obligation, there are also opportunities. Restoration practices may reduce poverty mainly by creating jobs and new income through payment for environmental services, logging and carbon credits generation. Moreover, the law predicts that RL may be located outside the property, as long as it is in the same Biome, as a compensation, opening doors for the market of quotes of whole reserves or in restoration, predicted by Environmental Reserve Quota (CRA).

In technical terms, the implementation of vegetation recovery, both APP and RL, may be divided between passive and active. In the first case, the regeneration process occurs naturally, simply resulting from abandoned areas, fenced or not. In active restoration, there is an effective seeding of native plants, either from complete planting or from species enrichment. The restoration costs, therefore, vary a lot, according to the original situation of the areas to be restored, the method used, the objective and the intention of the exploitation.

In the bio economical model, restoration was considered an activity for mere environmental adequacy, with no direct exploitation of resources and services, not to generate any income. The cost adopted for active restoration was of R$ 8 thousand/ha, without passive restoration being modelled.

2.1.4.2 Crop-Pasture (or Crop-Livestock) Integration

Integrated Production Systems (IPS), nowadays known as Crop-Livestock or Crop-Pasture (ICP) Integration are models for productive land use that use rotation or consortia for agriculture activities, aiming at economic diversification and consequent risk mitigation. Although becoming well known in the country in the 2000s and officially recognized as instruments of public policy only in 2013 through the National Politics Law from ILPF (Law 12.805/2013), in reality these systems were already being stimulated since the beginning of the 1980s, especially by EMBRAPA´s initiative. The so-called "Barreirão System", for example, formally launched in 1983, consisted of rotated rice planting for recovery of low support pasture in Brazil's Central West. Rescued from a centenary empiric practice – the use of rice as a pioneer culture for exotic grass implantation in the Cerrado – the Barreirão system carried on in dozens of experimental fields and private properties already revealed greater agronomic and economic efficiency in the first years of its implementation. The first of EMBRAPA´s published editions pointed out, for example, that their return indexes were up to 60% greater than that of conventional systems.

However, the IPS did not become promptly popular. Important barriers were imposed to its dissemination, which resist until today to some extent. The main barriers are: (1) public policies strongly focused on scope economy, encouraging specialization over diversification as a form of production optimization; (2) cultural resistance to innovation and lack of alternative technical knowledge by specialized producers, forged by the very scope economy, but also by personal producer's vocation; and (3) elevated initial investments. In the case of farmers, the greatest budget restrictions come from the capital immobilized in properties fencing and pasture rearranging, while cattle breeders are obstructed by elevated costs for agricultural machinery purchase or rental, especially in regions with no agriculture tradition.

Despite that, integrated system has grown considerably. It is estimated that currently in Brazil there are about 3,5 million hectares with integration, from which 700 thousand ha are in Mato Grosso, 96% of which for integrated crop-livestock (Eduardo Assad, personal communication). Compete for this growth: (1) the need for productive diversification in face of increasingly integrated chains; (2) the need to increase yield per unit area in face of raise of land opportunity costs, mainly in consolidated areas with developed infrastructure; (3) optimization of rural spaces such as break of idle fallow in grains' offseason; (4) opportunities for degraded pasture recovery with additional incomes; and (5) need of environmental adequacy joining opportunities of new markets of forest restoration.

It is important to stress that it is not terminated by the owner, nor is it restricted to the productive area. Much different, it may occur through outsourcing or partnership between landholder and not land owner producers with different agricultural vocations. The leaseholder's spatial mobility and the tendency for innovation by the lessor may stimulate integrated systems in landscape scale. In this process, the whole region, or at least many properties, will lose their primary specialized feature to become diverse systems by excellence, in which it is no longer possible to define the main activity.

Nonetheless, the analytical starting point must be the productive unit, that is, the farm, in its initial condition, for it is in it that social and production relations happen, as well as the resulting changes of land use, and it is also the basic technical and agronomic performance parameter. In MT, the most common case of integration has as starting point a farm whose main activity is grain production, particularly soy. However, it was considered here that the initial pattern is the livestock ownership, given that the system is analysed as a form of degraded pasture recovery, intensification costs mitigation, diversification with intelligent land use and risks minimization.

In this context, we considered that there is no investment in fixed assets, such as seeders and harvesters, replacing it by operational costs coming from equipment rental, an option that corresponds to the reality of Mato Grosso regarding beef cattle as the main activity.

2.1.5 Risk Analysis

As shown in previous sections, besides performance evaluation, the bioeconomic model offers risk analysis. It is a relevant differential in that the results become dynamic and sensitive to normal fluctuation of market conditions, such as input costs variation, oscillation in interest rates and commodity retail prices. Thus, we promote not only a more accurate panorama of the project, but it also permits testing the consistency of implementing innovation and specialized activities, as well as reporting inefficient projects. The risk is expressed in the probability of viable IRR and NPV.

In order to measure this probability, the Monte Carlo stochastic approach was used. In it, the variables with greater impact, such as products retail price (arroba and soybean bags), total production costs and finance interest rates were taken by the average value captured in field and secondary reference data. From the average values, random intervals were stipulated up to 10%, give or take, deviations defined from the historical data series of price and cost in the last decade. The impact of this variation is reflected in each monthly input and output of cash flow, in which for each project 1.000 repetitions are executed, which gives a robust random component for risk calculus, applied to IRR and NPV.

3. Results and discussions

Simulations performed in the bio economic model give three interactive prognoses as feedback: herd´s final composition, land use and financial results. Once the adoption of innovation and specialized activities crucially depend on the economic expectations, the financial impacts have a highlight in this section without, however, losing sight of changes resulting from the other modules.

3.1. Financial impact and land use

Considering the combination of the models' parameters such as scale, system, intensification, crop-livestock integration, confinement, restoration and financial boost by rural credit, and, still, ATER for the cases of extensive production, it is possible to draw no less than

432 scenarios. These scenarios multiply according to herd´s size and composition, as to offer a huge amount of analysis. The flexibility that this model brings allows for a big application, virtually working for any property. However, for an objective evaluation of performance, scenarios that are closer to Mato Grosso´s reality were compared, as well as those in which it was possible to highlight the impact of innovation. The following section is divided in three blocks of combined innovation, which allows for a concise evaluation.

3.1.1. Scale Effects, System and Intensification

This section analyses the combination of farm size and different productive systems (breeding, fattening or complete cycle), including the impact of pastures intensification, in order to evaluated the scale up gains and the economic performance of cattle ranching.

In the analysis, different scenarios were built depending on the farm size and pasture management (intensification). To calculate the financial risk, we used a variation of 10% in the cost of production and the beef prices. External factors are not considered since it isn't controlled by the landowner, but depend on the market.

The results showed that the breeding system has the lowest marginal gain from intensification, while fattening has the highest gain from intensification (Figure 3). The average additionality of pasture intensification on the VPL varied depending on the farm size: R$ -1,037/ha (negative) to R$ 227/ha in the breeding; R$ 3,525/ha to R$ 4,462/ha in the fattening; and R$ 3,096/ha to R$ 4,419/ha in complete. The fact that the fattening system provide higher gain with intensification is due to the higher working capital, or higher percentage of herd sales annually. Soil fertilization and pasture management increase the food supply for animals, which directly influences the weight gain, accelerating the process of fattening and sale of animals. In the case of breeding, genetics and veterinary care of the cattle are the main factors in order to increase productivity, since these are factors that affect the pregnancy rate of cows, which increase the production of calves.

In small farms with breeding system, the intensification of pastures causes greater damage than extensive land use (Figure 2). This happens because, as explained earlier, the genetic management has greater impact on the return. However, in larger scale, investment in intensifying pastures becomes more profitable than the extensive land use. It can be explained because the weight gains in calves (even the small ones) compensates the investments in large scale. In short, smaller property demands more pasture intensification and investments. In our analysis, properties with an average of one fiscal module (85 ha) in State of Mato Grosso are only viable with increased pasture, except breeding.

However, small properties with breeding tend to diversify production with the sale of milk and dairy products, not only selling calves. Although we do not evaluate milk production systems, small farms that sell milk and calves are more common in small properties in the Amazon.

Despite the fact that intensification shows high incremental gains, improved management and efficiency of production processes must follow investments in soil fertilization. In our modelling, we assume that the investment in soil fertilization occurs with the management of pastures. The management of pastures is the control of grass production through the rotational grazing of animals. For this, the pastures are divided and the cattle graze alternately and intermittently in the divisions. Thus, gramineous plants can regrow and the animals can eat a higher volume of quality grass. The control of time for grazing in each divided part of the pasture (known as “piquete”) requires monitoring and planning of the information collected by cowboys and analysed by the farm manager. Moreover, it is necessary to monitor soil fertility, because even if the rotational grazing increases the lifetime of the pastures, at some point fertilization is required.

One of the indicators of bad management in extensive cattle ranching is the underestimation of long-term costs, such as pasture depreciation. Thus, we can find cases of extensive farms with operational profit. However, in most cases, it does not include the depreciation of pastures, or the cost of pasture reform diluted throughout the years of grazing without reform. The fact that pastures depreciation causes decreasing productivity and profits and is still ignored by most producers, leads us to conclude that the farmer is the only businessman to believe in increased profits with decreasing productivity and increasing costs.

When disregarding depreciation, not only pasture but also that of processing, the producer has a distorted perception of business performance because it considers only the operational profit. These facts become clear when one talks to any farmer and notices that the reform of pastures is the main concern regarding costs to keep business going. Although everyone agrees that it is expensive to reform a pasture, few producers are planning their maintenance or recovery.

We have evaluated the financial risk of livestock in various production systems, and the size of pastures and intensification are the most impacting factors on the likelihood of loss (Figure 4). The results indicate a probability of profit over 40% in extensive use farms that increase the pasture area. This impact also is improved to over 90% in large properties that intensify the use of pastures. This confirms why livestock are common in large properties in the Amazon. The justification for the existence of small farms with cattle ranching may be: (i) occupation for land speculation, since extensive livestock demand lower costs and inputs for maintenance; (ii) small producers diversify production, and livestock supplements the income from other activities, such as non-timber products extraction, fruits and milk. In addition, the activity allows greater liquidity and value reserve on small subsistence properties. For example, in crop offseason the sale of milk or calves can keep the family income.

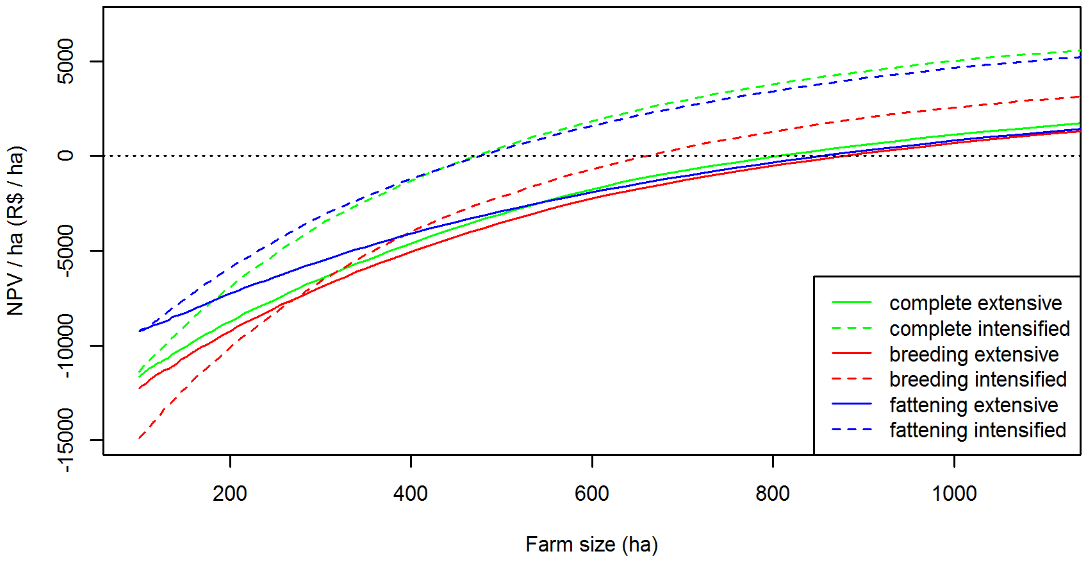

Figure 2. Net Present Value (NPV) per hectare in different production systems of cattle ranching, including intensification of pastures.

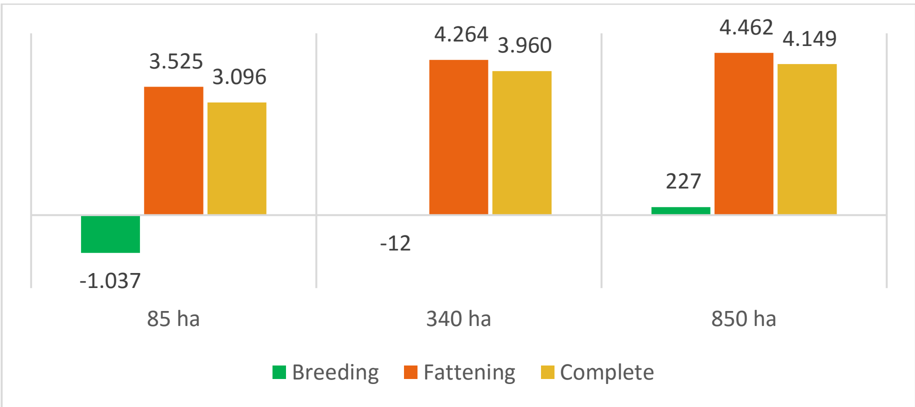

Figure 3. Incremental gain with intensification of pastures in different production systems.

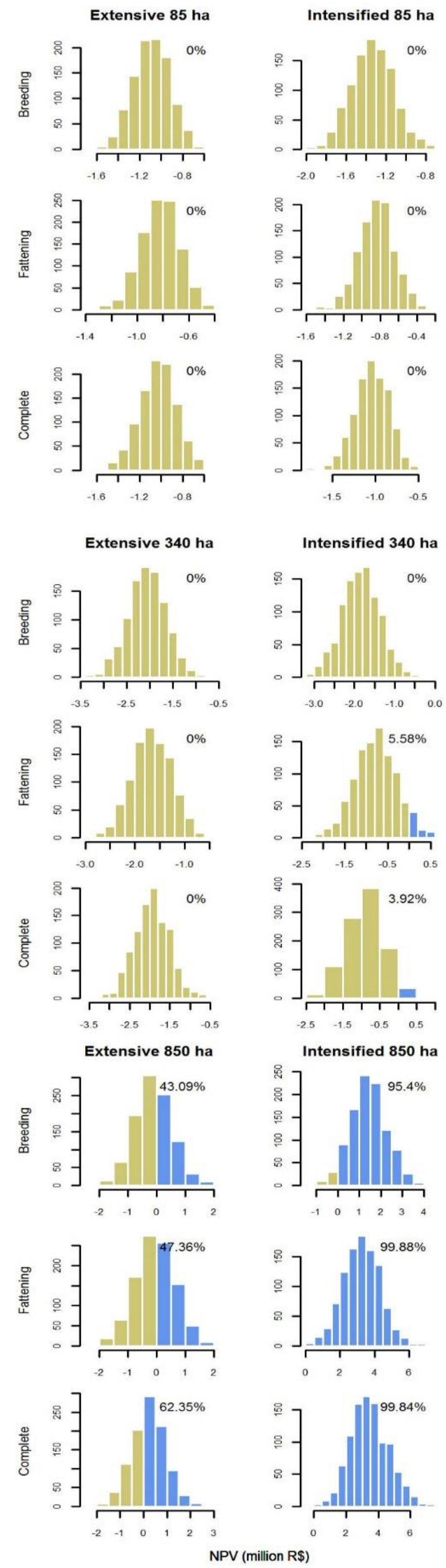

Figure 4. Risk, or probability of profit, in different production systems and farm sizes

3.1.2 Effects of Scale, Intensification, Integration and restoration.

On this block, the system of complete cycle remained fixed, the most common in Mato Grosso, but the scale, intensification and integration varied in order to focus on the analysis specifically on the additionality of innovations. Finally, we imputed on these combinations the restoration without commercial purposes as to assess the impact of compliance effort of Forest Code in the performance of productive activities. The graph below shows the behaviour curves of NPV/ha according to size of farm area used for the production in the different proposed scenarios.

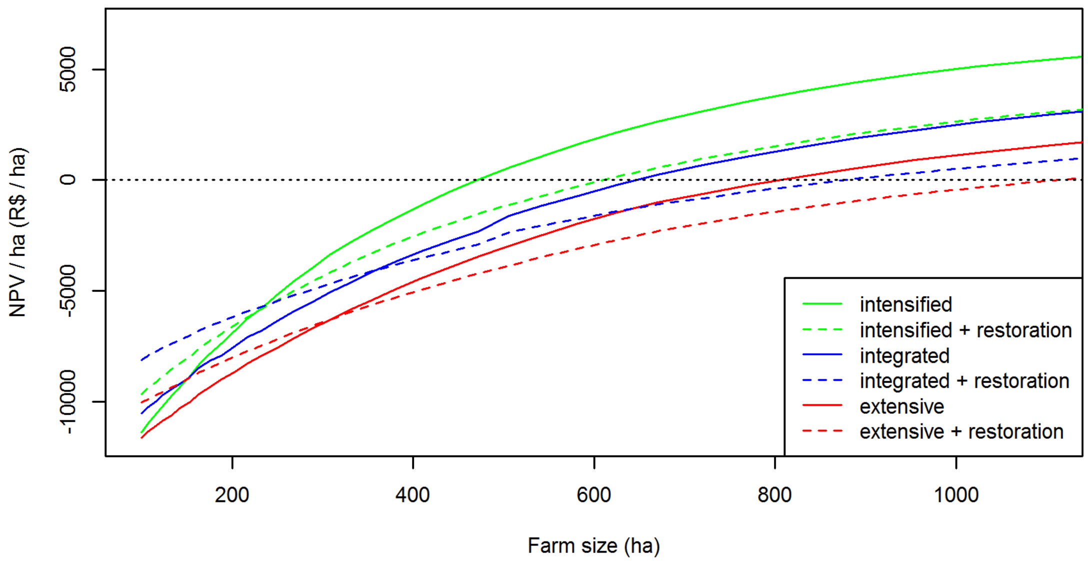

Figure 5: NPV/ha by scenario

The first feature is that in BAU conditions, farms smaller than 800 ha area not economic feasible. However, innovations improved economic performance at all possible scales, even in negative conditions of NPV, i.e. in conditions of loss. It has been argued that the extensive systems in the Amazon are justified, among other reasons, by the economic rationality of exploitation of abundant natural resources – beyond its carrying capacity – given shortage-funding conditions. Therefore, disregarding the speculative land gain, even with very low investment, the activity would be profitable because the marginal revenue still overcomes the marginal costs. This argument does not seem valid, however, unless it reaches useful area in an amounts over 800 ha (precisely 804.4 ha). It is possible to observe in the graphic that, even with minimum sizes, the BAU relative loss differs little from innovations because, although these investments and costs are much higher, its revenues are also proportionally higher.

However, insofar as one gains scale, the innovations will ensure disproportionately higher revenues than costs, so that a property, for example, with 471 ha in the BAU, accumulating loss of R$ 1.87 million, would reach the break-even point intensifying up to 20% of its pastureland.

In full cycle systems, usually the largest cost component is the cattle replacement. In BAU conditions, the low carrying capacity of pastures imputes the penalty of lowering the working capital since replaced animals, as well as calves, take time to reach the weight for sale; while in the intensification, the proper management allows the anticipation of cash inflows, which balance business results reducing operational costs faster and relieving financial expenses. There is a consensus in literature that the most appropriate strategy for intensification is the choice of normal, not degraded, pastures, in order to gain working capital, while part of the degraded pastures can go through a fallow period, especially during the dry season, naturally gaining greater supportability, even when far worse than improved pastures.

Comparing intensification strategy with the integrated crop-livestock system, our model showed advantages. The integration has been very encouraged, especially by Embrapa. Recently, Brazil has officially presented in the INDC (Intended Nationally Determined Contributions) for Cop 21 the goal of reaching 5 million hectares of integrated systems. These stimuli come from the recognition that such systems have strong environmental benefits, such as the use of land in idle fallow and decreased pressure over ecosystems, but also, because it improves the economic indicators.

A study executed by Embrapa in Mato Grosso state showed that a crop-livestock integration system resulted in a net income of R$ 2,349/hectare and a NPV of R$ 137.89/hectare, 22% higher than conventional farming. Another initiative, developed by Embrapa Gado de Corte - MT with crops and pastures, showed an average annual net income of R$ 1,225.30/ha, wherein the profitability of the grain crop was R$ 986.60/ha/year and beef was R$ 1,464.00/ha/year. For every R$1.00 of net revenue from soybean, beef provided R$ 1.50 with rearing and fattening of animals (Kichel *et al.,* 2014). Another study compared the results of integrated systems with isolated systems, and noted that there was a greater need of investment in integrated models when compared to each activity separately. However, the gross revenue was higher in the four integrated modules (Silva et al., 2012).

The economic advantages, however, are not consensual. In line with the results found in this study, other experimental studies have warned that the integration may be less profitable than specialized activities. Compared with monoculture of soybeans, for example, the ILP is disadvantageous especially because the herd purchase to compose the fattening stock is too onerous to the cash flow. In the case where livestock is the main activity, the low profitability can happen both because of high investments in specialized machinery (or rent), and because of transaction costs and learning. (Martha Júnior et al., 2011). Moreover, since the grazing areas for livestock have low carrying capacity, the persistence of slow working capital aggravates the system's operating revenues.

In this research, the lower profitability may be due only to this last justification, because we assumed as premise the lack of investment in machinery as well as transaction and learning costs. These assumptions are not just to simplify the model. Not deeply discussed in the literature, it is believed that the integration process should not necessarily be conducted by the farmer, but rather, may be more efficient through partnerships with specialized grain farmers, as has routinely occurred in Mato Grosso through farm's lease. For the farmer that does not possess the land, it is the opportunity to produce soybeans, while for the cattle farmer, it is the possibility of obtaining pastures reform. Thus the farm's lease was considered in the analysis as one of the plantation costs, such as opportunity cost, allowing the results of simulation to be reliable regardless if the soybean producer was also the cattle farmer, or a tenant partner.

In the model developed, contrary to what occurs with intensification, in which the cattle farmer devotes normal pastures to intensify, in the integration, it chooses degraded pastures to implement the system, ensuring the destination of normal pastures to its main activity and the soybean crops as an appendicular activity. It is precisely the cost of transforming the degraded pasture into crops in the first year, and the gain, on the other hand, growing – but starting from low soybean productivity levels over the 4 consecutive years –, that explain the increasing of NPV, making it less advantageous than intensification, although much more profitable than the BAU system.

As stated earlier, there is no consensus about the greater profitability of integration over specialized systems. On the other hand, different results have converged for the conclusion that other economic advantages are notorious in integrated systems. Integration increases liquidity due to diversification of production. The increase of liquidity due to diversified production and the provided increase of working capital results in lower risk over the total revenue, since the profitability is not dependent on price fluctuations of one single product. In addition, agronomic integration of different activities generates lower demand for inputs, such as fertilizers and soil remediation cost. The lower cost per unit produced allows greater margin of gain on prices, also reducing the risk of fluctuations in the market

Moreover, it is an important pasture reform strategy. The restoration and renovation, which includes chemical and physical correction of the soil, can be economically prohibitive in extensive systems, especially because the low productivity of the farm, and consequent low working capital, limits the availability of short-term financial resources to improving investments. With the integration, though, there may be an initial commitment of capital higher than during reform, the short cycle of the grain crop increases the working capital that allows down costs, and decreases financial expenses. As an illustrative effect, the financial result of a six-year cycle comparing restoration with integration can be noted on table x. It is considered that the additional costs of herd purchase, maintenance, animal weight gain and revenues from livestock are the same in both cases.

Table 4:** **Comparison between costs of pasture formation in integrated systems and conventional pasture reform. *Other costs with soy include every exclusive mechanic operation, chemical inputs, labour, administrative and financial costs for soybean, while other costs with pasture formation refer to exclusive mechanic operation, chemical inputs, labour, administrative and financial costs specifics for conventional pasture reform.

	R$ in 2016	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6
INTEGRATED SYSTEM	Soy Productivity (60kg/ha)	38	42	48	52	52	52
	COSTS	**3758**	**2938**	**2854**	**2839**	**2839**	**2839**
	First plowing	170	0	0	0	0	0
	Other costs with soy*	3170	2570	2570	2570	2570	2570
	Pasture formation with B. brizanta	418	367	283	269	269	269
	Soy revenues	3078	3402	3888	4212	4212	4212
	Results	680	464	1034	1373	1373	1373
CONVENTIONAL PASTURE REFORM	**COSTS**	**1431**	**201**	**201**	**201**	**201**	**201**
	First plowing	170	0	0	0	0	0
	Pasture formation with B. brizanta	418	0	0	0	0	0
	Other costs with pasture formation	843	201	201	201	201	201

In the first year, the total cost of physical and chemical soil preparation of degraded pasture for soybean implementation is up to 160% over the cost of conventional pastures reform. However, with the expectation of revenue generated by agriculture, even with very low initial productivity (38 bags of 60 kg/ha), the effective cost (operating result) is of about half the cost of reform. In addition, over the six years – average time for a new reform – the cumulative total cost for renovation and maintenance is R$ 2,436, while in the case of integration it is around 5 thousand reais (R$ 4,937) negative, i.e. the producer may obtain operating profit. In other words, integration not only reduces the cost for pastures recovery, but it also capitalizes the cattle farmer.

The economic bottleneck of integrated system, however, is the high cost of entry. Based on the minimum size of the total grazing areas in which the property reaches the breakeven, i.e. 804 ha, the initial investment to incorporate 20% of the area (161ha) would be R$ 7.93 million against R$ 3.92 million for a conventional reform, a difference over than R$ 4 million. The ABC program, which has integrated systems as one of its purposes, allows up to R$ 3 million funding with 7.5% interest for Pronamp's beneficiaries and 8% for others. It means that ABC alone could not financing the feasible scale to integrated system, as well as the difference needed to migrating from conventional reform to integrated.

Scenarios are huge changed when considering the need for restoration of native vegetation for Forest Code compliance. It should be noted that among the main changes in Brazilian forest legislation that led to the Law 12.651 of May 25, 2012, is the obligation to pay the debts of Permanent Preservation Areas (APP) and Legal Reserve (RL) in farms until 2032, either by restoring, or by compensation in native areas via Environmental Reserve Quota (CRA), provided that compensation is restricted to areas located in the same Federation Unit. In this sense, the establishment of CAR (Environmental Rural Registration) plays a fundamental role in the identification and quantification of these debts, which, according to recent researches, reaches 20.8 million hectares in Brazil. Only in the state of Mato Grosso, the debt in APP is about 505,000 ha, and 5.6 million ha in RL (Soares-Filho et al., 2014). The possibility of compensation in forested areas brings the double advantage of avoiding the high opportunity costs, while increasing the assurance that the remaining native vegetation can continue intact, fulfilling its biological and ecological role.

In Mato Grosso state, the areas that can be legally deforested is about 7.6 million hectares, while the total debt is 6.1 million. Since 8% of that is not compensable APP (Soares -Filho et al., 2014), the forest surplus is 995,000 ha. Despite this surplus, it is necessary to consider that CRA market is not developed. Thus, in the scenarios adopted here, it assumed that the property should devote 20% of its degraded pasture area for restoration, dividing it in restoration stages lasting 20 years. The remainder of the debit (which can reach 15% to 50% additional to the 20%, depending on Cerrado or Amazon areas, and on consolidated areas or not) is taken as areas to be compensated without modelling these costs in economic performance.

Nonetheless, the restoration had a negative economic impact because it represents an additional cost without generating revenue. In the BAU scenario, where the farm became viable over a total area of 804 ha pasture, in the hypothesis of 20% restoration, extensive livestock becomes viable only with 1,114 ha. In other words, it means an increase of 38,5% in the pastures dedicated to the production, which shows high economic sensitivity (elasticity) to restoration.

Nevertheless, the pasture intensification (even if only 20% of it) or even crop-livestock integration, is profitable for properties bigger than 472 and 649 ha, respectively. There is a consensus in the literature that productivity is an important factor of pressure decrease on native forest areas to avoid the horizontal expansion of production. Here, it is demonstrated that it is also a viable driver for restoration. The economic gain with higher productivity, intensifying the activity or diversifying the system by integration, clearly mitigates the production-conservation trade-off. For example, farms with intensified pastures with restoration, and farms integrated with restoration reach the breakeven point with 609 ha and 649 ha, what means 24% and 19% saved land compared with BAU conditions. Such interest is also the fact that, as the scale increases, the cost of restoration on the profit of production becomes disproportionately smaller, with an exponential trajectory, which allows us to evaluate that large properties should be the primary focus in restoration. First because they offer a gain in a scale in the restoration of native vegetation and its positive impact on biodiversity and ecosystem services. Secondly, because the relative cost is much lower.

The most important is to emphasize that, in all property size scales, the technological incremental gain on the BAU scenario is substantial, even with restoration, which means that in the cases of proprieties smaller than 200 ha, propriety is viable. The figure 6 illustrates the marginal gain (NPV/ha on BAU incremental) in categories of 1 fiscal module, 4 fiscal modules and 10 fiscal modules.

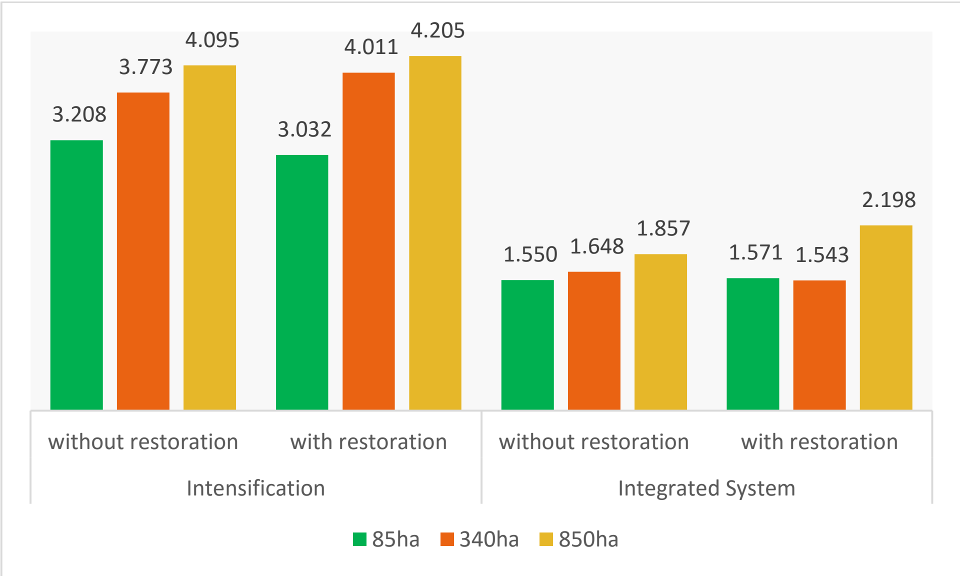

Figure 6. Incremental gain with increased pasture in different production systems and farms size

All discussions developed until now are based on average data. However, the field reality involves big uncertainties, such as the climate oscillations and changes in macroeconomic conditions, specially exchange rates and interest rates. All these uncertainties are reflected, ultimately, as price fluctuations, either in production costs or in the prices received by the producer. In the bioeconomic model, risks were calculated – changes in economic results – in terms of fluctuations of cost and retail prices in cash flows in order to calculate, for each scenario developed, the probability of economic viability. Therefore, we considered the NPV gains and the corresponding IRR to such gains, with its uncertainty obtained by quadratic spread. The results of this analysis are summarized in Figures 7 and 8. The relationship between the value of the propagated uncertainty for the NPV of each scenario and the value of the NPV of personal gain in the same scenario, δNPV / NPV, allows us to compare how much the average NPV value varies in each scenario in percentage, the same goes for IRR

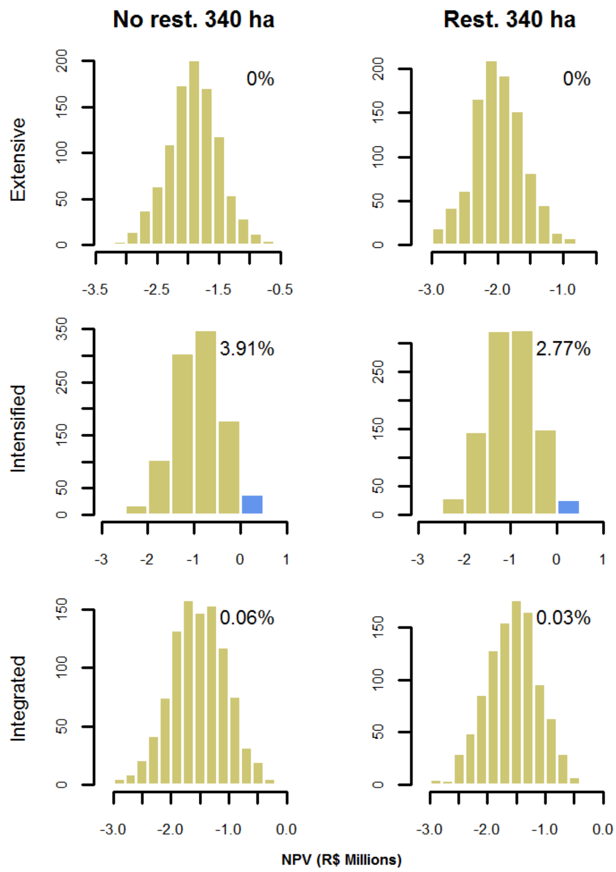

Figure 7. Profit probability (profit risk) in different scenarios for farms with 4 fiscal modules

We saw in the previous section that in the BAU situation, farms under 804 ha have negative economic performance. However, when they decompose farms in different fiscal modules and impute the oscillations in prices related to production costs and amounts received (revenue) to calculate risk, it is noted that in situations of cheapening of and very favourable prices to producer. While for farms with 4 modules or 340 ha (still considered family agriculture) the possibility of profit is near to 0. The risk of loss is mitigated when there is intensification, even when restoration costs are included.

However, for larger areas, in this case 10 fiscal modules or 850 ha (average size of Mato Grosso properties), the risk of loss is 35.4% in BAU while in restoration scenario it increases to 50.1%. But with intensification the economic loss is virtually null, even with the 20% recovery percentage for restoration, especially because, as previously seen, restoration costs increase disproportionately less than the revenue generated by the intensification in larger scales.

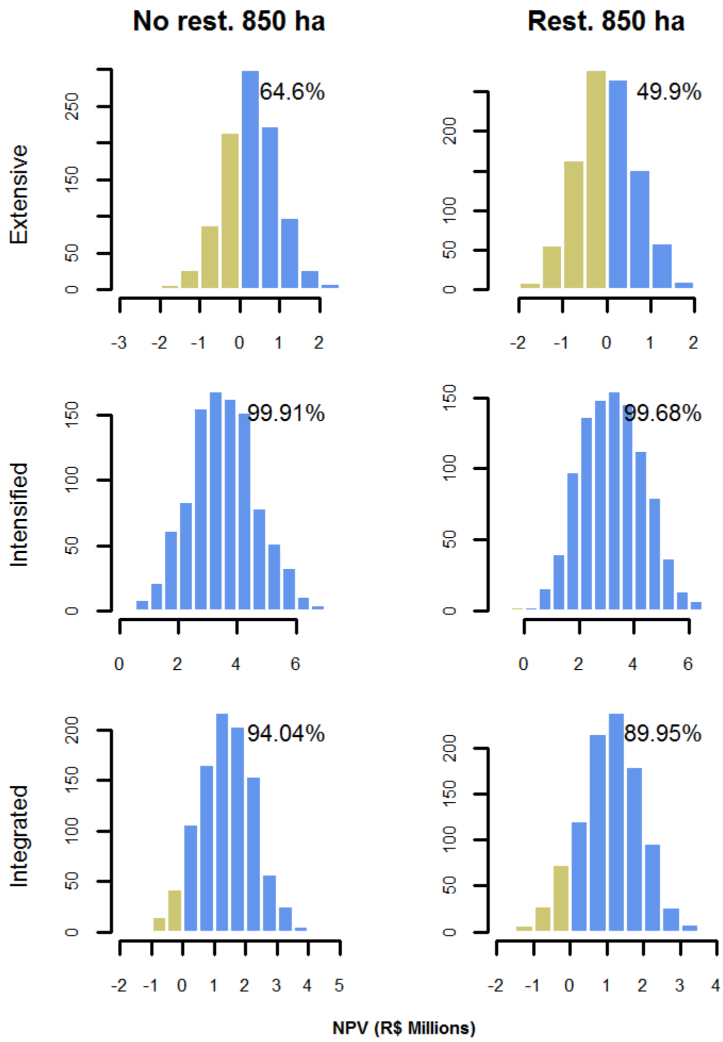

Figure 8. Profit probability (profit risk) in different scenarios for farms with 10 fiscal modules

However, it is important to emphasize that the economic feasibility does not imply in the solution of the trade-off production-conservation. Again, the proprietary has to give up volume profit. For a clear understanding of this issue, one example is enough. An 840 ha farm with 20% of intensified pastures and no restoration has a NPV/ha average of R$ 4.265, while in the same farm with 20% restoration, this NPV/ha falls to R $ 2.397. The biggest problem here is not the fall of relative NPV, but the total amount. In the first case, the total NPV is R$3.62 millions because the productive area is 850 ha, while in the second, the total NPV is R$ 1.63 millions with a production area of 643 ha.

But economic decisions must consider not only the expected profit, but also the Internal Rate of Return (IRR) that is the parameter which ranchers should use to decide to invest in livestock or not. Figure 9 shows IRR of some scenarios in the cases where farms have 840 ha (for farms smaller results didn't return valid IRR)

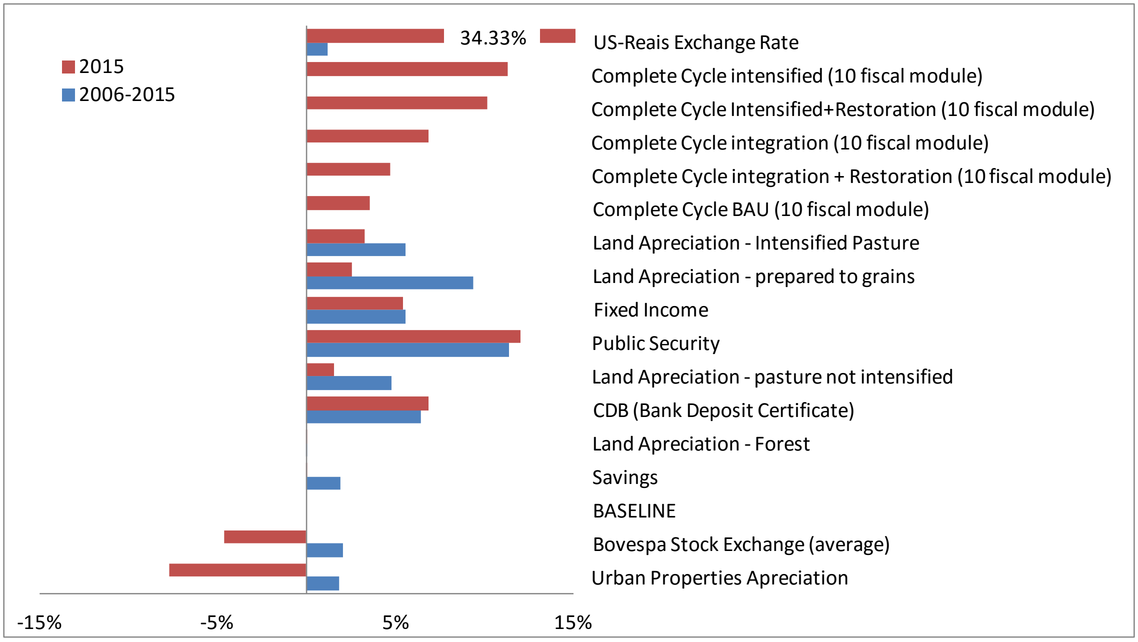

Figure 9. IRR in different scenarios and alternative returns rate

As noted in the graph, in 2015 the livestock in the complete system, even in the BAU scenario, offered rates of return consistent with various market alternatives, and have been especially higher than own land valuation. It can be explained by the fact that, while Brazil felt the political and economic crisis, the beef market continued in inertial raising, what does not happen when it considered the average rates of the last decade, and livestock becomes less attractive. Even so, it is important to see that intensification with restoration offers very competitive rate, the double the rate of land appreciation with intensified pastures, while extensive BAU without any restoration is less attractive than land appreciation with not intensified pastures, confirming that land speculation is a relevant component of decisions.

Considering the economic performance measured both by NPV an IRR, the main challenge to be faced for rural property adequacy to the Forest Code, and for Brazilian own restoration goals, is not the conviction that it is an economically viable strategy, being able to overcome the trade-off production-conservation. The challenge is, first, to equate the big gap of profit that requires the landowners to allocate most of the production areas to the recovery of native vegetation. The second point is that land policies must be prepared to face the possible rebound effect of land concentration that can start with the search for additional areas for the recovery of lost financial volume.

3.2 Other risk factors

Regardless of the decision to invest in intensification of livestock and in specialized integrated activities or restoration, farmers and other agents related to the productive chain should consider external factors that affect the profitability of the business, becoming a risk to economic performance. Thus, here is a brief analysis of business environment risks to be considered in addition to the project's own risk.

Low technological knowledge and its results: landowners are often unaware of or do not believe in the effectiveness of best practices, and this view extends to employees and technicians under their command. Due to lower vulnerability of livestock in the face of seasonal climatic changes, high liquidity of the herd and little control of depreciation costs, the farmer may have a wrong perception that the technological level is satisfactory and generates profit. In addition, low information management about their business suggests that low profitability is linked to prices paid in the market, and not to the ability to manage costs and productivity. This paradigm can be broken with training and dissemination of good agricultural practices (GAP) recommended, for example, by EMBRAPA.

Market requirements and competition of illegal markets: together with the expectation of growth in world demand for meat, it has been noticed, in recent years, an increase in market requirements related to meat quality, animal health and compliance with environmental rules. In this context, health risk falls mainly in the Amazon, which does not have all municipalities with zones free of diseases such as *aftosa*. It is estimated that the illegal slaughter market reaches 35% in the North (Santos, 2007), which creates an unequal competition for the farms that bear the cost of health and environmental regulation. In addition, since 2009, the market has increased environmental requirements for products purchasing and financing. For example, in 2009 the National Bank for Economic and Social Development (BNDES) and other banks have demanded the CAR for contracting credit. In the same year, several refrigerators signed a TAC, committing to buy only from farms with the CAR and outside the slave labour list of the Ministry of Labour (Barreto & Silva, 2010).

Legal uncertainty and environmental regulation: the lack of definition of environmental rules in Brazil and of property rights in some regions can constitute risk for investment. For example, the state of Mato Grosso presents the Ecological Economic Zoning (ZEE) that defines disturbed regions in which Legal Reserve (LR) is reduced from 80% to 50% of rural property. However, the lack of a grant of this work via federal act creates uncertainty over which area to be preserved or recovered in the near future. In addition, compensation mechanisms provided by federal law, such as the Environmental Reserve Quota (CRA) and the Environmental

Adjustment Program (PRA), do not yet have legal regulations in most states. Added to this, some states, such as Pará, still have most of their territories without land titles.

Image risk and default producer: part of the market and government requirements described here result from the fact that the activity is associated with illegal deforestation in the Amazon and slave labor lists (Barreto & Silva, 2010). As a result, livestock image is associated with risks for the production chain. For example, in 2008 Greenpeace published a report linking several companies to illegal deforestation in the Amazon simply by buying cattle and related products in the region. This report partially guided the legal action of the Public Ministry, sharing the responsibility with the production chain orienting retailers not to buy from areas with a history of illegal deforestation and slave labour. The producer in the region also received the default image, even with official delinquency rates at 1.5% for Brazil's rural credit in recent years. The first hypothesis for this incompatibility, in the view of the local banking agents with the official indicators, is that this default occurs more often at regional level. The second hypothesis is that there is low updating of specific locations and numbers, resulting in the use of old non-compliance indicators.

3.3 Developig a transition strategy to the intensification

The bio-economic model developed here showed expressive economic gains for the tested prototypic livestock farming lands. These gains are mainly a consequence of higher price markup, which appears in lower average costs per produced unit (R$/arroba, in **Figure 5**). However, the use of technology to increase productivity has been low, which can be explained by the high initial investment required, the lack of knowledge on the economical returns of the technology by most producers, as well as the poor qualification of the technical assistance and rural extension agents in the country. For those rural producers interested in migrating from the extensive model to the intensive, information control of the business and labour qualification are basic steps to change to intensive and profitable livestock farming more financially attractive.

3.3.1 Cultural impact and transformation experiences

Although the gains from adopting technical assistance and intensification of the pastures are evident, the transition from traditional to intensive livestock farming depends on producers' change in values and behaviour. For example, the Union of Rural Producers of the city of Paragominas - PA says that rural producers do not manage the productive processes and are resistant to new technologies (SPRP, 2014).

The main cultural changes are: lack of business management; no planning on land use, resulting in choices of areas with low agricultural performance or environmental restrictions, such as APPs; and extreme aversion to risk which leads to choosing extensive livestock farming, with low investment and profitability due to the opening of new areas. Aversion to risk derived from the use of technology is mistaken, because if producers knew the economical results of BAU, they would realize that the business is unfeasible in the long term without technology. The mistaken understanding of risks is related to the absence of management and little knowledge on the economical returns of livestock farming.

A supplementary explanation to some producers' incipient management is that some farmers using BAU are not concerned with business losses as they do not take livestock farming as a target activity. In many cases in the Amazon, livestock farming is only a justification to occupy the area and speculate with land prices.

To the producers and those interested in dealing with the livestock farming as a business itself, there are several previous experiences and lessons learned to be considered in the implementation of intensification systems, such as, for example, the Pecuária Verde project (Paragominas) and the farms followed up by the Low-Carbon Livestock Farming Project in Alta Floresta - MT. Those producers' main motivation to intensify is also connected to the risk of suffering penalties due to lack of environmental regularization (e.g., embargo of the areas), and market requirements. However, the success in implementing intensified farms also comes from external factors: the partnership with research institutions and NGOs to provide guidance on good practices, qualification of producers, and connection with the productive chain at regional level. The lessons regarding the farm's internal factors to the success of intensification are connected to the business improvements, initially associated with the investment in labour.

3.3.2 Costs and funding of the transition

Due to the high initial investment (R$ 2,400.00/ha) and to the barriers mentioned to obtain credit, some model farms have adopted the strategy of focusing on management and intensification in an area between 5% and 20% of their pasture. By doing so, producers reduce the volume of initial investments as well as loss risks, as this process also involves learning management and training employees/rural producers.

This strategy is adopted by several intensification projects under implementation in the Amazon region, such as in the cities of: Apuí-AM (project led by Instituto de Conservação e Desenvolvimento Sustentável do Amazonas - Idesam); Paragominas-PA (project of the Union of

Rural Producers of Paragominas in partnership with Imazon - SPRP/Imazon); and São Félix do Xingu-PA (project of The Nature Conservancy).

Integrated systems: economic indicators, opportunities and challenges

The CLI and CLFI systems present a more sustainable approach on production, as they include synergistic and potentiating effects, moving beyond those of each single system, and affect all activities (Kichel et al., 2014). This synergy changes environmental conditions, such as the biological cycles, having positive consequences in addition to those found in the non-rotation monoculture. As a result, a reduction in the use of supplies and an increase in production efficiency may occur (Alvarenga & Gontijo, 2008; and Kichel et al, 2014). Additionally, the integration can also promote diversification of productive arrangements, encouraging productive partnerships and labour inclusion (Sachs, 2004).

The first and most evident improvement in the economic indicators are an outcome of the higher liquidity due to production diversification. The liquidity increase due to production diversification leads to lower risks on the total revenue, as the profitability does not depend on price fluctuations of a single product. Also, the agronomic integration of the different activities generates lower demand for the use of supplies, such as fertilizers and expenditure with soil correction. The lower cost per unit produced allows greater profit margin on the prices, once again reducing the risks of fluctuations on the market.

From the environmental point of view, this leads to several benefits, such as the increment of organic matter in the soil, increasing the storage capacity of micro-nutrients and, consequently, productivity, biodiversity and resilience increase (forest restoration), recovery of degraded areas and erosion control, increased availability of residues and grains to feed cattle, increase in pasture quality, nutrient enhancement, and reduction of weed seeds. For agriculture, it can be beneficial to provide organic fertilizer, although not evenly, and to guarantee that no time is necessary to collect the stubble, in addition to the presence of dry matter in the soil, favouring direct plantation, and the improvement of the soil's physical capacities (Balbino et al, 2011; Machado et al, 2011). From the social point of view, the integrated systems can contribute to labor qualification, help to settle workers in the countryside, and increase food safety.

Rural credit funding the transition to more productive and sustainable livestock farming

Although rural credit is largely intended to livestock farming, it needs to use ATER funding mechanisms. Of the 15 rural credit lines for investment in livestock farming surveyed (Annex I), 33.3% fund pasture recovery, 87% fund productive systems, 53.3% have resources for environmental recovery, 40% for the purchase of animals, 40% for supplies, 46.7% for equipment, 20% for labour, 33.3% for technical assistance, and only 6.67% (a rural credit line) - INOVAGRO - funds Good Farming Practices (GFP). The interest rates vary from 0.5% to 5%, with Pronaf (with lower interest rates) as a highlight. Regarding grace period, the constitutional funds also must be highlighted. OCF has a grace period that can reach 12 years. Other lines, such as ABC, also present high grace periods of up to reach 8 years. In terms of amortization, the constitutional funds are those which present the best advantages, reaching up to 20 years. There are differences regarding total funded values, considering the borrower. The value varies from several thousands to 20 million.

Increasing volumes of credit intended to farming is not enough, it is also important to increase guided rural credit, linked to technicians' follow-up of the rural extension and conditioned to sustainability values. It is especially important in the Amazon, as deforestation has been associated to credit granted (Silva, 2009). Likewise, other studies have demonstrated the importance of Technical Assistance and Rural Extension to guarantee the success of rural projects borrowing credit, as well as to reduce the risks of delinquency. This is the importance of increasing credit through guidance so that it enables the use of part of the funding to contract Technical Assistance and Rural Extension.

3.3.3 Environmental adequacy of rural properties

The analyses of the bio-economic model were considered in a scenario of compliance with environmental laws, especially in the context of the Amazon and the Novo Campo Program, which include zero deforestation. However, it is often necessary to understand the costs and the financial impact of the environmental regularization in a transition process from traditional livestock farming to intensified livestock farming which complies with environmental laws. According to the data surveyed and presented in this section, environmental regularization makes the activity unfeasible in several scenarios.

According to Act no. 12.651 of 2012, the Permanent Preservation Area (APP) deals with the range of vegetation to be preserved. The Federal Law determines a minimum size of vegetation range to be preserved by all Brazilian states. But the Legal Reserve Area (percentage of rural properties to be maintained with forest cover) varies in the different Brazilian biomes, and may be changed according to the ecological-economical zoning which, on its turn, is responsibility of each state. Those areas, when smaller than mandatory, need to be recovered.

For cities located in the micro-region of Alta Floresta, the legal reserve is 80% of the total area of the rural property. However, an ecological-economical zoning was performed in the state of Mato Grosso, resulting in the presentation of a proposal to reduce the area of legal reserve from 80% to 50% of the total rural property, for restoration purposes. However, as the proposal has not been approved yet, we consider that, in the cities of the micro-region of Alta Floresta, the legal reserve is 80%.

According to the zoning, those rural owners who deforested before August 22, 2003 and have forest cover corresponding to 50% or more of the property's area would meet the Brazilian Forest Code requirements. However, estimates in the micro-region of Alta Floresta showed that the deficit of Legal Reserve (RL) was 146,820 hectares in the scenario of 30% of the area intended to RL (IIS, 2015). The results also indicated that 94.6% of the rural properties meet legislation requirements. But in the scenario of 50% RL, the deficit presents a significant reduction, totalling 38,828 hectares. However, the percentage of properties that don't meet requirements is still high (82.8%). But the deficit of forest cover in permanent preservation areas in the city is 10,296 hectares in the 80% RL scenario, and 66,463 hectares for 50% RL (IIS, 2015).

Adequacy of the rural properties from the restoration of APP and RL areas has to be performed according to the following stages:

- Registration in the Rural Environmental Registration (CAR): the main purpose of CAR is to receive environmental information on the properties (e.g., forest deficit, land use and occupancy in areas intended to preservation, etc.), monitoring, environmental planning, fight against deforestation and environmental inspection. During the registration, the APP and RL areas are limited in order to determine the area to be restored.

- If the property has environmental liability, the producer is required to present the Environmental Regularization Plan (PRA). Also in this scenario, the producer has to sign a Conduct Adjustment Term (TAC) to avoid penalties such as fines and embargoes.

Regularization of the legal reserve area may be done by implementing restoration or compensation projects by purchasing Environmental Reserve Share (CRA). When RL restoration projects are adopted, areas with low agricultural suitability are recommended to reduce competition over land use, for example, areas with greater declivity and difficult automation for agriculture.

Moreover, Law no. 12.651 provides for the use of restoration models with economical purposes by sustainable exploitation of wood and non-wood product, for RL restoration (Brancalion et al, 2013; Strassburg et al, 2014). Thus, the use of these models can contribute to reduce costs or even to increment revenue of rural properties (Strassburg et al, 2014). Studies by the International Institute for Sustainability (IIS) in the region of the Atlantic Forest showed that the models can generate internal return rates of over 14% (Strassburg et al, 2014). But in the event of restoration of APPs, the use of models for economical purposes is not allowed.

Implementation and maintenance costs for restoration project depend on the type of intervention adopted. The main ecological restoration models are: 1) Natural regeneration - passive restoration; 2) Conduction of the natural regeneration; 3) Enrichment plantation; and 4) Plantation of seedlings in total area.

The choice among the models should be based on the diagnosis of the area's degradation level, natural regeneration potential, the financial resources available and the timeframe to carry out the project (Holl & Aide, 2011). More interventionist models, such as plantation of seedlings in the total area, are preferably used in areas with low natural regeneration. The latter generally presents higher implementation and maintenance costs. On the other hand, in areas with expressive natural regeneration, the use of passive restoration is the most recommended.

If we compare the average costs of different restoration options (Table 9) with livestock farming CNV (Figure 2), the conclusion is that only the large scale (4,000 hectares) and intensified livestock farming areas are able to cover the costs of the cheapest restoration model. The figures in Table 9 refer to the micro-region of Alta Floresta. The great variation of the implementation and maintenance values reinforces the need for accurate diagnosis to assist in decision-making regarding the model to be used. Thus, support to restoration and the development of restoration models with economical purposes are important to make the environmental regularization of livestock farming feasible.

Table 5. Implementation and maintenance costs in the first two years per hectare for different models of ecological restoration in the region of Alta Floresta, Mato Grosso.

Models of ecological restoration	Activities	Cost (R$/ha)
Natural regeneration – passive restoration	Use of fences to keep the cattle out	R$ 2,360.00
Natural regeneration	Use of fences, weeding, and mowing to keep out invasive species	R$ 3,425.00
Enrichment plantations or consolidation by seedling plantation	Use of fences, weeding, and mowing, and seedling plantation	R$ 5,363.00
Plantation of seedling in the total area	Use of fences, weeding, and mowing, and seedling plantation in the total area	R$ 9,654.00

4. Final comments

Intensification, confinement and crop-pasture integration as paths to the adoption of good agricultural practices have presented financial viability, growing as a result of scale gains. Moreover, they are alternatives to increase production without expanding deforestation and which attends the growing demands of domestic and international markets, breaking away from unproductive and environmentally degrading inertia of the livestock sector. Mandatory restoration for properties in deficit of native vegetation, as a condition for environmental compliance and property social performance, is in many cases prohibitively costly, but necessary, opening, on the other hand, access to new markets and changes in reputation for the activity, on which fall the greatest national and international criticism, both in terms of pressure on ecosystems, and for extensive use of resources.

In this context, it is expected that this study may have decisively contributed to support the necessary changes to make a transition to a more productive, profitable and intelligent livestock in land use allocation. Therefore, it offered a set of comparative economic performance simulations to assist the producer decision-making, but also to promote public policies aimed at converging production and conservation of natural resources. The main points learned from the simulations derived from the model developed here and which deserve to be shared and disseminated are:

For Producers and Associations

Intensification increases livestock competitiveness: for farms up to 200 ha, the intensification turns loss-making activities into profitable ones. For other activities, the financial return is expressive and the risk reduction is considerable.

The cattle-crop integration increases livestock competitiveness in addition to being a good strategy for pasture reform: the integration is lucrative for any farm size and, although it brings poorer results than intensification, it is a financial strategy that reduces costs of pasture reforms and increases the property's working capital.

The size of pasture area affects viability and risk: pasture areas from 200 ha present lower risks of failure when combining integration or 20 % of intensification.

Restoration when associated to intensification or integration do not affect the production, even in small farms: restoration, necessary for Forest Code adequacy, causes profitability decrease, but it is economically compatible with the production if associated to productivity improvement.

The farm manager must have an integrated view of the property to make intensification: the business head should plan the actions for production intensification together with the requirements of environmental adequacy. For example, not invest in fertilizer for illegal deforestation areas or for those intended for recovery of environmental liabilities, remembering that governmental legal acts and the market demands also offer risks to the production.

Public Policy Managers and Financial Sector

Credit funding should be the main incentive for the implementation of technologies: rural credit funding focused on intensification, cattle-crop integration and restoration is crucial for productivity to boost livestock economic gains and to make restoration feasible.

Continuity of command and control actions to avoid intensification rebound effect: complementary policies linked to deforestation control in order to avoid that this model becomes a "deforestation vector" (rebound effect) are required. Deforestation command and control activities must be continued in order to avoid risks associated to livestock profitability and those related to interest in an additional land use, by opening new production areas.

To make progress on environmental regulation will give legal security and will open new markets: the low adherence to environmental laws involve risks, given the growth on market or financial sector demands or even demands from the access to public policies. As an example, we have CAR and LAR requirements by financial agents for credit release, and the product rejection without assurance of environmental compliance (as identified in section "Other risk factors").

5. References

Alvarenga, R.C. & Gontijo, M.M. 2008. Integração Lavoura-Pecuária-Floresta em SPDP na condição de clima tropical. 11o encontro nacional de plantio direto na palha. Produzindo alimentos e energia com sustentabilidade.

BACEN, Banco Central do Brasil. Anuário Estatístico de Crédito Rural, 2012. Departamento de Regulação, Supervisão e Controle das Operações do Crédito Rural e do Proagro –DEROP. Brasília, 2013.

Balbino, L.C.; Barcellos, A.O.; Stone, L. 2011. Marco Referencial: Integração lavoura pecuária floresta. Brasília, DF, Embrapa.

Barreto, P.; Pereira, R.; Arima, E. 2008. A pecuária e o desmatamento na Amazônia na era das mudanças climáticas. Belém: Imazon. Disponível em: <http://tinyurl.com/y8f7aob>

Barreto, P. & Silva, D. 2010. Will cattle ranching continue to drive deforestation in the Brazilian Amazon? Artigo apresentado na Conferência internacional de meio ambiente e gestão de recursos naturais nas economias em desenvolvimento e transição. Clermont Ferrand, France. Disponível em: <http://www.cerdi.org/uploads/sfCmsContent/html/323/Barreto.pdf>. Acesso em: 05 de janeiro de 2015

Silva, D. & Barreto, P. 2014. O aumento de produtividade e lucratividade da pecuária bovina na Amazônia: O caso do Projeto Pecuária Verde em Paragominas. Belém: Imazon. Disponível em: < http://bit.ly/12rEPf4>. Acesso em: 05 de janeiro de 2015

Brancalion, P.; Viani, R.; Strassburg, B. & Rodrigues, R. 2012. Finding the money for tropical forest restoration. Unasylva, 63, p. 25–34.

BRASIL, Lei 12.651 de 05 de maio de 2012. Disponível em: <http://www.planalto.gov.br/ccivil_03/_ato2011-2014/2012/lei/l12651.htm> Acesso em: 05 de janeiro de 2015.

Bustamante, M.; Robledo-Abad, C.; Harper, R.; Mbow, C.; Ravindranath, N.H.; Sperling, F.; Haberl, H.; Pinto, A.S.; Smith, P. 2014. Co-benefits, trade-offs, barriers and policies for greenhouse gas mitigation in the Agriculture, Forestry and Other Land Use (AFOLU) sector. Global Cahnge Biology (Print), JCR, v.20, p. 3270 – 3290

Candido Pereira, A., Silva Oliveira, A B., Ferreira Barbalho, V. (2007) "A Utilização da Informação Contábil na Gestão da Pecuária Bovina de Corte: Uma Pesquisa Empírica". BBR - Brazilian Business Review, 4:(1): 40-59

Comissão Pastoral da Terra - CPT. 2013. Conflitos no Campo no Brasil. 198p.

Empresa Brasileira de Pesquisa Agropecuária - Embrapa. 2000. Embrapa Florestas. Reflorestamento de Propriedades Rurais para fins Produtivos e Ambientais: um guia para ações municipais e regionais. Brasília, DF.

Empresa Brasileira de Pesquisa Agropecuária - Embrapa. 2001. Documentos 42: Benefícios da integração entre lavoura e pecuária. Brasília.

Empresa Brasileira de Pesquisa Agropecuária - Embrapa. 2011. Boas práticas agropecuárias (BPA): manual de orientações. 2. ed. rev. ampl. Campo Grande, MS: Embrapa Gado de Corte. Disponível em: <http://cloud.cnpgc.embrapa.br/bpa/files/2013/02/MANUAL_de-BPA_NACIONAL.pdf>

Feltran-BarbieriI, R. 2008. Passivo ambiental do agribusiness negligente: o desrespeito generalizado ao Código Florestal. Revista de Direitos Difusos , v. 45, p. 103-119.

Feltran-Barbieri, R. 2014. Origins of agriculture in Brazil. In: Selin, H. (org). Encyclopaedia of the History of Science, Technology, and Medicine in Non-Western Cultures. Dordrecht: Springer Science+Business, p.1-7.

Flitchman, G. & Allen, T. 2013. Bio-economic modeling: State-of-the-art and key priorities. BioSight Workshop – IFPRI. Washington. 23p.

Holl, K.D. & Aide, T.M. 2011. When and where to actively restore ecosystems? For. Ecol. Manage, 261, p. 1558–1563.

Homma, A.; Filho, A.; Ferreira, C.; Araújo, C.; Ribeiro, H.; Lau, H.; Veiga, J.; Albuquerque, J.; Júnior, J.; Neto, J.; Marques, J.; Filho, M.; Costa, N.; Mascarenhas, R.; Dutra, S.; Filho, S. Criação de bovinos de corte no Estado do Pará. Embrapa Amazônia Oriental. Série Sistemas de Produção 3. S.d. Disponível em: <http://sistemasdeproducao.cnptia.embrapa.br/FontesHTML/BovinoCorte/BovinoCortePara/index.html>. Acesso em: 05 de janeiro de 2015

Instituto Centro de Vida - ICV. 2014. Programa Novo Campo: praticando pecuária sustentável na Amazônia. 2014. Disponível em: <http://www.icv.org.br/site/wp-content/uploads/2014/10/Apresentacao_Programa_Novo_Campo.pdf>. Acesso em 05 de janeiro de 2015

Instituto Internacional para a Sustentabilidade – IIS. 2015. Contribuições para um Plano Estratégico de desenvolvimento da pecuária sustentável em larga escala na microrregião de Alta Floresta, Mato Grosso. No prelo.

Junior, G.; Alves, E.; Contini, E. 2011. Dimensão econômica de sistemas de integração lavoura‑pecuária. Revista Pesquisa agropecuária brasileira, v.46, n.10, Brasília, p.1117-1126.

Kichel, A.N.; Costa, J.A.A.; Almeida, R.G.; Paulino, V.T. 2014. Revisão bibliográfica sistemas de integração lavoura-pecuária-floresta (ILPF) - experiências no Brasil. B. Indústr. Anim., Nova Odessa, v.71, n.1, p.94 - 105. Disponível em: < http://www.researchgate.net/publication/262910884_Sistemas_de_Integrao_Lavoura-Pecuria-Floresta_(ILPF)_-_Experincias_no_Brasil_Integrated_Crop-Livestock-Forest_System_-_Experiences_in_Brazil>. Acesso em: 05 de janeiro de 2015

Latawiec, A.E.; Strassburg, B.N.S.; Beduschi, F.; Pinto, H. A.; Micol, L.; Rangel, M.; Telles, V.; Penteado, M.; Florence, E.; Stoner, L.; Kalif, K.; Iribarrem, A.; Barros, F.; Gardner, T.; Boelsums, J.; Lemgruber, L.; Simas, M. 2014. Opportunities for and constraints to adopt Good Agricultural Practices in cattle ranching. The producers´ perspective. International Institute for Sustainability, Rio de Janeiro, Brazil. 58p.

Machado, L.A.Z.; Balbino, L.C.; Ceccon, G. 2011. Integração lavoura pecuária floresta. 1. Estruturação dos sistemas de integração lavoura pecuária. Embrapa Agropecuária Oeste. Dourados, MS.

Ministério da Agricultura, Pecuária e Abastecimento - MAPA. 2012. Plano setorial de mitigação e de adaptação às mudanças climáticas para a consolidação de uma economia de baixa emissão de carbono na agricultura: Plano ABC (Agricultura de Baixa Emissão de Carbono). Ministério da Agricultura, Pecuária e Abastecimento, Ministério do Desenvolvimento Agrário, Coordenação da Casa Civil da Presidência da República. Brasília; MAPA/ACS.

Marion, J. C.; Segatti, S. Contabilidade da Pecuária. 10 ed. Atlas Mattei, Série Estudos nº 11. São Paulo: MDA, 2005. 136p.

Martha Júnior, G.B., Alves, E., Contini, E. (2011) "Dimensão econômica de sistemas de integração lavoura-pecuária". Pesquisa Agropecuária Brasileira 46(10) 1117-1126

Maya, F. 2003. Produtividade e viabilidade econômica da recria e engorda de bovinos em pastagens adubadas intensivamente com e sem o uso da irrigação. Dissertação mestrado Escola Superior de Agricultura Luiz de Queiroz (ESALQ), Piracicaba. 83p. Disponível em: http://goo.gl/tTWpj. Acesso em: 05 de janeiro de 2015

Mendes, F. A. T. 1997. A sustentabilidade socioeconômica das áreas cacaueiras na Transamazônica: uma contribuição ao desenvolvimento regional. Tese (Doutorado) Escola Superior de Agricultura Luiz de Queiroz (ESALQ), Piracicaba.105p.

Najera, C. C. A. 2010. La contabilidad en la empresa agropecuaria de bovinos / Accounting in the cattle agricultural business: Curso De Especializacion En Produccion Animal. 4 ed. exico: Trillas

Padovan, M.P. & Pereira, Z.V. 2012. Integração Lavoura- Pecuária - Floresta. A lavoura, ano 115, n°. 690, p. 16-18.

Ribeiro, E.B.S., Korelo, J.C., Silva, D.M.L., Prado, P.H.M. (2011). Inovatividade organizacional e seus antecedentes:um estudo aplicado às tecnologias para pecuária. Revista de Administração 46(4):342-357

Sachs, I. 2004. Inclusão social pelo trabalho decente: oportunidades, obstáculos, políticas públicas. Estudos Avançados, 18(51), p. 23-49

Salles, T.T.; Leite, H.G.; Oliveira Neto, S.N.; Soares, C.P.B.; Paiva, H.N. & Santos, F.L. 2012. Modelo de Clutter na modelagem de crescimento e produçãode eucalipto em sistemas de integração lavoura‑pecuária‑floresta. Pesq. agropec. bras., Brasília, v.47, n.2, p.253-260.

Santos, M. A. S.; Cunha, S.J.T.; Santos, J.S.B.S.; Santana, A. C. 2007. Estudos setoriais 1: Mercado e dinâmica local da cadeia produtiva da pecuária de corte na região norte. Banco da Amazônia. Belém. Disponível em: <http://tinyurl.com/yf27hgq>. Acesso em: 05 de janeiro de 2015.

Silva, J. 2009. Economic Causes of Deforestation in the Brazilian Amazon: an Empirical Analysis. Master thesis presented to the Economics Institute of the Economics and Behavior Science Faculty at the University of Freiburg, for the degree of Master of Arts in Economics and Politics. University of Freiburg.

Silva, H.A. da; Moraes, A.; Carvalho, P.C.F.; Fonseca, A.F.; Guimarães, V.D.A.; Monteiro, A.L.G.; Lang, C.R. 2012. Viabilidade econômica da produção de novilhas leiteiras a pasto em sistema de integração lavoura‑pecuária. Pesq. agropec. bras., Brasília, v.47, n.6, p.745-753.

Sindicato dos Produtores Rurais de Paragominas - SPRP. 2014. Pecuária Verde: produtividade, legalidade e bem-estar na fazenda. Paragominas: SPRP.

Soares-Filho, B., Rajão, R., Macedo, M., Carneiro, A., Costa, W., Coe, M., Rodrigues, H., Alencar, A. (2014). Cracking Brazil's Forest Code". Science 344:363-364

Sousa, T.R., Silva, A.c., Faria, R.Q., Silva Neto, S.P. (2013) Viabilidade econômica de cultivo da sucessão soja-milho, em áreas próprias e arrendadas. XII Seminário Nacional de Milho Safrinha.

26 a 28 de novembro. Dourados: Embrapa/UFGD. disponível em http://ainfo.cnptia.embrapa.br/digital/bitstream/item/95492/1/33805.pdf

Strassburg, B.B.N; Scaramuzza, C.A.M; Sansevero, J.B.B.; Calmon, M.; Latawiec, A.; Penteado, M.; Rodrigues, R.R.; Lamonato, F.; Brancalion, P.; Nave, A.; Silva, C.C. 2014. Análise preliminar de modelos de restauração florestal como alternativa de renda para proprietários rurais na Mata Atlântica. Relatório técnico do Instituto Internacional para Sustentabilidade - IIS. 64p. Disponível em: <www.iis-rio.org>. Acesso em: 05 de janeiro de 2015.

Vasey, D.E. 1992. An Ecological History of Agriculture, 10,000 B.C. - A.D. 10,000. Iowa State University Press, Ames, Iowa, 363p.

Vilela, L.; Martha Junior G. B.; Marchão, R.L. 2012. Integração lavoura-pecuária-floresta: alternativa para intensificação do uso da terra. Revista UFG, Goiânia, v. 13, n. 13, p. 92-99.

Walker, N. F.; Patel, S. A.; Kalif, K. A. B. 2013. From Amazon pasture to the high street: deforestation and the Brazilian cattle product supply chain. Tropical Conservation Science. Special Issue, Vol. 6(3), p. 446-467.

6. Supplementary Material (Annex I)

Agriculture and Livestock Financing	Specific characteristics of the line	Interest Rate (pv)	Grace Period	Amortization	Total Financeable Value	Catogory	Total resources allocated (crop year 2013/2014)
Goal: Investment							
ABC Program – Program for reduction of emissions of Greenhouse effect gases in agriculture	Rural properties adequacy or regularization in face of environmental legislation, including legal reserve recovery, permanent preservation areas, recovery of degraded áreas and improvement of sustainable forest management plans	8%	1 to 8 years (depending on the type of project)	From 5 to 15 years (depending on the project)	R$ 1 million to 3 million	Medium and major producers	R$ 3 billions
PRONAMP – Program of National Support for the Medium Rural Producer	Allows rural credit for squatters	4,50%	Up to 3 years	Agricultural funding: up to 2 years; Livestock funding: up to 1 year.	Funding: R$600 thousand, per agricultural year Investment: R$350 thousand	Rural producer who atend all the following requirements: • to be the owner, squatter, tenant or partner; • to have at least 80% of income comming from livestock activity or vegetal extraction; • To have an annual gross income of up to R$1,6 million, per participant involved in the enterprise.	R$ 13,2 billion

INOVAGRO – Program for the incentive of Technological innovation in livestock production	Technological innovation, productivity increase, adoption of good agricultural practices, rural property management, training and resources destined to ATER of up to 4%.	3,5% p.y.	3 years	3 + 7 anos years	R$ 1 million for individual enterprise. R$ 3 million for collective enterprises	Rural producers, legal entity or individuals; and rural production cooperatives	R$ 1 billion
FCO	Consitututional fund for the Brazilian Midwest financing	3,5% p.y., with a 15% bonus for prompt payments	Up to 12 years	20 anos years	TOP: R$ 20 million per taker, including agricultural groups, business groups, production cooperatives or rural producer associations	Rural producers and extractive exploiters I. mini: up to R$ 360 thousand; II. small: over R$ 360 thousand up to R$ 3,6 million; III. small-medium: over R$ 3,6 million up to R$16 million; IV. medium: over R$ 16 million up to R$ 90 million; V. large: over R$ 90 million	R$ 2,876 billion Intended for constitutional funds (FCO, FNO and FNE)
FNO	Northern constitutional finance fund. Funds from 100 up to 70% of the financed value (low/mini and high/large income)	3,5% with 15% bonus for prompt payments. In the case of Pronaf, according to program rates (0,5 to 2%)	6 months to 6 years	Up to 20 years	TOP: R$ 20 million per taker, including business group, agricultural group, production cooperatives or rural producer associations	Rural producers and extractive exploiters I. mini: up to R$ 360 thousand; II. small: over R$ 360 thousand up to R$ 3,6 million; III. small-medium: over R$ 3,6 million up to R$16 million; IV. medium: over R$ 16 million up to R$ 90 million; V. large: over R$ 90 million	R$ 2,876 billion Intended for constitutional funds (FCO, FNO and FNE)

FNE	Consitutional Fund for Northeast financing - MICRO AND SMALL COMPANIES	3,5% with 15% bonus for prompt payments.	4 years	12 years	Mini/Micro R$160.000,00 Small R$ 1.330.000,00 Small-Medium R$ 6.500.000,00 Medium/Large R$ R$10.000.000,00	Rural producers and extractive exploiters I. mini: up to R$ 360 thousand; II. small: over R$ 360 thousand up to R$ 3,6 million; III. small-medium: over R$ 3,6 million up to R$16 million; IV. medium: over R$ 16 million up to R$ 90 million; V. large: over R$ 90 million	R$ 2,876 billion Intended for constitutional funds (FCO, FNO and FNE)

Agriculture and Livestock Financing	**Specific Characteristics of the Line**	**Interest Rate (p.y.)**	**Grace period**	**Amortization**	**Total financiable value**	**Category**	**Total resources allocated (crop year 2013/2014)**
GOAL: INVESTMENT							
PRONAF	Line directed towards rural producers from family agriculture, reduced interest rates	0,5 to 2,0% P.Y.	3 to 5 years	10 years	R$ 150 thousand per producer and R$ 750 thousand shared	Rural producers from family agriculture	21 billion reais

Pronaf Microcredit	Intended to support investments in agriculture and non-agricultural activities developed in the rural establishments or in near rural community areas, as well as implementation, enlargement or modernization of production infrastructure and agricultural and non agricultural services.	0,5% p.y.	No grace period	Up to 2 years	Investment up to R$ 3,5 thousand per operation, bonus for prompt payment of 25% up to the first R$10,5 thousand	Rural producers from family agriculture
Pronaf Young	Intended to serve credit proposals of young producers (between 16 and 29 years old) according to technical project or simplified proposal	1,0% p.y.	Up to 3 years	Up to 10 years, including the 3 years of amortization	Up to R$15 thousand	Young rural producers from family agriculture
Pronaf More Food	Intended to promote increase in production, productivity and the reduction of production costs, aiming at raising the income of rural productive families	1,0% or 2,0%	Up to 3 years	Up to 15 years	Up to R$ 10 thousand, 1% p.y. of interest. From R$10 to 150 thousand, 2% p.y. interest.	Rural producers of family agriculture
Pronaf ECO	Intended to implement, use and/or recover: renewable energy technologies;	1,0% or 2,0%	Up to 3 years	Up to 12 years A and B: up to 3 years with	Up to R$ 10 thousand, 1% interest p.y.. From	Rural producers of family agriculture

	environmental technologies; water storage; small use of hydropower; forestry and adoption of good conservative practices and soil acidity/fertility correction			possibility to be extended up to 5 years depending on the technical project	R$10 to 150 thousand, 2% p.y..	
Pronaf Agroecology	Funding of Agroecological or organic production system, including costs related to enterprise implementation and maintenance.	1,0% or 2,0%	Up to 3 years	Up to 10 years, including 3 years of amortization	Up to R$ 10 thousand, 1% interest p.y.. From R$10 to 150 thousand, 2% interest p.y..	Rural producers of family agriculture
Pronaf Woman	Funding intended for credit proposals for women producers according to technical project or simplified proposal.	0,5% to 2,0%	Up to 3 years	Up to 10 years, including 3 years of amortization	Up to R$ 2,5 thousand per operation, 0,5% interest p.y.. Up to R$ 10 thousand, 1% interest p.y.. From R$10 to 150 thousand, 2% interest p.y..	Rural producers of family agriculture

Agriculture and Livestock Financing	Specific Characteristics of Line	Interest Rate (p.y.)	Grace period	Amortization	Total financiable value	Category
GOAL: INVESTMENT						
Pronaf Agrobusiness	Intended for investments, including infrastructure, aiming at processing and commercializing agricultural production, forest products and extractive activities, or handmade products. And development of rural tourism.	1,0% or 2,0%	Up to 4 years	Up to 15 years, including a 4 years grace period	Rural individual and family enterprises up to R$ 10 thousand; cooperatives and associations up to R$ 1 million, respecting the individual limit of up to R$ 10 thousand per active associate. 1% p.y. interest. Individual over R$ 10 thousand up to R$ 150 thousand, rural family enterprise over R$ 10 thousand and up to R$ 300 thousand; cooperatives and associations over R$ 1 million and up	Rural producers of family agriculture

					to R$35 million, respecting individual limit of up to R$45 thousand per active member. 2% p.y. of interest.	
Pronaf Forest	Intended for technical projects focused on: agroforest systems; environmentally sustainable extractive exploitation, management plan and forest management; restoration and maintenance of permanent preserved areas and legal reserve, recovery of degraded areas that already present diverse forest cover through planting one or more native species of the biome;	1,0%	8 to 12 years	Up to 20 years	I – When intended exclusivelly for projects from agroforest systems, except for recipients from the groups “A”, “A/C” and “B”: up to R$ 35.000,00 (thirty five thousand reais); II – to other ends: up to R$ 25.000,00 (twenty five thousand reais); III – for the recipients from groups “A”, “B” and “A/C”: up to R$ 15.000 (fifteen	Rural producers from family agriculture

					thousand reais), observed what was written on MCR 10-1-22;	

Agriculture and Livestock Financing	Specific Characteristics of Line	Interest Rate (p.y.)	Grace period	Amortization	financiable value
GOAL: INVESTMENT					
MODERAGRO - Program for Agriculture Modernization and Natural Resources Conservation	To support and foment production sectors, processing, industrialization, packaging and storage of apiculture, aquaculture, poultry, chinchilla breeding, warren, floriculture, fruticulture, olive culture, nuts production, horticulture, sheep and goat farming, dairy farming, fishing, frog culture, silkworm breeding and pig farming. To foment actions related to animal defense, particularly the National Program for Brucellosis and Tuberculosis Control and Eradication (PNCEBT), and the implementation of animal tracking system for human feeding. To support soil recovery	5,5% per year	Up to 3 years	Up to 10 years, including the 10 years grace period	For individual enterprise: up to R$ 800 thousand per costumer; for collective enterprise: up to R$ 2,4 million, according to the individual limit per participant. For bovine or bull matrix replacement in the PNCEBT: up to R$ 200 thousand per costumer and up to 4,5 thousand per animal. Funding limited to 35% of the investing

	through funding for purchase, transport, application and implementation of agriculture correctives.				project budget when related to maintenance expenses until the first crop or production or when related to acquisition of matrix and bovine reproducers in the milk livestock activity.
BNDES Finem - Support for projects of Energetic Efficiency	To support projects of energy efficiency. Interventions that are proven to contribute to energy economy, to increase global efficiency of energetic system or to promote the replacement of fossil fuels for renewable sources.	• Direct operations: (a) Financial costs + (b) BNDES remuneration + (c) credit risk rate. • Indirect operations: (a) Financial cost + (b) BNDES remuneration + (c) Financial intermediation rate + (d) Remuneration of accredited financial institution.	2 years	Up to 6 years, including a 2 years maximum grace period deadline.	Up to 90% of the value of financeable items
BNDES Environment	Support to investments involving basic sanitation, eco-efficiency, rationalization of use of natural resources, mechanisms of clean development, recovery and conservation of ecosystems and biodiversity, management systems and recovery of environmental liabilities.	For direct and indirect support, see: http://www.bndes.gov.br/SiteBNDES/bndes/bndes_pt/Institucional/Apoio_Financeiro/Produtos/FINEM/meio_ambiente.html	Determined according to the possibility of payment by the enterprise, company or economic group.		Minimum financeable value: R$ 20 million
Climate-Fund Program – Fighting Desertification	To support and fund projects or studies and enterprises with the objective of mitigating climate changes such as renewable energy and projects of	Direct support: Financial Cost + Basic	Minimum of 3 months, which must finish in up	Up to 15 years,	R$ 5 million

	efficient transportation modals. Biomes restoration: implantation, expansion and modernization of nursery of forest seedling for restoration purposes and revegetation of Permanent Preservation Areas, Legal Reserve Areas, Conservation Units, Private Natural Patrimony Reserves, Settlements and Indigenous Land; and Sustainable Productive Activities: fruits, fibers and native wood production.	BNDES remuneration + Credit risk rate Indirect support: Financial cost + Basic BNDES remuneration + Financial intermediation rate + Remuneration of accredited financial institution	to 6 months after the starting date of the commercial operation enterprise, not exceeding 8 years.	including grace period	
Climate-Fund – Native Forests	To support projects associated to sustainable forest management, forest plantation of native species, including the productive chain, processing and consumption of forest products with sustainable origin, as well as the technological development of these activities.	Direct support: Financial cost + Basic BNDES remuneration + Credit risk rate// Indirect support: Financial cost + BNDES basic remuneration + Remuneration of accredited financial institution	Sustainable forest managing; forest planting with native species; restoration of vegetal cover with native species: up to 25 years, including up to 8 grace years. Support to the productive chain of timber and non-timber products from native species; to the acquisition of timber or timber products from native origin: up to 20 years. Technological development: up to 12 years.		R$ 5 million

Climate Fund – Innovative Projects	Support innovative projects related to supportable enterprise in the other subprograms from Climate-Fund Program	Direct support: Financial cost + Basic BNDES remuneration + Credit risk rate// Indirect support: Financial cost + BNDES basic remuneration + Remuneration of accredited financial institution	Up to 6 months after the commercial operation entrance date, not exceeding 8 years.	Up to 15 years, including grace period.	R$ 1 million
Climate Fund – Renewable Energy	To support investments in generation and distribution of local renewable energy, in the technological development and in the productive chain of the renewable energy sector.	Direct support: Financial cost + Basic BNDES remuneration + Credit risk rate// Indirect support: Financial cost + BNDES basic remuneration + Remuneration of accredited financial institution	Up to 6 months after the starting date of commercial operation, not exceeding 8 years.	Up to 16 years, including grace period	R$ 3 million (only for operations performed in direct or indirect non-automatic forms).

BNDES Forest Compensation	Support to regularization of legal reserve liability in rural properties intended for agribusiness and to preserve and value native forests and remaining ecosystems.	Direct support: Financial cost + Basic BNDES remuneration + Credit risk rate// Non automatic Indirect support: Financial cost + BNDES basic remuneration + Remuneration of accredited financial institution	Up to 12 months, according to harvest cycle and cash flow of the beneficiary or of the rural producers with environmental reserve liability to be regularized, following BNDES criteria.	Up to 15 years.	The minimum value to support direct operations will be R$ 10 million.
BNDES – Reforestation, Recovery	Support to reforestation, to conservation and forest recovery of degraded or converted areas, and to sustainable use of native areas in the form of forest management. Funding may occur in two forms: funding planting of forest species with energetic purposes and/or oxy reduction with environmental positive externalities: projects that reduce the pressure on native forest by wood supply intermediation in the pig iron, iron garters, ceramic products and chalk productive chains. Funding reforestation of degraded or converted areas and forest management: planting of native forest species for conservation and recovery of degraded or converted areas, including permanent preservation areas and legal reserves, and sustainable forest management of native areas.	Direct support: Financial cost + Basic BNDES remuneration + Credit risk rate// Indirect support: Financial cost + BNDES basic remuneration + Remunaration of accredited financial institution	The grace periods and amortization are defined according to species and exploitation model of the financed project.	Grace period and amortization are defined according to species and exploitation model of the financed project.	Minimum of R$ 1 million