ILIAN BEEF-CATTLE UCTION AND ITS --

MARFRIG'S STRATEGIC POSITIONING REGARDING CHAIN SUSTAINABILITY

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GLOSSARY



Agribusiness: concept developed by Davis Goldberg (1957) in Harvard University, it represents the total amount, in each currency, of all operations involving: production and distribution of inputs and capital goods for agriculture; production operations in agricultural establishments; and storage, processing and distribution of agricultural products and the items produced with them like food, beverages, fibers, renewable energy, wood, paper and cellulose to the consumer.



Agribusiness system model: based on the concept of agribusiness, Goldberg (1968) built the model based in sector analysis and highlighted the inter-sectorial connections as well as institutional and organizational ones involving laws, associations, cooperatives, research institutions and universities.



Beef-cattle system: it is the beef-cattle agribusiness comprehended by the whole supply chain, consumers, culture, social behaviour, the government and policies, laws, and institutions (national and international), organizations like ABIEC, ABPA, Embrapa.



Beef- cattle production systems: it's the group of production agents, all suppliers that can be organized in plural types of systems to attend the demand for cattle.



Industry: sector



Slaughterhouse: companies responsible to process meat production; processing.



CONTEXT

The Climate Change 2021: The Physical Science Basis Summary for Policy Makers published by the Intergovernmental Panel on Climate Change present a clear message that anthropogenic green-house gas emissions concentrations are causing extreme weather events worldwide and that the temperature increase can reach 1.5 C between 2030 and 2040. This evidence puts weight to the global challenge to reduce 45% emissions up to 2030, based on 2010 levels, as a trigger to achieve the Paris Agreement goals.

The **26th Conference of the Parties (COP26)** of the United Nations Framework Convention on Climate Change (UNFCCC) taking place in Glasgow between October 31st and November 12th of 2021 have the ambition to finalize the book of rules of the carbon markets and the challenge to foster climate finance to assemble at least US\$ 100 billion per year as outstanding issues to be agreed.

Moreover, COP26 is a paramount moment to push forward climate action aiming to climate neutrality. The definition of targets to balance emissions and removals are critical and a sine qua non condition to put the world on a route to limit temperature increase to 1.5 C above pre-industrial levels. Companies all around the world are taking the lead to improve business towards a climate transition.

As a leading company at the Be**ef-cattle system in Brazil, Marfrig has an important role to play to transform livestock production based on good practices,** pasture recovery and maintenance, adopting innovation and allowing to produce meat while reduces carbon.

Having these challenges in mind, this paper aims to explore the challenges faced by Brazilian beef-cattle system, especially related to key environmental and social issues that are at the core of the Sustainable Development Goals of the United Nations Agenda 2030.

The first part will present economic data regarding the evolution of beef-cattle system in Brazil and its economic importance for the country.

The second part will present the environmental and social aspects of beef-cattle system and its concerns related to deforestation, the Forest Code implementation and greenhouse gas - GHG emissions. Social aspects are placed as cultural aspects of consumption in Brazil and also the exclusion and difficulties faced by small-holders and family producers in this system.

Looking from the food system perspective, the third topic of the paper, it brings to the debate **beef-cattle system on Food System Summit (FSS).** This topic places a glance of the discussion and how Brazil positioned and committed with coalitions for improvements. Based on Brazilian pathways, a simple analysis of

how beef-cattle system is related to those pathways is presented. Also, presents tendencies of food consumption from the demand side.

The fourth topic gives a more conceptual **discussion about coordination on this system and its importance.** Slaughterhouses are placed as the coordinators. The quality programs developed by them were just a first picture about the leading role they represent. The historical evolution of environmental issues in the Amazon linking the system to deforestation and their actions are other example of system coordination.

The last topic presents the case of Marfrig on **dealing with the challenges** placed since 2009 concerning the relation of their beef-cattle system and environment. As a leading company, Marfrig has been establishing strategies to measure and monitor the environment as an asset of its products and the company to be coordinated and valuated by systems and markets.

2. BEEF-CATTLE PRODUCTION IN BRAZIL

This topic aims to provide a picture of Brazilian beef-cattle industry and its economic and social-cultural importance, bringing a historical perspective about the sector and evolution using qualitative and data analysis. Moreover, presents an analysis of Brazilian beef-cattle markets – internal and external and provides a picture of internal consumption per capita. The last section of this first topic brings opportunities observed along the chain – especially on production and international trade.

2.1 Beef-cattle Economics: General Aspects



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- Beef-cattle system is considered one of the most complexes around the world on daily basis. Cultural aspects, the internal relationship between agents, international market, NGOs' positions, regional aspects, processes, technology level, and genetics diverge from country to country. Despite different aspects, it is one of the oldest agricultural sectors and most valued when it comes to consumer preferences and vitamins contained (complex B12, especially).
- Understanding of structure and governance forms of main agents involved in the system is a key factor for development. In Brazil, beef-cattle production systems can be considered flexible and diverse. The historical economic perspective of this system brings the development of an activity based on land expansion and asset valorisation due to inflation, the use of traditional systems (land use, capital and employment) leading to low productivity and poor safety food system until the end of 1990s. Technological improvements on nutrition, sanitary aspects and genetics have been replacing this traditional system to efficient and sustainable ones (Wedekin et al., 2017).
- These several technologies on nutrition, genetics, sanitary and monitoring and controlling processes can also be considered as a pool of characteristics that shape different products to markets and consumers, that, when coordinated, bring optimized structures to the system (Lemos & Zylbersztajn, 2018).



BRAZILIAN AGRIBUSINESS - GDP

Brazilian Agribusiness GDP is done through a methodology that considers all the activities involved along the chain, before and after production system.

The Brazilian Institute of Geography and Statistics (in Portuguese IBGE) only considers and measures what is done inside production system (aggregated value in farm). However, this methodology undervalues coordination between agents and, also, their work on improving the whole system.

Agribusiness GDP has grown 564,8% between 1996 and 2020 (Figure 2.1). Nominal value came from almost 300 million in 1996 to 2 trillion, in the national currency, Brazilian reais (R\$ or BRL). Agribusiness GDP has two shades, one of agriculture and other of livestock aggregated values. The period analysed showed an evolution of 835,6% in livestock sector's GDP, it represented 22% of Agribusiness GDP and since 2015 sustain a 30% share. As part of the livestock sector, beef sector represented 10% of Brazilian total GDP in 2020, according to the Brazilian Exporters Processors Association (in Portuguese, ABIEC).

Figure 2.1 - Brazilian Agribusiness GDP and Livestock Sector GDP (Million and %)





Agribusiness in Brazil is a very important sector. It represents around **30%-33% of Brazilian Total GDP** and it's the most exposed sector to international competition (PWC, 2013).



From 1996 to 2020, a great development can be observed, especially on inputs' agents and (in farm) production (Table 2.1). The first explains an increasing of technologies on the field. However, when compared to production and its growth, it could be better explored. Production growth can be explained part by prices, exports (market) and the continued growth on cattle herd.

Table 2.1 – Brazil: Livestock sector GDP (R\$ million)

Main Agents	1996	2006	2016	2020
Inputs	1,616	6,997	20,716	26,816
Production	7,541	21,859	104,633	169,954
Processors	17,649	25,401	79,970	113,408
Services	37,568	47,721	197,678	292,120
Total	64,374	101,979	402,995	602,298

Source: CEPEA (2021)/CNA (2021)



If ignored the results from 2020 and base the analysis between **1996** and **2016 only, in two decades processors tripled their GDP.**

BEEF-CATTLE CHAIN QUANTIFIED

Since Plano Real, the economic plan that modified economic structure in Brazil and stabilized the currency, **in 1994, business environment in beef industry has been changing.** Cattle in the past was a synonymy of an asset to be transacted and hold value, liquid value for those who owned it. The economic change brought this activity to reality of agribusiness and the constant search for efficiency to survive.

According to ABIEC, in 2020 there were 165.2 million hectares dedicated to cattle production in an occupation of 1.14 cattle/hectare, since the total amount of animals were quantified in 187.55 million (Figure 2.2).

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Figure 2.2 - Production quantification (2020)



Source: ABIEC (2021)

Note: CWE - Carcass Weight Equivalent is the weight of meat cuts and meat products converted to an equivalent weight of a dressed carcass. Includes bone, fat, tendons, ligaments, and inedible trimmings (whereas product weight may or may not).

The picture of 2020 reflects a growth in exports supported by currency devaluation and the high level of international demand due to substitutes' crises, pandemic, and new markets.

Although the market had appetite for the protein and the devaluation of Real boosted exports, it's important to highlight those new markets came through the years, due to constant improvements that lead to efficiency and better quality. Technology, innovation, and technical assistance are the key factors for this turnaround in this industry, even it's not completely reformulated. Figure 2.3 signalize those improvements historically reflected on the animal time life before being slaughtered.

Figure 2.3 Brazil - Percentage of animals slaughtered after 36 months (males only)



Brazilian beef-cattle system was boosted after 2000s by technologies and innovations that is shaping the system to a more efficient one. International trade also boosted development due to the standards required in exports, mainly sanitary. Since then, Brazil reached a credible sanitary status internationally, mainly for foot and mouth disease (Lima, 2005).

2.2. BEEF-CATTLE MARKETS

Although Figure 2.4 below shows that domestic market holds 73% of production share in beef industry, it's relevant to analyse international trade participation and consumption per capita reduction along the years. In 2015, market structure was 81% of production destinated to domestic market and 19% to foreign markets. In 2020, international trade represented 26.07%, in which: 83% was commercialized *in natura* to 119 countries; China had 50.63% of total share, followed by Hong Kong - 11.68%, Egypt - 6.86%, Chile – 5.25% and others 25.39% (ABIEC, 2021).

Figure 2.4 –



Brazilian exports from 2000-2020 (US\$ billion x million tons)

Source: ABIEC (2021)

Industrialized meat represents only 10.23% of Brazilian beef exports, especially to developed countries. The United States represents 35.45% of total, followed by European Union – 33.37%, Egypt – 3.31%, Canada – 2.58% and others – 25.28%. Even, it can be noticed a great movement in exports, the largest quantity occurred between 2000 and 2008 (Figure 2.4).

The first great increase occurred due the WTO Agreement on Application of Sanitary and Phytosanitary Measures (SPS). After that, Brazil supplied 20% of the world demand (ABIEC, 2021). Data of beef supply around the world from 2018 to 2020 shows that Brazil already corresponds to 24%, and by 2030 it will represent 30% of world exports (USDA, 2021).

On the other hand, domestic market always represented the largest share of Brazilian beef production volume. The consumption of beef comes from a cultural aspect. Since colonial times, beef-cattle protein is a basic meal on Brazilian home tables. Even though, it's not the largest total volume consumed, being behind United States, China, and European Union (USDA, 2021). In kg per capita , Brazil has similar consumption as the United States (around 37 kg/per capita/year in 2020), but much lower than Argentina (52 kg/per capita/year) and Uruguay (45 kg/per capita/year). Technological advances made **possible superior standards**, **processes**, **and products**. In the last decade, several brands and programs were developed by slaughterhouses to improve quality to attend international market, at a first objective, and found a hunger appetite in domestic one. Those programs were mechanisms of coordination between cattle production and slaughterhouses and have been playing a great role on inducing to technological updates, technical assistance and sustainable systems of production based in science.

2.3. OPPORTUNITIES – IMPROVING PRODUCTION AND OPENING NEW MARKETS

There are several opportunities in the agribusiness of beef cattle systems for improvement, increase international trade and feeding domestic market. The key for development is based on sustainability. USDA projections for 2030 shows the growth on domestic market and consumption (15%), also the increasing exports (49%) from 2020 to 2030 (Figure 2.5).





Source: USDA (2021)



The forecast brings light to incremental production on **24% due a 17% increasing** in heads slaughtered and 6% gain of carcass weight and will correspond to a 15.7% of total beef produced around the world.

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Although the perspectives are pleasant at a first glance, **it demands push improvements on processes and technology adoption by all agents.** On production side, constant gains on efficiency will lead the activity and provide better quality to market, transparency, and repositioning production in consumers' minds. Inputs' companies, research institutes, universities, technical assistance, agricultural policies oriented to beef-cattle production are key for changing, looking for global institutions and their challenges.

Quality improvements and building reputation on international market are constant challenges for associations and organizations in this industry. The efforts to expand and open new markets have had positive signs. But diversification must be a target to avoid disturbances related to dependence. There are opportunities to pursue especially in Asia and Africa, where most of the countries are developing or least developed (Figure 2.6).



Figure 2.6 – Continent's consumption and production x Brazil

Source: OCDE (Outlook 2019-2028)

There are no missing opportunities for Brazilian livestock, **in line with projections and Brazil's capacity to catch up on producing more.** The main challenge now is doing that on a sustainable basis, which brings a new specification when it comes to production process by all agents, environmental and social responsibilities, among other indicators. Being sustainable in all dimensions is mandatory for the survival of food systems, not only beef-cattle one.

3. SOCIO-ENVIRONMENTAL CHALLENGES IN BEEF-CATTLE SYSTEM

The third topic emphasizes social and environmental aspects of cattle raising and beef sector in Brazil. It brings the main discussion around the world related to livestock production, deforestation, and consumption, mainly in the Legal Amazon, and discussions regarding the Cerrado biome.

Despite of the technical and technological advances in beef-cattle systems and its dynamics in Brazil, many critics have been placed to production and consumption due to the relation with deforestation and climate change. Also, it is considered an inefficient agribusiness due to the amount of land dedicated, degradation process that can cause, consumption of water and proportion of population fed.

Sustainability presents itself with three main axes – economic, environment and social. The economic aspect of this system could be observed through the evolution of technical aspects, as well as international market expansion, as explored in the previous section.

3.1 SUSTAINABILITY AND TRIPLE BOTTOM LINE– ENVIRONMENTAL, ECONOMIC, AND SOCIAL ASPECTS

In the discussion about sustainability, the Sustainable Development Goals (SDG) must have to guide the understanding of real picture and necessary improvements to be adapted. Beef-cattle system in Brazil, like other food systems, has a key role to play when it comes to nutritious food and food security (SDG 2 and 3). Bovine meat is a very rich source of vitamins important to human body and its development, especially the complex B. Some of them are not necessarily founded in other types of proteins, animal or planted based ones, like B12 (Comerford et al., 2021).

However, when it comes to environmental and social aspects, this system does not lack criticism. The basis for a rational debate on the main environmental and social challenges of the livestock sector in Brazil must be settled in reliable data that consider the patterns of livestock production today (2020). a brief comparison with the past (2000s) and projections for the future (2030), considering always the links with SDG 8 - decent work and economic growth, overviewed on the last topic about the importance for Brazilian economv: and SDG 12 responsible consumption and production, one of the basis for the approach of this topic.



Source: FAO



SOCIAL AND CULTURAL ASPECT OF BEEF-CATTLE SYSTEM

The culture of bovine meat consumption in Brazil comes from colonial times. It's part of the basic meal in domestic market (Wedekin et al., 2017). However, prices and income are the leading aspects that determines consumption, especially in developing countries and least developed ones. As it could be observed in the previous topic, the devaluation of domestic currency opportunities to exports opened associated with the lack of supply increase in several countries around the world.

Innovation and technology impact directly on prices if they lead to efficient modes of production and its rising. Brazilian protein agribusinesses are examples of changing consumption patterns due prices and technological advances. In 1970, bovine meat detained the majority share, 67% of total meat consumption, pork 24% and chicken 9%. Brazilians were capable to buy 7.9 kg of bovine meat for each 1 kg of chicken. In 2016, bovine meat consumption represented 38%, pork 14% and chicken 48%, and each 1 kg of bovine meat could buy 1.3 kg of chicken (Wedekin et al., 2017).

Chicken system incorporated advances and cost technological dramatically. Availability reduced increased and consumption raised over the time, but it doesn't mean that preferences changed for Brazilians. Going deep on domestic preferences for protein consumption, Figure 3.2 reveals that the population disposed to spend is more. approximately 1/3 plus, to buy bovine meat compared to chicken meat.



Figure 3.2 – Brazilian comparison between beef and chicken consumption (Kg/per capita/year) and spent (per capita/year)

Source: USDA (2021), IBGE (2021) and SEAB (2021). Elaborated by Agroicone



These simple analysis reveals the relation of consumer behaviour and income, their preferences shaped by culture that can be linked directly to SDG 3 about wellbeing, but must address the discussion on SDG 12 of responsible consumption, which is related to have balanced meals including most diverse types of food available. Knowledge about nutrition, availability and access are key to provide good solutions of consumption balance without neglecting cultural differences.

The bovine meat consumption behaviour in Asia, **especially in China**, ended up boosting exports like shown on previous topic – Figure 2.6. There are imbalances of production and consumption in the continent and the increasing of income of the last years allied to African Swine Fever that annihilated swine cattle, ended up for demanding bovine meat from Brazil. It's important to highlight that income increases can also lead to behaviour changes.

REGIONAL GROWTH, LABOUR, AND INCOME GENERATION

Agribusiness was a working force on Brazilian production expansion, nonetheless it was based on hunger combat (SDG 1) through giving access to safe food in affordable prices (SDG 2) as stated by Wedekin (2021) about the tropical agriculture revolution. Two analyses were conducted to explain the benefits of agribusiness expansion on Brazilian Cerrado. The first one was the Human Development Index by Municipality (IDHM) of 1,102 municipalities that are on Cerrado biome, which was 0.386 in 1991 and went to 0.671 in 2010. It was an increase of 73.8% in places where agribusiness is the main economic activity. In other words, agribusiness and its development bring well-being, healthy and generates work and development to a region where started to be developed, in accordance with SDG 2, 3 and 8.

The second analysis was based on food costs share on domestic consumption expanses, categorized by minimum salary between 1974-1975 to 2017-2018 (Table 3.1)..



Table 3.1. – Brazil: share of food costs on consumptionexpenses of family budget, by minimum-salary (MS) per month,in the period of 1974-1975 to 2017-2018 (% of total expenses)

Period	Total	Up to 2 MS	>2 to <3 MS	>3 to <10 MS	>10 to <15 MS	>15 MS
1974-1975	33.9					
1987-1988	25.3	44.1	41.3	34.6	28.7	21.3
1995-1996	23.4	35.2	37.1	30.2	24.2	20.4
2002-2003	20.8	34.5	31.9	24.8	19.4	15.1
2008-2009	19.8	29.6	27.0	21.7	17.3	13.8
2017-2018	17.5	23.8	21.3	18.2	15.6	12.6
Reduction (percentual points)	-16.4	-20.3	-20.0	-16.4	-13.2	-8.7

Source: POF-IBGE/ elaborated by Wedekin (2021)

Data turns clear the reduction of food expenses on family budget along time in Brazil, emphasizing that innovation efforts brought well-being (SDG 3) and sustainable consumption and production (SDG 12) to a country that was in its 1960s dependent on food imports. Food expanses on family budget share reduced from 44.1% to 23.8% in low-income social classes, evidencing the importance of agriculture advances.

Bonelli (2001) brings similar results through a different methodology to check agribusiness in economic and social impact. The author analysed data between 1975 and 1996 to check the dynamics of agribusiness and its impact on states' GDP and Human Development Index (in Portuguese – IDH) and its evolution. Results made clear that innovation and agribusiness improvement in Brazil brought social inclusion and economic growth.

Authors looked at the demographic dynamics associated to urbanization that brought new insights. On new cropping and pasture areas, demographic growth was superior even when national rural population was not growing. This leads to a conclusion that agribusiness growth led to urbanization development though services and establishment of local business to support regional demand. In terms of impacts, authors affirm that 1% of agribusiness income growth led to 1.07% in income in other non-agribusiness activities.

General analysis of agribusiness expansion and growth in Brazil shows its relationship with urbanization, development of support services that leads to employment of work force not directly in agribusiness, but generating income and well-being characterized by Human Development Index.



In terms of direct and indirect impacts of agribusinesses' sectors, Costa, Guilhoto and Imori (2013) using national input-output matrix of 2006 (updated to 2010 values) showed that a "shock" of R\$ 1 million on final demand of processed agricultural products (as bovine slaughter) brings impacts on the Brazilian economy, separated by direct and indirect impacts and income effect (Table 3.2). For each R\$ 1 million additional final demand on bovine slaughter generates 111 employments in the economy, increases Gross Product Value by R\$ 5.4 million and national GDP by R\$ 2.4 million.

Table 3.2 – Brazil: Direct and indirect impacts and income effect resulting from a "shock" of R\$ 1 million* on total demand of bovine slaughter

Variable	Direct and Indirect Impact	Income Effect	Total impact
Employment (numbers) Gross Product Value (thousand R\$)	62 3,084	49 2,359	111 5,443
R\$)	1,167	1,267	2,434

 R\$ 1 million on total demand represents only 0.0041% of bovine slaughter Value of Production in 2006 (in 2010 values).Source: adapted from Costa, Guilhoto, Imori (2013)

According to the authors, most of the impacts on this shock occurs on agricultural sector (primary production), then on own sector of the shock (bovine slaughter), but also impacts other economy's sectors, mainly GDP and remuneration of services' sectors and imports of agricultural inputs' sector.

When it comes to beef-cattle system, ABIEC (2020) estimates that 4.5 million jobs supply the entire supply chain in Brazil. Just considering farms and slaughterhouses, operations had 3.3 million jobs in 2019 and generated R\$65 billion in salaries (11% of beef-cattle GDP).

Even innovation employment on farms brings the idea of lack of human capital or establishment of the population in rural areas, this thesis can't be entirely applied. Innovation and development enforce to rural areas the need to new capabilities and human development to manage business in perspectives that leads to efficiency, boosting educational systems (SDG 4) to support development. Also, levels up employment in services, human capacitation, technical assistance, and supply industries that creates an environment of evolution.



THE IMPORTANCE OF SMALLHOLDERS ON CATTLE PRODUCTION IN BRAZIL

According to Garcia et al. (2021), the 2017 Agricultural Census presented its results based on Law No. 11.326 / 2006, therefore, in family and non-family farmer. The results revealed that Brazil has around 5.07 million agricultural producers, occupying 351 million hectares. Of these, family members were 3.90 million (76.8%), occupying 80.9 million hectares (23.0%), while 74% of it has livestock production and pasture is the main land use, with 39 million ha.

Considering total sales of cattle herd surveyed by IBGE Agricultural Census 2017, family farmers had 17% share in total (considering farms with more than 50 heads), while sales for other cattle ranchers for the purpose of fattening and reproduction represented 23.4% of the total animals sold. This reveals the importance of family farmers in the beef-cattle system in Brazil, with lower direct relationship with slaughterhouses.

The same authors also affirm that, in addition to its productive importance, family farming is also responsible for the occupation of more than 10 million people, representing 67% of the people employed in farms (15.1 million); of this, 8.8 million are related to the producer, that is, a family member, and family farming is still home to 32% of the total employed people without family ties with the producer, directly related to SDG 8 about decent work and SDG 10 about reducing inequalities.

These numbers alone reveal the importance of family farming for the Brazilian society and, also, for cattle production. However, family farming has several challenges, due to complexity and heterogeneity found in family production: poor socio-economic indicators, land distribution, size of farms, access to technology and insertion to markets (Garcia et al., 2021).

Other important indicators that result on low productivity, low income and, consequently, environmental degradation, is the fact that, in 2017, 87% of family farmers did not use limestone to correct the soil, essential input for at least maintaining pasture support capacity; 82% did not receive any technical assistance; only 14% accessed rural credit (IBGE Agricultural Census, 2017).

This calls attention to the necessity of innovation and technological inclusion to support constant growth of efficiency in their properties and construct coordinated supply relations to slaughterhouses with economic incentives and quality standards, otherwise it will continue discouraging smallholders and their successors to continue their activities and/or deepen environmental degradation.



Another sensible social feature that can be discussed is the inclusion of informal cattle producers. Those are all cattle ranchers that have some pendency with land use formalization of property rights and informal relationships with other producers. This situation can create barriers to traceability and informal slaughter or slaughter that couldn't be related to any type of sanitary system. Sustainable production doesn't bring only environmental issues, it also includes governance about land use and land property rights. These rights are important for control and monitoring from government and private sides, also are essential for the access to credit in banks and developing projects.



Informality along the system has been addressed by monitoring and projecting plans of inclusion of these agents. If Brazil has informal relations in beef-cattle system, full traceability won't be possible and this opens doors to opportunist behaviour with complex consequences, deforestation is just one of them. Majorly it settles population on vulnerable sanitary status.

ENVIRONMENTAL ASPECT: NATIVE VEGETATION PROTECTION LAW

The Native Vegetation Protection Law (Law n. 12,651/2012, known as "Forest Code") reflects a key policy instrument aiming to promote restoration of natural vegetation, curb illegal deforestation and regulate with a great degree of enforcement permitted conversion or legal deforestation.

The 2012 Forest Code have several amendments and regulations relate to the obligations to keep and restore Permanent Preservation Areas (so called APPs) and Legal Reserve areas (so called LR). The Code created a compliance process considering producers who deforested before and after July 2008, with specific rules for each. Producers must restore APPs and LR areas planting native species, promote natural revegetation if possible and, in the case of LR, compensate in remaining natural vegetation areas that would be legally eligible for deforestation in the same biome and state (compensation in different states would need to take place in priority areas and follow strict criteria).

In this regard, the compensation may become a kind of payment for environmental services, in which the owner will be paid to conserve the natural vegetation. Although the regulation related to the Environmental Reserve Quotas (Cota de Reserva Ambiental – CRAs) is not yet approved, there are different schemes aiming to build compensation markets in many states and promising to become an essential tool for environmental compensation and market incentive in the future.

The first step required by the new law is to enroll the rural property in the Environmental Rural Registry (Cadastro Ambiental Rural - CAR), an electronic registration website platform (SiCAR) that will comprise information about Permanent Preservation Areas (APP), Legal Reserves (LR) and if there is a vegetation deficit.

⁴ Available at: http://www.planalto.gov.br/ccivil_03/_ato2011-2014/2012/lei/l12651.htm

⁵ The APPs are spaces to be preserved both in rural and urban areas and its criteria vary according to the width of the river and water bodies, steep slopes, hilltops, and mangroves. On the other hand, the LR means a native vegetation area of 80% in the Amazon (50% in some cases), 35% in Cerrado areas in the North and 20% in other areas that must kept in rural properties.

Hence, for the first time in history the country will have a reliable and clear source of information describing the real scenario of natural vegetation protected by farms and the debt of APPs and LRs that will need to be restored, pass-through revegetation or be compensated in other natural areas (this last only in the case of LR cleared areas before July 22nd, 2008). However, rural properties need to be enrolled in the CAR.

CAR also can be used as a tool for landscape planning, for farm planning and for transparency regarding environmental compliance of Brazilian farms. The usefulness of the CAR in the future given the possibility to pass clear and reliable information about land use situation may become an important instrument for producers, industry, retailers, and consumers. Additionally, starting from 2019, producers without CAR are not eligible for public credit in banks. In Brazil, banks and government represent 90% of credit to agribusiness (Agricultural Census, 2017).

As the second step, the law creates the Environmental Compliance Program (Programa de Regularização Ambiental – PRA) defining specific rules to be followed for those producers that will need to comply with the APPs and/or LRs areas. Thus, restoration is the goal for compliance, and natural restoration (revegetation) where is possible; the LRs areas could also be compensated and 50% of the LR debt could be planted with exotic species for economic exploitation if some requirements are followed.

In most states, the PRA is far from operational. The PRA has only been effectively implemented in six states, with a fully operational system, signed commitment agreements, and plans for compliance being executed and monitored in APPs and Legal Forest Reserves. Of the states that had not yet effectively implemented the program last year, only Acre has advanced in 2020. As for the number of commitment agreements signed and in execution in the states, numbers range from 100 to 200 in Acre, Pará, and Rondônia; more than 500 commitment terms were signed in Mato Grosso alone. (CPI, 2020, p. 4)

It must be highlighted that the compliance agenda is a long-term policy, predicted to **last up to 20 years after each producer accede to the compliance process.** In light with the CAR process in the states, the approval of PRAs to base the compliance process and the start of restoration will promote a new dynamic on land use, mainly reducing pasture areas (Harfuch et al., 2016a).

GHG EMISSIONS AND SUSTAINABLE PRODUCTION IN BRAZIL

Brazilian GHG emissions' pattern has shifted in the last years. In 2005 emissions from the land use, land use change and forestry (LULUCF) sector represented **63.9% of the total emissions in CO2 equivalent** (Sirene, 2021).

In 2012, this number shifted to **14.9% due to deforestation reduction, and the energy and agricultural sector became the most important sector in terms of emissions, representing 34.7% and 39.7% % each.** Data from 2016 shows that LULUCF represented **27% of total emissions in CO2 equivalent**, but agricultural sector continued to be the most important one in terms of emissions, **representing 33%** (Sirene, 2021).

Methane (CH4) accounts for 63.4% and nitrous oxide (N2O) for 32.4% of the total agricultural emissions. It was a total of 487 million tons of CO2 equivalent registered in 2016, an increase of 2.3% in relation to 2015, and 5.1% related to 2012 (461 million tons of CO2 equivalent) (Sirene, 2021).

Residue burning, emissions from soils, enteric fermentation as the pushing activity for methane emissions (58%), where enteric fermentation from livestock represents 86%, followed by 11% of dairy cattle and 3% from enteric fermentation of other animals, manure, residue burning from sugarcane and rice. The main emissions of N2O come from agricultural soils due to manure from animals, the use of synthetic fertilizers and animals in pastures (MCTI, 2020). In the Second Communication to the UNFCCC (2005), Brazil highlighted a methodological aspect related to the accounting based on the Global Warming Potential (GWP) versus the Global Temperature Potential (GTP).

The GTP compares greenhouse gas emissions by means of their contributions to the change in the average temperature of the Earth surface in a given future time period and better reflects the real contribution of the various greenhouse gases to climate change. GTP would, thus, allow for more appropriate mitigation policies. GWP does not appropriately represent the relative contribution of the different greenhouse gases to climate change. Its use would overemphasize and erroneously stress the importance of greenhouse gases that remain in the atmosphere for only short periods of time, such as methane, leading to erroneously driving mitigation priorities. Exaggerated importance has been assigned to methane emission reduction and to some industrial gases that remain in the atmosphere for a short period of time, thus shifting the focus away from the need to reduce CO2 emissions from fossil fuels and to control some of the industrial gases that remain in the atmosphere for a long period of time." (MCTI, 2010, p.16).

The importance of the debate about measuring carbon balance with GWP and/or GTP is not new in the UNFCCC. The Intergovernmental Panel on Climate Change states "the most appropriate metric and time horizon will depend on which aspects of climate change are considered most important to a particular application. No single metric can accurately compare all consequences of different emissions, and all have limitations and uncertainties" (IPCC, 2013).

Therefore, it is important to situate the debate about the most appropriate methodology to account for short-lived GHGs. Livestock methane emissions are highly impacted using GWP considering its emission factor. The report of 2020 that brings data from 2016 emissions highlights this difference: total emissions using GWP was 567,043 and using GTP 198,043.

The Brazilian iNDC also highlights the importance of capturing the differences of GWP and GTP methodologies. The Fourth National Communication to the UNFCCC, that is about to be published, will also consider both methodologies. However, IPCC affirms that GTP metric is more adequate to be the base for public policies for GHG mitigation and climate change.

In parallel, it would be important to follow how Paris Agreement will affect land use, land use change and forestry and the agriculture sectors emissions balance and accounting. It is reasonable to say that soon Parties will adopt decisions considering methodologies and rules for detailed carbon accounting, which will cover pastures and livestock production.

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In Brazil, it is already possible **to notice improvements in methodological aspects related to GHGs in livestock.** Data organization and information for integrated analyzes at regional levels, the development of new assessment methods, the methodological standardization, and the creation of databases of emission factors for evaluation of life cycle accounting for the carbon footprint in cattle production systems and the Developing applications for production systems to allow the assessment of greenhouse gas balance and mitigation strategies of greenhouse gas emissions on farms (Baroni, 2015).

Along with the improvement of methodologies and GHG accounting, it is relevant to quote that the adoption of low carbon practices can have positive impacts on livestock production and other agricultural practices, in accordance with SGD 7, 12, 15 to promote clean energy, sustainable production and land conservation.

Brazil adopted the path towards a low carbon agriculture in 2010, as part of the National Climate Change Policy (Federal Law No 12,187/2009), which was enacted after Brazil committed to Nationally Appropriate Mitigation Actions – NAMAs, during the COP15 in Copenhagen.

The ABC Plan (Low Carbon Agriculture) is a sector plan for mitigation and adaptation of climate change, created by the Federal Government and managed by the Ministry of Agriculture. Among its several goals, there were specifically financial incentives for the 6 following most relevant actions to be accomplished until 2020⁷:

- Recovery of degraded pastures (15 million hectares)
- No till (8 million hectares)
- Biological nitrogen fixation (5,5 million hectares)
- Integrated crop-livestock-forest iLPF (4 million hectares)
- Planted Forests (3 million hectares)
- Treatment of animal waste (4,4 million m³)

To achieve such goals, it was created a special incentive/credit line, approved by the federal government (National Monetary Council – CMN), for financing sustainable technologies/projects, which offered 4.5 billion Reais in 2014 alone, with 5% annual interest rates. Through the ABC Plan is expected that a total of 197 billion Reais be used to finance low carbon agriculture projects during the timeframe 2011 – 2020, achieving up to 163 million tons of CO2e reductions until 2020. Results about the decade 2010-2020 of ABC Plan are expected until COP 26, they were not officially communicated. However, new goals are already part of Brazilian Operational Plan ABC+ (MAPA, 2021):

- Recovery of degraded pastures (30 million hectares)
- No till (12.58 million hectares)
- Biological nitrogen fixation (5.5 million hectares)
- Integrated crop-livestock-forest iLPF (10 million hectares)
- Planted Forests (4 million hectares)
- Agroforestry systems (0.10 million hectares)
- Bio inputs (13 million hectares)
- Irrigated systems (3 million hectares)
- Finishing feed termination (5 million animals)
- Treatment of animal waste (208.4 million m³)

⁶ Regulated by the Federal Decree No 7,390/2010

⁷ Federal Decree No 7,390/2010, Article 6.

8 CMN Resolution 3,896/2010.



The ABC Program was launched as the finance instrument to finance ABC Plan technologies and Forest Code compliance since 2010. However, despite the importance of the ABC Program as a GHG mitigation finance program for rural sector, from the beginning it faced challenges regarding regional disbursement/credit assessment concerning the time frame. It could be clearly identified a severe disproportion of disbursement and contracts signed among regions.

From crop seasons 2013/2014 to 2020/2021, the Center West and Southeast regions received 4.2 billion Reais and 3.9 billion Reais respectively, while the North and Northeast, which strongly need more support to develop their economies and reduce poverty, especially concerning rural population, received 2.3 billion Reais and 2 billion Reais respectively in the same period (SICOR, 2021). Those last regions increased the demand for ABC Program resources more recently.

ABC+ Operational Plan also relies on the Paris Agreement and the need to create an enabling environment aimed at promoting pasture recovery and good agricultural practices when it comes to livestock. The ability to measure GHGs reductions based on the Plan is also a cross cutting challenge that deserves attention.

Considering a mitigation potential of 6.78 tCO2eq/ha for pasture recovery and integrated crop-livestock-forestry system, which includes soil carbon stock variation, enteric fermentation, manure and nitrogen fertilization these actions might mitigate about 100 and 25 million tCO2eq, respectively (Observatório ABC, 2013).

Other studies, such as Economic and Social Implications (IES-Brasil, 2014) has included carbon content of forest in the iLPF system. This would lead an increase in mitigation potential of 106 tCO2e/ha in 20 years. According to Imaflora,

With the use of areas of degraded pastures currently existing in Brazil and the adoption of low-carbon practices, by 2030 it will be possible to meet the demand for agricultural products and reduce by 50% GHG emissions from the agricultural sector, without carrying out deforestation. Moderate intensification of livestock production, the use of no-tillage cultivation system and the implementation of IAFP systems are key to achieving this scenario. (Piatto et al. 2015)

Acknowledging that degraded pasture recovery and livestock intensification are the key drivers towards productivity gains, it is important to consider carbon sequestration from better pasture management, pasture recovery and practices as iLPF as parameters to measure the life cycle of beef production in Brazil.

These figures could be improved if carbon stocks from avoided deforestation due to increase of stocking rate in these areas (pasture recovery and iLPF allow more animals in the same area) are considered and related to the conservation and restoration under the Law on Protection of Native Vegetation (Federal Law No 12,651/2015). These factors will allow accurate GHG balances of agricultural production.



3.2. CHALLENGES FACED BY BEEF-CATTLE SYSTEM

Issues such as land use dynamics and policies, exclusion of minorities (indigenous people, local communities, and small producers), deforestation trends, engagement of the private sector and actions to address sustainability goals, GHG emissions and low-carbon agricultural practices, as well as a focus on continuous improvement are some of the topics presented.

LAND USE DYNAMICS AND DEFORESTATION

The interplay between conservation and production policies are at the forefront of the agriculture and livestock sustainability. In one side, conservation policies based on the National System of Protected Areas – SNUC, **represents 113 million hectares** (Ministry of Environment). Add to that, indigenous lands represent 118 million hectares.

Moreover, Guidotti et al. (2018) estimated that there are 185 million hectares of native vegetation protected on farms due to conservation requirements of the Forest Code (Permanent Preservation Areas – APPs and Legal Reserve areas) and 103 million hectares of remaining vegetation in private lands not covered by specific conservation policies.

On the other side, crop and planted forest areas comprise 77 million hectares of crops (just for the first harvest) and around 167 million hectares of pasturelands, which respectively represent 9.0% and 19.6%. Given the amount of available pastureland, the possibility to improve productivity through technology deployment, the availability of degraded areas to be recovered and the challenge to promote restoration of native vegetation, land use for agriculture and livestock will pass through an accommodation process in the next decades. Figure 3.3 represents land use in Brazil in 2020.

Figure 3.3 – Land use in Brazil (2020)

Brazil Total Area: 851 Mha 77 Mha 564 Mha of agriculture (1st crop) of natural vegetation and planted forests · 113 Mha of Protected Areas • 118 Mha of Indigenous Lands · 185 Mha of natural vegetation on farms (Permanent Preservation Areas 44 Mha and Legal Reserves) of urbanization · 103 Mha of remaining vegetation on farms and Other uses · 45 Mha of Other remaning vegetation 167 Mha Source: Agroicone based on IBGE - PAM (2020); Guidotti Source: Agroicone based on IBGE – PAW (2020); Guidotti et al. (2018); LAPIG (2020); Mapbiomas (2021). Ministério do Meio Ambiente/CNUC (2020) (excluding APA – Environmental Protected Area); Instituto Socioambiental – ISA (2020). Note: Calculations for all categories considered the best available data in 2020 of pastures



It's important to highlight that land use changes for agriculture and livestock in the coming years will come from three sources:

- The amount of pasture area that will be recovered (degraded pasture)
- The area of pasture that will be intensified (using different technologies from pasture plantation and management, passing using genetics, crop-livestock rotation and integration of crop, livestock and forest)
- The area that will be released by pasture to other agricultural activities
- Effective implementation of the Forest Code, requiring restoration of native vegetation

The expansion of livestock and agriculture does not depend on deforestation. The land use changes taking place over pasture will be key to allow a more efficient land use, considering productivity gaps. From 178 million hectares in 2015 it is estimated that in 2030 pasture area would comprise 161 million hectares, releasing 17 million hectares of land for crops, planted forest and restoration under the Forest Code.



Figure 3.4 – Pasture area and beef production in Brazil

Source: Agroicone using the Brazilian Land Use Model - BLUM, adapted from scenarios presented by Centro-Clima (2020)¹⁰

The livestock intensification and pasture recovery will also increase cattle herd productivity, that is projected to achieve, in average, 6 @/hectare in 2030 (from 4.2 @/ha/year in 2020). However, this process would rely on several issues as, for instance:

- Dissemination of knowledge about cattle herd intensification and its benefits to producers
- Adoption of good agricultural practices
- Perform rotational grazing and pasture management
- Improving access to rural credit enabling the investment of less capitalized producers and accelerating recovery process

¹⁰ Trend scenario developed by Centro Clima and partners for The World Bank initiative "Partnership for Market Readiness (PMR)" and delivered to Brazilian Ministry of Economy. Land use, forestry and agricultural sectors were simulated using BLUM – Brazilian Land Use Model, developed by Agroicone. Pasture area by technology (productivity gain per live animal in kg, per hectare and per year): low - up to 45 kg/ha; medium – higher than 45kg/ha and lower than 90 kg/ha; growing – higher than 90 kg/ha. See Harfuch et al. (2016b).



- Contracting technical assistance to implement intensification and provide funding for this type of assistance
- Encourage producers to make cost and revenue control of their properties and controlling efficiency of their product and employees
- Encourage producers to invest in capacitation of their team towards technological process and sustainable practices
- Support producers to comply with the Law on Protection of Native Vegetation
- · Improve the use of inputs and genetics

Deforestation in Legal Amazon has been increasing above the expectation on last five years. The connection done with beef-cattle system was direct due the increasing number of cattle herds (as well as soybean production), especially in the Legal Amazon (Figure 3.5). However, it can be also observed the systematic growth and developing system in times where deforestation was "in control" and trying to accomplish the international commitments. **Yet, Brazilian voluntary goal on reducing deforestation in the Amazon (reaching 3,900 km2)** was not achieved, and in 2019 and 2020 it has been increasing again since 2012 and closed the period with more than 10,000km2 (Figure 3.5).



Figure 3.5 – Brazil: Deforestation and cattle herd in the Legal Amazon

Sources: PRODES/INPE; PPM-PAM/IBGE. Elaboration: Agroicone.

The lack of deforestation control in recent years called attention around the world, not only to beef-cattle system, but especially because domestic institutions and international commitments were not accomplished. This occurrence calls attention on opportunistic behavior and deploys the ones that are following rules, laws and defending position to grow sustainably.



According to Arias et al. (2017), Brazil has increased agricultural productivity above other countries, doubling livestock productivity and multiplying by four crops' productivity. Same authors states that:

"Despite negative environmental claims of the Brazilian agriculture sector, which mainly involves deforestation and land degradation, the sector has contributed to reduce the pressure on natural resources over the past decades. Over the last 25 years, production has grown by around 90%, but thanks to technological innovations introduced – and increasingly taking into account environmental restrictions – the incorporation of new land was only 32%. This trend should be accentuated by the diffusion of climate smart agriculture (CSA) technologies and practices". (Arias et al., 2017, p. 20)

Additionally, it's essential to stress that private sector compromises to curb and control deforestation, the compliance process under the Forest Code, the strict control over illegal deforestation and the intensification process will be key drivers affecting land use and, specifically, pastureland dynamics in the coming years.

3.3. LIGHT IN THE DARKNESS – CAN BEEF-CATTLE SYSTEM BE SUSTAINABLE?

Beef-cattle system has already passed through a revolutionary history. From traditional to technological one, from a secondary activity to a rental and valuated one. And from the last fifteen years has been presenting itself as evolutionary in the sense of traceability and nature positive, fighting against deforestation. Figure 3.6 shows this system in an historical perspective.



Figure 3.6 – Historical perspective of beefsystem, deforestation, and traceability



Source: Agroicone (2020)



Milestones involving the evolution of domestic institutions and reordination of main agents of the system plays a great role and calls attention for a system that reacts and defend interests supported by private sector and science.

Although all this evolution, beef-cattle systems face a continuous challenge of reinventing itself to produce more, with less resources and time and into a low emission-based production system. Efficiency of total production has sustainable axes.

From recent official statements, this subject could be addressed as too dramatic since Brazil represents only 3% of total GHG emissions. However, the country is among the 10 biggest emitters and, as a Party to the Paris Agreement, has targets to reduce emissions, considering agriculture and land use as key sectors.

If beef-cattle system is considered one of the largest agriculture sources of emissions, it must be addressed the same way ABC Plan was created, based on science. Stepping on ABC+ is an advance to control and promote changes in land use, consequently beef-cattle system would pass through structural changes reflected on yield improvements and lower GHG emissions of the production systems. The recovery of degraded pasturelands, integrated systems with agriculture and forest, genetics and intensification are the basis for those changes.

The main objective is guarantee that beef-cattle emissions were compensated along the entire production cycle by forest growth, and that livestock production is based on managed pastures, pasture recovery and integrated systems. Forestry also improves animal well-being. The analysis was done in the Cerrado biome, Mato Grosso do Sul state, and will be tested in other biomes to be equally validated (Embrapa, 2015).

Integrated systems are Brazilian technologies, developed and implemented only in the country that were recognized recently by UNFCCC as climate change positive. Koronivia report on improving livestock production stresses the importance of spreading good practices like integrated systems because recoupling livestock and croplands result in carbon sequestration, enhance manure and nutrients management due to the process and spares natural resources. Other benefits can be placed as more efficient conversion, higher biodiversity, better animal welfare, reduced waste and dependency on external inputs and diversified income for farmers (FAO, 2020).

The importance of this milestone is that turns possible and tangible Embrapa's initiative to become an attribute of beefcattle production that can be coordinated and valuated by other agents of the system (for example: sghterhouses and supermarkets), as shown in topic 4.



4. THE FUTURE OF FOOD SYSTEMS

According to the FAO, between 720 and 811 million people faced hunger in 2020 and nearly 2.37 billion people did not have access to adequate food in 2020, an increase of 320 million people in just one year. The challenges to achieve food security and nutrition and to eradicate poverty (SDGs 2 and 1) were severely impacted by the Covid-19 pandemic, which puts stronger pressures to the goal of achieving food security to a growing population.

The Food System Summit (FSS) convened by the United Nations in 2021, generated an important debate about how to improve and transform the different segments of food systems, from the farm to the fork.

The global challenge towards food security and nutrition needs to consider four dimensions: availability, access, utilization, and stability (HLPE, 2020).

Availability of nutritious, healthy, and diverse foods depends on several factors, according to each country's realities and characteristics. Water supply, availability of productive land, access to technology and innovation, good agricultural practices, access to technical assistance and finance, among other factors.

Access to food relies on different aspects, such as availability, socio-economic conditions and levels of development, social policies aimed at delivering safe food to vulnerable populations, school feeding programs, urban agriculture programs, food trade, among others.

Utilization of food, for instance, has relation to how people are using their resources to ensure their livelihood, including food security. And stability means all three dimensions stable.

During 2021, the Food System Summit (FSS) process proposed a global debate on how to improve and transform food systems, considering 5 action tracks:



Ensure access to safe and nutritious food for all



Shift to sustainable consumption patterns



Boost production "positive with nature"



Promote equitable livelihoods



Build resilience to vulnerabilities, shocks, and stresses

Sources: PRODES/INPE; PPM-PAM/IBGE. Elaboration: Agroicone.



The connection of each action track with countries realities and challenges, and the debates that took place at the pre-Summit in July 2021, generated a global convergence among the need to foster resilient and improved agricultural systems as a basis to face climate change impacts over food security. **Coalitions for change emerged on the pre-Summit, 5 specific and 2 generals related with the 5 action tracks:** school feeding, zero hunger and nutritious, agroecology and sustainable systems, aquatic and blue food, and climate resilience. The general or transversal ones were income and decent work, and food is never wasted.

The Food System Summit, September 2021, accounted with the commitment of 155 State-Members. **More than 100 countries sent strategies of their local priorities to be implemented in the next 10 year.** About 2,500 game change solutions ideas were proposed to be developed along the same period. The 5 action tracks were grouped into 4 (Nourish all people, Boost scaling positive production with nature, promote equitable livelihoods and empower communities and Build resilience to vulnerabilities, shocks and stresses) and those 7 coalitions turned to be 26 linked to these 4 tracks.

Brazil is part of 5 coalitions:

Food is never waste, School feeding, Zero hunger, Global sustainable husbandry and zero deforestation and zero conversion of FS. All of them have connections with beef-cattle system, but it's important to highlight the last 2:



Global sustainable husbandry which the main objective is support decision-making at all levels for farmers and value chain oriented national / bioregional development of sustainable livestock systems.



Zero deforestation and zero conversion of food systems has as objective to bring together a broad group of producer and consumer countries, companies and national and international civil society organizations committed to working together to deliver food supply chains free from deforestation and conversion as part of a new model of agriculture that optimizes food production, it improves rural livelihoods and protects and restores the natural environment.

Antonio Guterres in 2021 FSS drew attention to the negative relationship between food systems and the emission of **1/3 of greenhouse gases and 80% of the loss of biodiversity in the world.** There is a need for solutions that change this perspective completely and at the same time are able to nurture people. He also points out that agriculture should be part of the solution for mitigating climate change and biodiversity loss, and a problem.

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Coalitions bring ways to achieve this goal. Main contributions discussed during the FSS can be summarized in the following points:

- Climate-smart agriculture can address the sector as part of the solution, not a problem. Technology and innovation adapted to local food systems can allow the reduction of GHG emissions and build resilience.
- Science and Technology as the base to transform and adapt food systems, jointly with technical assistance and capacity of producers.
- Reduction of food waste and loss along food systems by improving infrastructure, cold-chain access, and monitoring.
- School-feeding and breast-feeding coalitions for guaranteed health nutrition since early childhood.
- Protection of smallholders, indigenous people, forms of cultivation and land ownership rights, engagement in the inclusion of minorities, including women and their empowerment in financial matters access to credit, knowledge of techniques and technologies and better income.
- Financial assistance to implement technologies and promote change. Most least developed countries and developing countries doesn't have enough budget to include all producers in sustainable food systems, provide technical assistance and promote income.
- Water access scarcity and high temperatures, soil degradation leaves entire countries in states of constant vulnerability and dependence on imports.
- Fair international trade and equal conditions of production in all countries reducing subsides and barriers.

These main topics discussed during FSS and debated on national dialogues gives a notion of the principles that will guide food systems development and transformation for the next decade (2020-2030). The General Secretariat of the United Nations stated in its speech that food is not a mere commodity, but a right. She emphasized the need for government leadership and governance in their pathways, as well as resources and platform support at the United Nations.

Animal production, especially beef-cattle, is part of many forums that **includes climate change and deforestation, land degradation, water efficiency and health nutrition.** Beef-cattle production and its importance was highlighted by several countries. Latin American ones detached themselves – Argentina, Paraguay, Uruguay, and Brazil. In addition to those that suffers from the lack of animal protein and vitamins.



Photo: Fazenda Capão Redondo, Rodolpho Botelho





The debate was led to decarbonization of this system though sustainable technologies, integration with agriculture and forest. Brazilian National Pathways brings balanced objectives to agribusiness in accordance with work developed by public policies, private sector, research institutes and NGOs. Continuous and inclusive scientific research and innovation to promote and improve food systems. In Beef-Cattle system continuous R&D and innovations are the key for efficient and sustainable production. As important as the evolution of methodological measures of GHG emissions for these systems globally recognized.



Development of food systems adapted to local circumstances that encourage the reduction of greenhouse gas emissions and promote resilient agriculture. Linking livestock production to other systems by biome can be challenging, but a solution for adaptation process on creating sustainable food systems. Biomes and its characteristics need to be considered before constructing coordination plans for resilient agriculture and livestock production.



Agriculture as a solution for climate change. Livestock as part of an integrated system also can be a solution for climate change. Developing low carbon agriculture is the best solution for the entire system.



Promote the generation and use of renewable energy in food systems. Beef-cattle system is connected to biofuel generation though tallow and feed produced as co-product (as corn ethanol), but also can incentivize and coordinate the adoption of renewable energy along the chain.



Support smallholders and family farming to promote sustainable livelihoods and food diversification. Husbandry isn't an exclusive large farm size activity. Smallholders and family farming are part of this chain, and it can be more information about their supply. Also, coordination mechanisms can diversify linking aid for land use problems and social inclusion, as well as technical assistance for promoting integrated systems.



Ensure safe, healthy, and nutritious food for everyone. Beef is one of the richest sources of complex B of vitamins, especially Vitamin B12. Ensuring availability and access to a safe, healthy amount of meat is desirable of the population to ensure nutrients and well-being.



Combat food waste and loss. Beef is one of the most expensive goods for consumers, avoiding waste and loss implicates in providing safer products for them. Coordination of process between producers and processors can avoid loss during slaughtering. Training adequately supermarkets and specialized establishments for proper cutting can also avoid loss. However, one of the main issues that needs to be improved for avoiding beef waste is the cold chain logistics. It's important for proper transportation and storage and ensure safe and healthy product.



Fair trade. Beef-cattle system is one of the most protected on international trade. Sanitary barriers or tariffs are part of the repertory. Promoting fair trade when system follows international standards must be placed.

Concerning beef-cattle system, ABC+ Operational Plan, is the main public policy to incentivize pasture recovery, **integrated production systems and efficient livestock production that allows to reduce emissions.**

Another subject related to Beef-cattle system is deforestation, biodiversity loss, land property-rights and climate change. This agenda has many institutional aspects like the enforcement of Forest Code in Brazil and the detachment of beef production as highlighted on topic 2. Brazilian livestock increases undependably of deforestation (Figure 2.9), but it doesn't mean that this industry can't contribute to all these topics in positive ways by boosting efforts and joining forces with other systems to provide agriculture as a solution and not a problem.



Looking for this picture and Brazilian National Pathways to develop Sustainable Food Systems, tendencies are:

- Partnerships of private and public sector for research and development of positive technologies to beef-cattle production in decarbonized systems.
- Promoting capacity of producers, processors, technical to work with these technologies and spread to all farm types and sizes.
- Improving communication and information about the system processes from farm to fork and promoting transparency.
- Appreciation on environmental and social assets and communication to market, not only production efficiency and economic assets.
- Including small farmers and communities on sustainable beef-cattle production systems, technologies and technical assistance as well as helping with land property rights and environmental knowledge leading to biodiversity preservation and conservation on Brazilian biomes.
- Coordinated actions of the entire system to avoid food loss and waste, as well as resources uses (land, water and its reuse).
- Boosting international trade and opening new markets, fairly, based on nutritional necessities also.

Trends appreciated on Food Systems Summit and pictured in Brazilian National Pathways corroborate with research done previously by State of São Paulo Industry Federation (FIESP) in 2017 about Brazilian food consumers' behaviour. One of them is prioritization of cheaper products when national economy faces crisis and income decreases. This leads to cooking at home with more frequency and choose to prepare food instead of buying semi-prepared one.

Another aspect is about information and sources that people look for knowledge. Internet dominated as a main channel, instead of TV, as it was pointed in the first research in 2010. The topics that were substantially more searched between 2010 and 2017 were: organic food (26 p.p.), sustainability (21 p.p) and carbon emissions (14 p.p.). Food was the third subject most researched on google between 2011 and 2016. In 2017, it lost one position to finance.

Some contradictions were pointed as 81% of interviewed people confirms to look for better ways to improve their feed and 71% doesn't bother to pay more for healthy products. However, 61% confirms that tasty drives their food choices instead of healthiness and 52% says that healthy food doesn't have much taste. The research also revealed that there is a difference between feeding (healthy food during the week) and eating food (tasty food during the weekend to enjoy). Beef is in third place as Brazilians' favourite food, just after rice and beans (basic daily food in Brazil) and pasta.

Figure 4.1 transcend the first analysis and brings tendencies of food consumption in Brazil. This can be idealized as a step ahead or what's coming for the future of food system from the demand side. Ageing of population needs, new generations values, origination and social appeal, convenience and practice are drivers for changing food consumption and habits. However, income and middle-class growth will drive those changes' speed.

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FIGURE 4.1 – FOOD CONSUMPTION: DETERMINANTS AND HABIT CHANGES



Finally, when it comes the two pictures (supply and demand sides) to beef-cattle systems as stated by Malafaia et al., (2021), global advances in the beef supply chain by 2040 will come from highly technical, professional, and competitive livestock production, based on technology and quality. For Brazil, the authors concluded the following megatrends:

"(i) biological advances and waste management; (ii) biotechnological transformation of beef farming; (iii) less grass and more meat; (iv) profits based on animal welfare; (v) consolidated livestock with major players; (vi) more natural and quality-demanding slaughterhouses; (vii) meat with a designation of origin; (viii) digital technology that transforms the entire supply chain; (ix) availability of quality labor; (x) Brazil as a major exporter of beef and genetics". (Malafaia et al., 2021).

5. INDUSTRY'S POSITION TO DEAL WITH SOCIOENVIRONMENTAL CHALLENGES

This topic emphasizes the **big role of the beef processors on coordinating beef-cattle system and its limits.** It brings some concepts of the system dynamics and coordination and how the processors are reacting to the challenges concerning socioenvironmental issues and pressures. This topic aims to be a connector to the next one, bringing a few concepts.

5.2. AGRIBUSINESS SYSTEMS AND DYNAMICS – THE ROLE OF COORDINATION ALONG A SYSTEM

The origin of **"Agribusiness System Analysis"** comes from the concept developed in Harvard University up to the beginning of the sixties as:

The sum of all operations involved in **manufacture and distribution of farm supplies, production operations on the farm, and the storage, processing, and distribution of farm commodities**. (Davis & Goldberg, 1957)

The analysis is rooted on two main elements (Zylbersztajn, 2017):

- Agriculture is treated as an isolated sector, became part of specialized interdependent system of agents that operate in interconnected industries.
- The value added at the farm level tends to decline through time as a share of the total value of production, with serious strategic consequences.

Goldberg was the first academic specialist to stress that margins are larger as the product approaches the final market destiny. The model developed highlights the inter-sectorial connections. It's implicit in his studies the assumption of costless operation of markets and frictionless interactions among sectors, institutions being absent.

The conceptual model opened a new door of possibilities to look agriculture towards strategic issues. Several case studies were done around the world observing systemic analysis. Beefcattle system analysis and strategy were conducted by Lemos & Zylbersztajn (2017). Its importance for the development of the system was the main theoretical finding (Lemos & Zylbersztajn, 2017) of an industry were agents behaved against each other for decades (Wedekin et. al, 2017). Also shed light on the different strategies conducted by the biggest slaughterhouses in Brazil to be able to attend different market demands (Lemos & Zylbersztajn, 2017).

However, the importance of this type of analysis is not only to respond to market demands or institutional shocks, but it also shapes strategies to evolve the entire supply chain due coordination efforts. Looking the entire interaction of agents along the system and how institutions and non-private organizations influence them is a challenge for any agribusiness. Less developed ones in technology and innovation support, human capabilities and strong and established institutions can be more challengeable.

Beef-cattle system in Brazil faces these challenges due the origins of production and its complexity. There are many variables to be analysed that influences the final product delivered to slaughterhouses: genetics, internal sanitary system (inside the farm), feeding system adopted, production phases developed by the producers and their suppliers, level of information about producers and their suppliers. Some of those characteristics were listed by Lemos & Zylbersztajn (2017) in a study about quality-perceived standards on international and domestic markets.

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Called by specific assets or beef-cattle attributes, they are the one that shape product strategies and governance structures along the chain (Lemos & Zylbersztajn, 2017). Through coordination those attributes are measured, controlled, and valuated along the system creating a financial and attribute information flux.

5.3. BEEF-CATTLE SLAUGHTERHOUSES – THE IMPORTANCE OF THEIR COORDINATION TO THIS SYSTEM AND ITS IMPROVEMENTS

Beef-cattle system are coordinated by slaughterhouses (Lemos & Zylbersztajn, 2017). They are the agents that demand **specific assents on their transactions with producers, translated into animal attributes.** Coordination "movement" is done and shaped by settling requirements, transparent monitoring and control of results and incentives (economic, status of development and other rewards).

Coordination has several positive results and generate positive externalities to the entire system. The research conducted by Lemos (2017) with three main slaughterhouses demonstrated that:

- Coordination was done through quality programs created by slaughterhouses and producers responded positively to the demands of attributes and economic incentives.
- Technologies were progressively adopted by producers to "be part of the programs and standards". Technologies related to genetics, nutrition, and sanity, as well as process to animal well-being were adopted and standardization of products became a reality.
- Patterns of supply made possible for slaughterhouses to promote brands in domestic market, linking organization's strategies to product differentiation.
- Quality patterns and systems especially coordinated (one example is organic beef-meat) could be observed in domestic market not only done to attend requirements of international market.
- It also could be observed a better relationship between producers and processors and understanding their interrelation.

Positive externalities can be related to good results coming from private sector coordination:

- It boosted technologies and low carbon beef-cattle production through integrated systems programs or recovery of pastures (see Plan ABC and ABC+).
- Improvements on quality patterns lead to open new markets and explore different strategies on domestic market. Organizations could focus efforts on their targets, not only attend the "mass".
- Differentiation was possible through information exchange and transparency between all agents.

Marfrig



However, transacting tangible attributes and promoting a positive relationship with producers that lead to an informational and financial flux was part of 15 years of development "plan" and didn't contemplate bureaucratic attributes as mandatory (only production to attend the European Union, mainly sanitary standards). Controls demanded were also valued differently, but they never represented a major part of beef-cattle system dynamics, being considered strictly coordinated to attend a specific market.

5.4. MAIN CHALLENGES FACED BY SLAUGHTERHOUSES TO DEAL WITH SOCIOENVIRONMENTAL ISSUES

When it comes to socioenvironmental aspects and requirements, system coordination gains another dimension. Challenges presented in previous topics have great interfaces with public domain, as enforcement of land use, plan and regulation.

On the other hand, taking responsibility for monitoring suppliers and enforcing transparency from both sides is a win-win partnership to provide information to consumers, markets, government, inclusion of stakeholders and promoting coordination of sustainable standards.

The conceptual debate about the role that slaughterhouses have on sustainable patterns of production brings to play ethical, sociological and governance aspects. It can lead to boost efficient and sustainable ways of production that have positive results on productivity, reducing GHG emissions and deforestation.

But mainly this coordination brings moral to the debate of beef-cattle consumption and environmental efficiency. The challenge is not about doing or not, cooperating or not, it's about the survival of a system if transparency, information and decarbonization is not promoted as mandatory to humanity well-being.

Slaughterhouses have a great importance due to their coordination role, but it's not their full responsibility of the industry to accomplish socio-environmental goals. Seeing as a big picture, partnerships between public and private sector to enforce sustainable requirements must be done to evolve all the agents and secure Brazilian Beef-cattle industry.

That way organizations, especially slaughterhouses, can strategize in their market and develop control mechanisms aimed at meeting specific demands. Transparency and communication should be a public right in this case. Next topic and final one, brings the case of Marfrig, one of the largest slaughterhouses around the world. This case calls great attention from coordination perspective because this organization turned the concepts of sustainability and environmental protection into tangible assets to be controlled, measured, monitored, and coordinated through incentives along the system.



6. MARFRIG'S SOCIO-ENVIRONMENTAL STRATEGY

This last topic brings Mafrig's strategy and positioning about environmental challenges and its role as a chain coordinator. By an historical perspective, a narrative will be constructed about the "problem" and "strategical movements" that the company designed along the years and will culminate in "Marfrig Verde+Plan". An entire section should be dedicated and designed about Mafrig Verde+to explore transparency, rational behind, data about producers connected to the company and those that are not yet monitored. The last section of this topic brings the discussion of how to include the excluded, addressing problems and anticipate new ones.

6.1. MARFRIG'S STRATEGY AND POSITIONING

Marfrig is the largest hamburger producer around the world and one of the leading beef companies as well. It holds units in South and North America with a daily capacity of 31.8 thousand slaughtered cattle, in Brazil this capacity is 16 thousand cattle/day; and a total production capacity of 232 thousand tonnes of hamburgers per year. The company employ more of 30 thousand people nationally, distributed in 32 production units processing beef-cattle products and subproducts as leather for domestic and international markets.

In 2020 the company net revenue was **67.5 billion reais**, **35.3% more than 2019.** Marfrig is well known by being a leading company in coordination for quality of its products and its more recently sustainable performance due being pioneer in several projects on the preservation of the environment and natural resources.

(V) Marfrig

MARFRIG POSITION AGAINST DEFORESTATION

Cattle production has historically been perceived as the sector with the greatest impact on Brazilian forest and biodiversity loss. Responding to the growing environmental concerns internationally and domestically, Marfrig's ambition over the last ten years has been to incrementally decouple its products from deforestation.

Since 2009 and following on agreements with Greenpeace and subsequently with the Brazilian government, Brazil's major meatpackers (including Marfrig), have been working on strengthening their cattle procurement procedures to reduce environmental and social risks from their supply chains. Along more than 10 years several partnerships, projects have been developed, the main objective is to construct a sustainable beef-cattle system through private coordination.

Government and private sector efforts have supported an impressive decline in Brazilian Amazon deforestation trends throughout many years, however cattle raising are still perceived to be at the centre of deforestation, not a consequence or one of the possible causes.

Deforestation rates in the Brazilian Amazon have in fact risen since 2012, and even more significantly since 2018 (Figure 2.8), but beef-system never stopped off risen even when deforestation was under control, efficiency plays a great role and coordination programs are leading figures, as Marfrig Club.

On a historical perspective since 2009 Marfrig has developing several strategic plans to improve sustainability on its coordinated system. From the beginning, assumed commitments and stated strategizing actions based on data monitoring, investments on science to develop low carbon or neutral carbon beef. Figure 6.1 shows an evolution of plans, actions that translate companies' perspective about sustainability as a strategic and specific asset with high value.

Figure 6.1 – Marfrig's strategic investments on sustainability





Until 2019 timeline shows clearly actions for controlling the origin of cattle in the Amazon biome. By 2020 ahead, strategic governance and transparency plays a major role. Results from investments done on science and coordination with producers can be observed and a new product "beef carbon neutral" is launched on market, as well as, green credit, organic beef production certification by USDA, among others.

Marfrig Club Program incentivizes producers to adopt good livestock practices, which contributes to sustainable development of farms and guarantees safer production with less environmental resources. Launched in 2010, it has three dimensions: animal respect (traceability, animal wellbeing, nutrition, and sanity), environmental respect (preservation of native vegetation, soil and water, waste treatment), and social respect (labor laws, housing conditions, health and incentives). Available at: https://www.marfrig.com.br/en/sustentabilidade/controle-

de-origem/cadeia-produtiva

6.2. MARFRIG VERDE+ PROGRAM

Marfrig Verde+ Plan was launched in July 2020, in partnership with IDH - The Sustainable Trade Initiative. Its objective is to ensure that **100% of the company's production chain is sustainable and deforestation-free until 2030.** In other words, a system that is positive with nature and climate smart.



Eliminating deforestation throughout the supply chain is quite new in this industry, not only because other private companies couldn't achieve it, but mostly because a great deal depends on the enforcement of the law – Forest Code and other illegalities in private areas. This brings to questioning the limits of private coordination on avoiding deforestation.

What distinguishes Marfrig's commitments is the conviction that for achieving zero deforestation on entire chain, as the company desires, such change needs to become systemic. In other words, the company should not limit itself to excluding those ranchers involved in deforestation from its supply chain (partially due to the issue of leakage mentioned above). The company intends to bring the non-compliant suppliers on a pathway towards more sustainable production models.

Marfrig ultimately commits to achieving a deforestation free supply chain in the Amazon Biome by 2028 and in the Cerrado Biome by 2030. (Marfrig commitment)

By deepening its traceability systems (monitoring) and strengthening 'purchase and compliance' mechanisms (control), the company believes that for change to happen, it needs to be channelled through a process of inclusion, continuous improvement, ultimately leading to compliance for these suppliers. By different tools and innovations, coordination will be placed again by the company to get **"sustainable asset"**.



In other words, Marfrig is contributing to improve availability and access to nutritious food (SGD 2) through sustainable ways of production (SDG 12) and boosting adaptation of beef-cattle system to a zero emission to avoid climate change (SDG 13). Indirectly can be also related to better use of land and its conservation (SDG 15) and decent work, economic growth (SGD 8) since the system is quite important for Brazilian economy. Other relations can be deepened between SDG and beef-cattle system improvements, but the most important for the plan to be highlighted are those, based on the three main solutions:



Financial Mechanisms: attract investments for farmers to implement Forest Code, intensification systems of calves using integrated systems with crops and forestry, payment for environmental services and maintenance.



Technical Assistance: support change on farms through nutrition, genetics, sanity, environmental conformity. It also rellies on implement "carbon neutral protocol" and "low carbon protocol" on farms.



Monitoring Indirect suppliers: creating a close connection with suppliers, Marfrig intend to mitigate deforestation risks. The long-term view of plan implementation is to have 10 years to approach the full sector following the steps and goals:

- **Direct suppliers (until 2025):** Expand the purchasing policy and monitoring other biomes, promote integration livestock systems for all sizes and stages of production.
- Indirect Suppliers (until 2025): Develop mechanisms of control to indirect suppliers under an
 inclusive approach supported by a technical assistance network and financial mechanisms,
 promote better conditions to small and medium producers to be included.
- Industry approach: Coordinated efforts between producers, slaughterhouses, retailers, banks, investors and society to promote equality on the market and also avoid risks of opportunistic and illegal behaviour.

Figure 6.2 – Shows the links between these main goals to obtain a sustainable beef-cattle system, SDG goals and their steps of implementation





As a result, Marfrig plans to eliminate all illegal deforestation by 2025, and eliminate all legal deforestation among indirect suppliers in the Amazon Biome by 2028, and in the Cerrado Biome by 2030. (Marfrig Commitments)

6.3. THE CHALLENGE – INCLUDING THE EXCLUDED

Since 2009, Marfrig has accomplishing the monitoring of direct suppliers in the Amazon biome for the following socio-environmental indicators as **mandatory from Federal Public Prosecutors (Imaflora, 2020):**

- Rural Environmental Register CAR
- Farms' perimeters without overlaying Conservation Units and Indigenous Lands
- Zero illegal deforestation in the farm since August 1st, 2008
- · Zero deforestation (legal or illegal) in the farm since October 5th, 2009
- No slavery alike work in the farm
- Environmental embargoed areas, by federal agencies (and a few state agencies)
- Environmental licencing register in a few states
- Farmer needs to present the GTA Animal Transit Guide for the slaughterhouse

When the producer does not comply with at least one of those requirements, Marfrig cannot by cattle from her/his farm. So, the producer is excluded as a (direct) supplier of the slaughterhouse.

Excluding farmers involved in deforestation from its suppliers' base would only put an end to the problem for the company's supply system, as those farmers will have more incentives to continue deforesting or doing some illegal activity. Systemic and effective change demands inclusion mechanisms of these farmers.

Marfrig Club, an acquisition program launched in 2010, fostered the relationship between cattle producers and the company. The club is used as a platform to support knowledge sharing and promote incentives-based schemes for improving environmental and social practices. Nowadays, Marfrig has 100% of direct suppliers from the Amazon biome registered in Marfrig Club by the end of 2020.

The inclusion-based approach is the expansion of the company's zero deforestation procedures to indirect suppliers obtained through the establishment of a network that targets small and medium producers to provide technical assistance and finance mechanisms for the implementation of the farm level changes, as already explained.

Inclusion of small and medium farmers will be connected to the improvements of several SDG bringing to reality the balance to social, economic, and environmental axes of sustainability. They also allow Marfrig to improve supplier's ability to comply to its policies. The inclusion is not only about direct suppliers (1), but mostly about the indirect ones (2), which the company doesn't hold any relationship.





Marfrig buy its cattle for slaughtering from approximately **5,525 direct Amazon Biome suppliers in 2019** (including the state of Mato Grosso, Para, and Rondônia). For these direct suppliers, the company's vision is to establish new forms of relationships that support a more organized chain, through the development of a commercial integration model. This group doesn't seem to be Marfrig greatest worry, especially because they won a solid base of farms that represent their 80% slaughtered on the biome interested in advance that Verde+ Plan proposes.



Based on its RFI tool, which requires information of indirect suppliers from the producers that sell cattle to Marfrig (direct suppliers), the company estimated that it currently has potentially 25,000 indirect suppliers in the Amazon Biome without any relationship established. This is a serious risk for the company and entire industry itself. Marfrig's intention is to track the origin of livestock at farm level and throughout the various production levels (from breeding to the slaughterhouse), in the Amazon and the Cerrado (i.e. 'Origin control').

According to Marfrig, in the Legal Amazon, in 2020, 17,830 farms were monitored (area of 30.3 million hectares), in which 3,603 farms (20.2%) were blocked, and could not sell cattle to Marfrig. In 2021, with solutions and actions as technical support for documentation, multitemporal geospatial technical analyses and forest restoration program, 1,139 farms were reinserted to the Marfrig supply chain, representing 193,660 animals slaughtered (or 15% of yearly slaughtered animals in the Legal Amazon).

The re-insertion of those producers brings not only more suppliers to the company, but specially reinforces their compliance with socioenvironmental criteria, reduces informalities on selling those cattle in the market and, also, removes these producers from illegality.



Using evidence on socio-environmental variables associated with cattle production and land use, the company is using risk maps to strengthen the monitoring system, guide and tailor solutions by region to the commercial conditions set forward to suppliers. If indirect suppliers address legal and/or illegal deforestation, and social aspects in the Amazon and the Cerrado biomes, acquisition policies get improved. The final intention is achieving "Origin Control" in both biomes up to 2030 aligned with technical assistance and financial instruments to make possible that small and medium farmers afford transformation in their production systems.

The greatest challenge of including the excluded is what will provide a turnaround to the company strategy and market position. On the industry level, it's expected that similar action plans are holder to take care of the same issues.

On the other hand, this battle is not a one side approach, it needs to have support of several stakeholders to be a win-win process. Plenty of them are already aligned and allied to Marfrig's cause, as partners in the following initiatives: Monitoring Protocol of Cattle Suppliers, Reinsertion and Monitoring Program in Mato Grosso state, PCI – Produce, Conserve and Include Institute in Mato Grosso, Sustainable Calves Production Program, Conecta monitoring tool (block chain pilot application), beef production protocols (as low carbon beef, carbon-neutral beef). Other partners are working on risk mitigation maps, improving Marfrig Club Protocol and socioenvironmental monitoring system.

The stablished governance is an example of how coordination and incentives can bring positive socio-environmental externalities for all stakeholders and transformational changes for the industry.

7. FINAL REMARKS

Beef-cattle is a relevant supply system to Brazil and, also, other nations involved. In terms of net contribution to GDP and workforce, develops the SDGs 2, 8 and 12.

On the demand side, it is in the cultural root of Brazilian agribusiness and consumer behaviour. Beef is a protein rich in vitamins to human development, especially B12, important for growth, health improvement and well-being.

Historically, beef-cattle production was the main activity developed in the countryside, with a role to occupy the territory. Along time, Brazilian beef improved its sanitary system, which was essential to be a major exporter.

The urgency of climate change actions brought challenges for food systems globally. Brazilian beef-cattle system is seen as a source of environmental degradation, linked to GHG emissions and deforestation.



Public policies provide pathways for low carbon agricultural production. ABC Plan (from 2010 to 2020) and ABC+ (2020 to 2030) strengthen mitigation and adaptation technologies and practices. However, total implementation is far from the actual picture.

Since 2009, Brazilian beef-cattle system implemented zero deforestation commitments in the Amazon biome, using geospatial monitoring tools. Up to 2019, the main action from the industry was excluding farms and producers non-compliant with socio-environmental attributes.

Slaughterhouses are the main coordinator or leading companies on orchestrating change in this system since quality standards to sustainability compliance. The case of Marfrig illustrates this change, through creating control and compliance mechanisms, as well as incentives for sustainable beef-cattle production.

The company launched Marfrig Verde+ with the commitment of zero deforestation and including the producers' excluded from the supply chain, planning to achieve those goals in the next 10 years. This is a positive example of how to transform a food system in a sustainable pathway, with positive impacts in the entire industry.

First because it will support smallholders and medium producers non-compliant with sustainability attributes, bringing them to the formal supply chain and eliminating illegalities. Second, it will provide knowledge, technical assistance, and combat deforestation. Third, it will bring legitimacy and transparency to all stakeholders, including consumers.

Finally, with positive incentives and coordination, it's possible to have a sustainable beef-cattle system to supply a growing population around the world by assuring that this one is built based on social and technological inclusion and environmental compliance. As a result, the industry does not need to face exclusion from food systems, as has been defended by many agents.



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