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TEEB
The Economics of Ecosystems & Biodiversity

BACKGROUND STUDY - EXECUTIVE SUMMARY

OBSERVATÓRIO DE BIOECONOMIA

FGV EESP
ESCOLA DE ECONOMIA DE SÃO PAULO

The Economics of Ecosystems and Biodiversity (TEEB) is an initiative organized by the United Nations Environment Programme (UN Environment Programme) and coordinated by the TEEB office in Geneva, Switzerland. The Economics of Ecosystems and Biodiversity for Agriculture and Food programme a (TEEBAgriFood) has many research and training projects on the holistic assessment of agriculture and agrifood systems along their value chains, including their most significant externalities.

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1. INTRODUCTION

The value chains associated with Brazilian agribusiness contribute to the generation of wealth, employment and the country's trade balance surplus. Agricultural production, the core of agribusiness, depends on the intensive use of natural resources, such as land, water and minerals. The generation of economic returns and social benefits by the agricultural sector is a consequence, therefore, of the capacity of these natural resources to provide ecosystem services and favorable conditions for production. On the other hand, agriculture has consequences for the stock and quality of these same natural resources. The need to understand the relationships of dependence and complementarity between agricultural production and natural resources is increasingly pressing. Measuring and evaluating these relationships and how the different production processes can contribute to increasing the productivity and resilience of production systems, and their effects on the other links of the agribusiness production chains, from the manufacture of inputs, through the processing industry and the logistics and distribution systems, to the final consumer.

The purpose of this document is to present a "Background Study" on challenges, opportunities (opportunity assessment) and policies (policy assessment) that contribute to improving the relationship between the Brazilian agribusiness production systems and the environment and sustainability, considering their socio-economic benefits. Thus, the document is intended to inform and motivate stakeholders towards the choice of the object of analysis of the global initiative The Economics of Ecosystems and Biodiversity for Agriculture and Food (TEEBAgriFood) in Brazil, aiming to promote desirable changes in the use of natural resources by the agrifood value chains in the country. TEEBAgriFood allows for a holistic and comprehensive assessment of the complexity of "eco-agri-food" systems, identifying the positive and negative externalities that affect the economic environment operated by farmers and making society aware of the dependence between natural, human and social capital. The document aims to guide the debate and further development of the TEEBAgrifood approach and its consequent transformations.

The two topics covered in this executive summary of the preliminary study are:

a) the broader adoption of production systems that generate favorable impacts on natural resources (which will be grouped in the document, in a simplified way, as "sustainable agriculture");

b) better use of extensive areas of degraded pastures.

The discussion of these two themes does not exclude the possibility of the TEEBAgriFood initiative to look into other themes of interest to Brazilian agribusiness. It is noteworthy that Brazil has the opportunity to combine its environmental vocation with its competence in agriculture in a strategic and synergistic way, given its natural capital (extensive areas of natural vegetation, vast biodiversity, water resources, favorable climate conditions), its technologies and structured production chains, and the framework of public policies aimed at protecting the environment (Forest Code, Conservation Units, policies to combat deforestation, commitments in climate and biodiversity agreements, Low Carbon Agriculture Plan). In this context, it is necessary to understand how the environmental benefits arising from the country's stock of natural resources, enhanced by existing public policies, contribute to ensuring the strength of national agriculture, to consolidate the country's vocation as an "agri-environmental power", in which these attributes develop in a complementary and harmonic way.

2. PROMISING PRODUCTION SYSTEMS FOR THE EXPANSION OF SUSTAINABLE PRODUCTION IN BRAZIL

Sustainable production is associated with the conservation of natural resources (stock of natural capital), the economic return of assets and investments made in the activity (produced material capital), the maintenance or improvement of the conditions and quality of life of rural workers and agricultural producers (social capital and human capital), as well as improving institutional conditions, including organization within and along the agrifood chain (social capital). The techniques and practices grouped here under the name of "sustainable production" are capable of conserving or improving some or several of these capital stocks, increasing their positive flows of services and generating benefits for agriculture and other agribusiness sectors.

The practices considered here are: integrated systems that combine the production of crops, livestock and/or forests in the same area (crop-livestock-forest integration systems – iLPF, portuguese acronym); agroforestry systems (SAF, portuguese acronym); direct planting; sustainable intensification of livestock; waste management and treatment; precision agriculture; organic agriculture.

These various practices have different characteristics, adoption potential, target audience, scalability, potential to improve productivity and profitability, and the ability to generate ecosystem benefits or reduce undesirable environmental impacts. However, they have as a common point the improvement of the production process in relation to traditional agricultural systems, together with the reduction of negative socio-environmental externalities.

Adoption and distribution of these systems

The production systems mentioned above are in different degrees of adoption and have different geographic distribution. Integrated systems, for example, were estimated at 11.5 Million hectares (Mha) in 2015/2016, approximately 5% of the area under agricultural use in the country. However, they have been expanding rapidly, as they occupied 1.87 Mha in 2005. About 40% of the area is in the Midwest, 13% in Rio Grande do Sul State and 10% in Minas Gerais State. The adoption of systems that integrate farming and livestock corresponds to 83% of the total area. These systems are more common on commercial agricultural properties, with hired labor and a high level of mechanization.

Agroforestry systems (SAF), according to the 2017 Agricultural Census (IBGE, 2018)[1], are present in 491 thousand agricultural establishments and occupy 13.9 Mha (or 4% of the establishments' area). About 75% of establishments with SAF have an area equal to or less than 50 hectares. Sixty three percent of the SAF area is located in the Northeastern states. It is believed that SAF are more associated with the employment of family labor, with low level of production mechanization.

Direct planting is adopted by 11% of agricultural establishments in the country, occupying an area of 33 Mha (or 60% of the country's temporary crops area). The states of the Midwest concentrate 41% of the direct planting area, while those in the South account for 36%. Hired workforce is predominant in the Midwest of the country, while in the states of the South Region the use of family labor is common. Direct planting is commonly carried out with mechanization of activities. Producers who use it have access to rural credit and/or private financing.

In the case of animal waste management and treatment, the Ministry of Agriculture, Livestock and supply (MAPA, Portuguese acronym - 2019)[2] estimated that systems capable of treating between 1.7 million and 4.51 million m^3 of waste from 2010 to 2018 were implemented in the country. The use of sugarcane bagasse contributes, according to the Energy Research Company (EPE, Portuguese acronym - 2019)[3], with 10.8% of the final energy consumption in the country. The treatment of animal waste requires the installation of structures and equipment (biodigesters) intensive in capital and credit/financing, as well as the use of sugarcane residues. The use of hired workforce is the usual.

Organic agriculture, on the other hand, according to the 2017 Agricultural Census (IBGE, 2018)[1], is present in 1.3% of agricultural establishments in the country. Roraima, Rio de Janeiro and Acre are the states with the highest percentage of establishments that adopt this practice (respectively, 3.8%, 3.6% and 3.4% of Brazilian establishments with organic agriculture). It is more associated with the production of vegetables in small properties and with the use of family labor.

The adoption of these production systems and practices has been encouraged, in some cases, by public policies. The ABC Plan and the ABC Program, for example, encourage integrated iLPF systems, pasture recovery, direct planting and waste treatment. Of the total ABC Program credit taken by farmers in the 2017/18 and 2018/19 crop plan (Plano Safra), respectively R$1.55 billion and R$1.63 billion, direct planting received about 39% and 46%, about 6% was

[1] IBGE. Censo Agropecuário. 2018. Disponível em: https://censos.ibge.gov.br/agro/2017/ . Acesso em 20/06/2019.
[2] MAPA. Adoção e mitigação de Gases de Efeitos Estufa pelas tecnologias do Plano Setorial de Mitigação e Adaptação às Mudanças Climáticas (Plano ABC). 2019. Disponível em: http://www.agricultura.gov.br/assuntos/sustentabilidade/plano-abc/plano-abc-em-numeros/arquivos/ResumodaadooemitigaodegasesdeefeitosestufapelastecnologiasdoPlanoABCPerodo2010a2018nov.pdf . Acesso em 18/06/2019.
[3] EPE. Balanço Energético Nacional – Relatório Síntese Ano Base 2018, 2019. Disponível em: http://www.epe.gov.br/sites-pt/publicacoes-dados-abertos/publicacoes/PublicacoesArquivos/publicacao-377/topico-470/Relat%C3%B3rio%20S%C3%ADntese%20BEN%202019%20Ano%20Base%202018.pdf. Acesso em 19/09/2019.

destined for the iLPF systems, while only or less than 1% promoted the treatment of waste. The Agroecology and Organic Production National Plan (PLANAPO, portuguese acronym), on the other hand, encourages the purchase of organic products, including incentives to government to purchase via the Food Acquisition Program (PAA, portuguese acronym) and the National School Feeding Program (PNAE, portuguese acronym). State policies also contribute to this incentive, for example, in the State of Paraná, state public schools must provide school lunches made up 100% of organic food.

The influence of other agents in the agrifood value chain is also relevant for the adoption of these practices. In the case of iLPF and precision agriculture, companies that sell inputs and machines play the role of developers and technical assistance providers. In the case of organic agriculture, public rural extension is very relevant in serving small rural producers and family farmers. In the case of organic agriculture, another vector is that of alliances between consumers and producers in participatory and solidarity-based certification networks, such as Ecovida (REDE DE AGROECOLOGIA AGROVIDA, 2019)[4]. Large consumer industries and retail chains can also encourage and coordinate organic agriculture among their suppliers, aiming to offer more attractive products to their customers.

There is great potential for expansion of several of these techniques and production systems in the country. Integrated systems can expand into extensive areas of temporary crops (55.6 Mha in 2017), or of planted pasture area (which exceeds 112 Mha). The Midwest has 33% of crop areas and 40% of pasture areas, and has favorable climatic conditions for integrated systems, the same occurring in the northeastern cerrado region (Bahia, Piauí, Maranhão states) and in the state of Tocantins. On the other hand, direct planting is very mature and diffuse, being adopted in 60% of the area of grain crops, such as corn, soybeans and cotton. However, typical family farming crops, such as vegetables, may experience advances in cultivation in direct planting systems (A LAVOURA, 2019)[5]. Organic agriculture and SAF, on the other hand, have enormous potential for expansion in family farming, which accounts for about 3.9 million establishments (77% of the country's total), and occupies an area of 80.9 Mha (23% of the total) (IBGE, 2018)[1]. However, the wide variety of SAF configurations and the greater complexity of SAFs and organic agriculture are relevant challenges to be considered. The treatment of waste has great potential for expansion in the southern region of the country, where the production of swine is concentrated.

Importance of ecosystem services: externalities, flows, results and impacts

The production systems and practices considered here allow, to a greater or lesser degree, improvements in natural capital and/or the generation of positive externalities. In general, there is less use and, therefore, less dependence on chemical inputs (such as fertilizers and pesticides) in these systems, which generates less impact on biodiversity and the presence of natural enemies, less risk of infestation and losses by pests and diseases, greater potential for increased productivity and greater systems resilience. These systems also help to preserve moisture and water in the production system, or to reduce their need and use, or even their contamination. They also generate benefits for the soil, increasing the organic matter content

[4] REDE DE AGROECOLOGIA AGROVIDA, 2019. Disponível em: http://ecovida.org.br/certificacao/. Acesso em 04/11/2019.
[5] A LAVOURA. Sistema de Plantio Direto de Hortaliças reduz uso de agroquímicos. Disponível em: https://alavoura.com.br/agricultura/tecnicas-agricolas/sistema-de-plantio-direto-de-hortalicas-reduz-uso-de-agroquimicos/. Acesso em 31/10/2019.

and reducing physical and chemical problems compared to traditional production systems. In this way, they potentially contribute to increasing agricultural production and resilience. In addition, they have effects and consequences on the economic and social conditions of agricultural production, as well as on other links in the agri-food chains.

These practices and systems can also contribute to improve the perception and attractiveness of consumers regarding the environmental and even nutritional quality of agricultural products. Thus, there is a potential for adding value or differentiating the product and its price, for the producer, and/or along the production chain, from the adoption of these techniques.

Potentials and opportunities to expand sustainable production systems

The transmission of information and knowledge, as well as farmers' awareness that can happen through technical assistance, rural extension, field demonstrations and access to information, and promotion of peer-to-peer learning, is necessary for the understanding of how the ecosystem services provided by these technologies can improve their productivity outcomes and less need for inputs. Incentives for the formation and strengthening of associative initiatives, cooperativism and producer networks are also paths for the dissemination of sustainable practices and systems, as well as the production and commercialization of products generated on a small scale individually.

Metrics capable of generating data and information to decision makers on trends in changes in natural resource stocks, and flows of ecosystem services are important for the formulation and implementation of policies and private actions in the agri-food sectors towards conservation and improvement of these resources. The application of TEEBAgrifood is important in supporting the development of environmental accounting metrics and measurements, including national accounts for water, forests and ecosystems.

Sustainability standards and certifications (environmental, economic and social) along the production chain should allow consumers to make decisions consistent with their preferences for sustainable attributes, as well as signal to the productive sector their willingness to pay differentiated prices for such attributes. Mechanisms for valuing and pricing sustainability and certification standards need to be developed along the production chain. Initiatives and examples in this direction are the certification of organic products and the effort of the multi-institutional laboratory led by Embrapa (Platform ABC) to develop tools for collecting and recording data and information, calculating greenhouse gas emissions, instruments for remote verification and local verification protocols for low carbon agriculture (Agricultura ABC). It is important to note that these initiatives, however, do not ensure that agricultural producers will earn significantly more due to higher prices paid by consumers, as it is a challenge to distribute this price "premium" among agents in the production chain. Seals and certifications such as "fair trade" in some chains and products are, therefore, also necessary.

Interventions based on the functioning of markets, such as payment for ecosystem services (or payment for environmental services - PES), can generate a benefit for individuals or

companies that provide some ecosystem services. Such payment can encourage an increase in the provision of these services by producers and greater adoption of practices and techniques that generate these services. PES can be implemented between agents on a local basis, as well as on a regional and international level, through tax policy mechanisms or arrangements (such as subsidies or tax exemptions to providers of environmental services), for example, as well as by sectorial agreements and arrangements, or along production chains, either national or international.

The financial sector can act as a promoter of practices and production systems that generate favorable socio-environmental results. Directing and providing credit for agricultural producers and chains that adopt these practices is a type of incentive, as in the case of the ABC Program. In the case of private resources, environmental performance metrics can be associated with investment resources with sustainable purposes, considering monitoring and verification instruments. Furthermore, norms can be established that encourage loans to companies in the agri-food sector to meet sustainability requirements.

Main actors in the value chain and geographic distribution

The main actors with potential to adopt the practices and technologies considered here are agricultural producers. Yet, several other relevant actors in the agri-food chains can either benefit from the positive externalities and ecosystem services generated by the practices and technologies in question, or contribute and influence their adoption by farmers. The table below summarizes the main relevant actors and institutions.

Table 1: Actor groups, pressure for change

Actor	Pressure	Relevant TEEBAgriFood input and how TEEB results can be translated
Large grain producers	Pursuit for increased profit margins and productivity gains; search for new markets and greater acceptance in international markets	Metrics of impacts on natural and social capital and flows of environmental services measured and associated (labelled) to products; measure and demonstrate the flows of environmental services that generate productivity and resilience (e.g.: water volume, soil moisture retention, soil quality and productivity)
Large livestock ranchers	Search for increased profit margins and productivity gains; avoid negative image	Measure and demonstrate the flows of environmental services that generate productivity and resilience (e.g.: water volume, soil moisture retention, soil quality and productivity)

Medium-sized grain producers and livestock ranchers	Pursuit for increased profit margins and productivity gains; search for new markets and greater acceptance in international markets	Measure and demonstrate the flows of environmental services that generate productivity and resilience (e.g.: water volume, soil moisture retention, soil quality and productivity)
Sugarcane Producers	Search for improvements in profit margins and productivity gains	Metrics of impacts on natural and social capital and flows of environmental services measured and associated (labelled) to products; measure and demonstrate to producers the flows of environmental services that generate productivity and resilience (e.g.: water volume, soil moisture retention, soil quality and productivity)
Family producers and small producers	Search for improvements in family income and permanence in the activity; Reduce dependency and loss of margin for middlemen	Measure and demonstrate to producers the flows of environmental services that generate productivity and resilience (e.g.: water volume, soil moisture retention, soil quality and productivity)
Input suppliers (seeds, pesticides, fertilizers, machinery and equipment)	Increased sales and improve image; they can act as funders of sustainable practices	Metrics of impacts on natural and social capital and flows of environmental services measured and associated (labeled) to products
Agricultural products processing industry	Ensure supply of raw materials, improve image, avoid boycotts and negative images with national and international consumers	Metrics of impacts on natural and social capital and flows of environmental services measured and associated (labeled) to products
Distribution and marketing sector	Ensure supply of raw materials, improve image, avoid boycotts and negative images with national and international consumers; they can act as funders of sustainable practices	Metrics of impacts on natural and social capital and flows of environmental services measured and associated (labeled) to products
Final consumer	Search for healthier products with less undesirable environmental impact	

Associations, cooperatives, class representative institutions	Improve margin and image of its associates; improve coordination in the value chain; promote technology diffusion	Metrics of impacts on natural and social capital and flows of environmental services measured and associated (labeled) to products
Research institutions	Develop new technologies, innovation in products and processes, in order to reduce environmental impacts and increase productivity	
Third sector organizations	Influencing opinion towards greater sustainability; Contribute to project implementation and technology diffusion	
Public sector	Define standards, criteria, impact indicators, regulation, inspection	Metrics of impacts on natural and social capital and flows of environmental services measured
Financial sector	Growing demands from savers and investors to apply resources in sectors and projects with positive socio-environmental impacts; risk of co-responsibility in supporting projects with negative environmental impacts; opportunity to add value and environmental and/or social image to the brand	Metrics of impacts on natural and social capital and flows of environmental services measured and associated (labeled) to financed products and projects.

There are some barriers and challenges for the development of actions of agents that have the potential to influence sustainable production in agri-food chains. Among them, we can mention the absence or weak articulation between different entities and spheres of government around converging objectives towards sustainable agriculture, the scarcity of human and financial resources for the implementation of actions by the government (such as technical assistance and rural extension, research and development), segmentation and low coordination between different production chains and their representations, low knowledge of agents in all links of the chains regarding the beneficial environmental and productive impacts of sustainable agriculture practices and techniques. In this last aspect, the TEEBAgrifood framework contributes towards reducing this limitation, as it generates information and analyzes that contribute to the understanding of the positive impacts arising from actions to encourage sustainable agricultural practices. This also contributes to strengthening the links between adopted policies and practices, and the effectiveness of specific measures potentially adopted by both the public sector and private entities linked to the sector.

3. THE CHALLENGE OF DEGRADED PASTURES IN BRAZIL AND WAYS TO RECOVERING AND INTENSIFYING

Pastures are the main anthropic use of land in Brazil, with about 170 million hectares, including native and planted, which represents 20% of the national territory[6]. The balanced and efficient use of these pastures is, therefore, strategic for agricultural production, environmental conservation and development of the country.

The low productivity of these pastures is, on the one hand, worrying and problematic, as it represents a waste of resources and loss of economic opportunities that generate employment and income. On the other hand, pastures represent a great asset for the country, as they indicate a huge potential for increasing productivity and expansion not only of livestock, but of all agriculture, together with conservation and environmental recovery.

The decision of what would be the best use of Brazilian pastures is a broad issue that involves different interests and particularities given its scope and the heterogeneity of agriculture. Considering the focus of the TEEBAgriFood Project on eco-agri-food chains, this study will focus especially on productive uses of pastures, from the perspective of the rural producer and landowner (in detriment to non-productive uses of pastures).

Pastures are the main land use in all property sizes, including small and family-owned ones. According to the last Agricultural Census 2017, almost 50% of the area of family properties is occupied by pastures. Considering the importance of pastures and animal husbandry for family farming, it is necessary to define a specific profile for this group of producers when analyzing pasture recovery options in Brazil.

Pasture intensification makes it possible to accommodate the two major demands for land use, environmental recovery and expansion of agricultural production. When recovering a pasture, the area can be transformed into a better quality pasture or converted to various other uses, either agricultural or not. The expansion of agricultural crops over degraded pastures is crucial for growing production without deforestation. Ecological restoration for the purpose of environmental adequacy also requires an area that must largely come from pasture conversion.

Characterization of the degraded pasture problem

The recovery and intensification of pastures leads to better, more productive pastures, with greater livestock production, allowing the inclusion or spare of areas for other agricultural uses. Thus, it is a strategic issue for the Brazilian agriculture and for land use in general. From

[6] According to the website Pastagem.org, from the Federal University of Goiás (UFG), which includes natural and planted pastures.

the point of view of the conservation of natural resources, crucial for the proper functioning of natural cycles and human well-being, the use of pastures is also fundamental, especially given its vast territorial extension on a global and national scale.

The pasture area grew in Brazil throughout the 20th century and has been decreasing in recent decades, along with an increase in the herd and, therefore, in the average stocking. The growth in productivity levels is significant on the average for the country in recent decades, especially between 1996 and 2006. Embrapa researchers estimated that the increase in productivity explained 79% of the strong increase in production between 1950 and 2006; 21% is due to the increase in pasture areas. Between 1996 and 2006, livestock productivity grew 6.6% per year (MARTHA JR. et al., 2011)[7]. The historical trend of intensification generated large increases in meat production and a drop in the meet price, which was very beneficial to the population. The main challenge is, therefore, to considerably accelerate the intensification process for economic, social and environmental reasons, and to avoid situations of degradation that imply high costs or impossibility of reversal.

Although the importance of pastures in the Brazilian livestock activity is known, around 80% of cultivated pastures are in some stage of degradation, which results in their low productivity (DIAS-FILHO, 2014)[8]. Considering the total stock of pastures in the country, there are approximately 100 Mha of degraded pastures or in process of degradation. This trend is due to historical factors: according to Melo (2017), it is due to the extractive mentality of a large part of cattle raisers who consider cattle as a capital reserve and cattle farming as an activity to guarantee land tenure. As we will focus on the productive perspective, this historical aspect will not be the focus of the study, and other background factors will be explored.

For Dias-Filho (2017)[9], pasture degradation is the sharp and continuous fall in pasture productivity over time, "...may or may not have lost the ability to maintain productivity from a biological point of view (accumulate carbon)".

Specialized literature defines pasture degradation as "an evolutionary process of loss of strength, of productivity, of the natural capacity of pastures recovery to sustain its production levels and quality required by animals, as well as to overcome the harmful effects of pests, diseases and invaders, culminating in the advanced degradation of natural resources due to inadequate management". As a consequence of degradation, productive capacity and income generation fall, affecting producers.

Pasture degradation can occur at different levels, being Grade 1 - Mild degradation, Grade 2 - Moderate degradation, Grade 3 - Strong degradation, Grade 4 - Very strong degradation.

Among the factors responsible for pasture degradation, Dias-Filho (2010)[10] and Macedo (2009)[11] indicate the following:

[7] MARTHA JR, G.; ALVES, E.; CONTINI, E. Pecuária brasileira e a economia de recursos naturais. Embrapa Estudos e Capacitação, Brasília, 2011.
[8] DIAS-FILHO, M. B. Diagnóstico das pastagens no Brasil. Belém, PA: Embrapa Amazônia Oriental, 36 p, 2014.
[9] DIAS-FILHO, M. B. Degradação de pastagens: o que é e como evitar. Embrapa, Brasília, 2017.
[10] DIAS-FILHO, M. C. Produção de bovinos a pasto na fronteira agrícola. Embrapa Amazônia Oriental, 32p. 2010.
[11] MACEDO, M.C.M. Integração lavoura e pecuária: o estado da arte e inovações tecnológicas. Revista Brasileira de Zootecnia, v.38, p.133-146, 2009.

1. Inappropriate grazing practices such as the use of stocking rates or rest periods that do not consider the rate of grass growth;
2. Inadequate pasture management practices, such as lack of replacement fertilizer, excessive use of fire to eliminate uneaten pasture, or to control weed invasion;
3. Failures in the establishment of pasture, caused by inadequate preparation of the area, use of low-quality seeds, or by planting at an inappropriate season;
4. Biotic factors such as insect attacks;
5. Abiotic factors, such as excess or lack of rain, low fertility and poor soil drainage.

Pasture degradation impacts

In addition to the environmental impacts resulting from pasture missing a space after, socioeconomic impact is significant. The quality of the pasture has a direct influence on its carrying capacity, that is, on the quantity and weight gain of the animals produced and, consequently, on the income from the activity. Despite the difficulty of specifying income from livestock in Brazil due to the great heterogeneity of production systems, several authors indicate low income (or even negative income) in low productivity systems.

Ways to recover and maintain good pasture quality

When considering ecosystem services associated with pasture degradation and recovery, actions can be taken with better results for society. As these benefits are diffuse, and may incur additional costs for the producer, it is essential not only to estimate the benefits, but also assess who bears the costs and who benefits from it. This assessment provides an analytical basis for negotiating ways to internalize costs or finance the provision of associated ecosystem services. The benefits felt by society can be incorporated through the correction of consumed product prices and/or financial incentives for the adoption of good agro-environmental practices that produce such benefits.

Considering that the area covered by degraded pastures is large, prioritizing the choice of interventions to be used for improving pasture quality is a key step, especially for policy purposes. The potential for intensification can be used, overlapping stocking rates and pasture vigor. An option indicated by experts would be to exclude areas with a stocking rate below 0.6 animal unit per hectare (AU/ha), in order to disregard areas with low aptitude (low carrying capacity) for cattle raising. We can also choose regions that contain certain important characteristics, whether productive (herd size, among many others) or environmental (provision of certain ecosystem services such as watershed area). Agricultural suitability (slope, water availability and rainfall pattern) would be a key factor to promote pasture recovery for sustainable intensification.

In each class of degraded pasture, different interventions must be made in order to make it suitable for productive livestock. For pastures with low levels of degradation, it is indicated that pasture recovery[12] is adopted, while for higher levels of degradation it is recommended

[12] The concepts of pasture recovery and renewal adopted herein can be summarized by stating that recovery is taking advantage of the existing pasture, seeking to re-establish its productivity when the level of degradation is still light or moderate. Renovation is the replacement of existing pasture with a new, more drastic method when pasture degradation reaches higher levels.

to use pasture renewal and integrated crop-livestock systems - ILP, considering the most suitable crops for each region. The aim is to use the ILP as a way to obtain revenue from the crop, which can cover or, at least, reduce the impact of pasture renewal costs on the producer's cash flow. In addition, these systems are based on the models developed by Embrapa, Barreirão, Santa Fé and Santa Brígida, where a combination of crop and pasture is implemented.

Regarding the costs and feasibility of recovering pastures for livestock intensification purposes, some of the key factors are size of the property, initial investments (and financing for this), type of system (breeding, rearing, fattening or full cycle) and training and technical assistance.

The cost of pasture reform varies in general between R$ 1,200 to R$ 3,900/ha and can be done every 3 years or take more than 30 years, depending on the property's use strategy[13]. Values depend on the type of intervention (recovery being cheaper than pasture reform), location (due to varying input and labor costs) and property size (scale gain).

Estimates of costs and feasibility of intensification projects are important to define bottlenecks and support policies. Considering a scenario of properties of 300 ha and 3,000 ha[14] in Mato Grosso carrying out the intensification process together with environmental regularization, it was found that only the property with the largest area can afford, without external subsidies, the necessary investments for the process, given the economy of scale. In this case, the project has a positive return and a seven-year payback (HARFUCH et al., 2017)[15]. It is noteworthy that this analysis considered the complete brood-breeding-fattening system, and for small producers it could make more sense to specialize in brood, possibly associated with another more intensive agricultural activity, which can even be facilitated by the recovery of pastures associated or not with forest restoration (as in the case of SAF).

Despite the deeper debate on the economic viability of different forms of degraded pasture recovery, it can be said, in a simplified way, that there will always be a positive environmental and agronomic return. What varies is the decision regarding which intervention should be made, either spending more or less and incorporating different technologies. This decision depends heavily on advice via technical assistance and rural extension (ATER, portuguese acronym), credit and market insertion, in addition to other support policies and programs.

Environmental and socioeconomic benefits of pasture recovery

It is necessary to estimate with greater precision all the potential for generating jobs and income resulting from the intensification and conversion of pastures to other uses. As the technological level increases, the demand for training the workforce also increases, which would favor training programs and qualified rural employment. This is a clear social and economic benefit of pasture recovery, which is still not well appreciated. Service providers, and especially input producers, have a clear interest in the agenda, as well as local governments that will potentially benefit from a more dynamic economic activity.

[13] Some references for values and techniques for pasture recovery are Programa Novo Campo (ICV), Embrapa, and AthenaAgro-Agroconsult.
[14] Two sizes of livestock properties were evaluated in the study, with 300 ha and 3,000 ha of pasture, considering that they carry out the full production cycle.
[15] HARFUCH, L. et al. Intensificação sustentável da pecuária de corte em Mato Grosso. São Paulo, 2017. Disponível em: <https://www.inputbrasil.org/wp-content/uploads/2016/10/Intensificacao-Sustentavel-Pecuaria-MT_Agroicone.pdf>.

The good use of Brazilian pastures can significantly contribute to environmental quality, especially considering its large area in the country. Degraded pastures increase soil erosion and compaction, in processes that can be irreversible (or too costly to reverse). Thus, well managed pastures are essential for good soil conservation, a very valuable and strategic resource, as well as for mitigating greenhouse gases (GHG) emissions.

Table 2: Actor groups and interfaces with pasture recovery

Actor	Interfaces with pasture recovery
Large grain producers	Increase productivity and revenue, in addition to image and production and flows of environmental services (e.g.: water volume, soil moisture retention, soil quality and productivity)
Family producers and small producers	Increase productivity, and revenue, permanence in production and income activity; productive diversification; subsidies for the production of flows of environmental services
Large grain producers	Areas suitable for expansion of production with greater acceptance in international markets (support for controlling deforestation in the chain)
Meatpacking companies	Receive better quality cattle (carcass, leather, etc), improve image and support for controlling deforestation in the chain
Input suppliers (seeds, pesticides, fertilizers, machinery and equipment)	Increased sales, especially of pasture seeds and fertilizers, and fences; improve image; they can act as funders of sustainable practices.
Agricultural products processing industry	Increase the offer and variety of agricultural products with low environmental impact
Distribution and marketing sector	Increase the offer and variety of agricultural products with low environmental impact. Improve image with national and international consumers
Final consumer	Greater range of products with low environmental impact
Research institutions	Develop new pasture and package recovery technologies for different situations
Third sector organizations	Harmonize production and conservation, given that intensifying pastures increases meat production and frees up area for other crops and for conservation. Contribute to project implementation and technology diffusion
Federal government	Good management of the territory, reduction of GHG emissions - Plan and Program for Low Carbon Agriculture (ABC), fulfilling the commitment of the Climate Convention in Paris to the Brazilian NDC (indicates recovery of 15 million ha of degraded pastures)
Financial sector	Finance recovery and degradation technologies, encouraging their large-scale use
International organizations	Contribution to Sustainable Development Goals (SDGs)

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