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**Brazilian Competitiveness and Food Security  
in the Animal Production Global Market**

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## **Brazilian Competitiveness and Food Security in the Animal Production Global Market**

**Gustavo Bittencourt Machado**

### **Abstract**

In the world, Brazil is an agricultural potency and a great producer in the animal global market. The country is the first exporter of chicken meat and other its industrialized foods; is the second one in the bovine meat and its industrialized foods and the biggest livestock in the world. It is the fourth exporter of swine meat and has enormous potentialities to extend its fish production from aquaculture production to feed its population and to export. Brazil had become a big player in the commodity markets. The classical and historical modernization process is accepted in Brazilian literature, with agricultural credits and agricultural research since the institution of the Empresa Brasileira de Pesquisa Agropecuária (Agricultural Research Brazilian Company), in 1972, as a public enterprise that has grown quickly, becoming the main agricultural research organization in the tropical zone. The Embrapa has developed various technologies for different production systems in the Brazilian diversity of ecosystems and biomes, including, equatorial and tropical forests (Amazon Forest e Mata Atlântica), caatinga (steppe), cerrados (savanne), Pantanal Matogrossense and Pampa Gaúcho, fields for cattle breeding systems. The country became an important producer of honey and *propolis* and exports them. The agrarian structure continues to be concentrated so this modernization is known for some researcher as conservator modernization that did not modified the land concentration. This modernization was possible by the green revolution with all technological packages, maintaining the best lands for the big producers. Brazil is the one of the main soybean producer in the world.

**Keywords:** Agricultural Modernization, Agricultural Research, Competitiveness, Food Security.

## **Introduction**

In the world, Brazil is an agricultural potency and a great producer in the animal global market. The country is the first exporter of chicken meat and other its industrialized foods; is the second one in the bovine meat and its industrialized foods and the biggest livestock in the world. It is the fourth exporter of swine meat and has enormous potentialities to extend its fish production from aquaculture production to feed its population and to export. Brazil had become a big player in the commodity markets. The classical and historical modernization process is accepted in Brazilian literature, with agricultural credits and agricultural research since the institution of the Empresa Brasileira de Pesquisa Agropecuária (Agricultural Research Brazilian Company), in 1972, as a public enterprise that has grown quickly, becoming the main agricultural research organization in the tropical zone. The Embrapa has developed various technologies for different production systems in the Brazilian diversity of ecosystems and biomes, including, equatorial and tropical forests (Amazon Forest e Mata Atlântica), caatinga (steppe), cerrados (savane), Pantanal Matogrossense and Pampa Gaúcho, fields for cattle breeding systems. The country became an important producer of honey and *propolis* and exports them.

Recently, the world agriculture is changing based on biotechnologies, nanotechnologies, information technologies, precision agriculture, with the augmentation of patents and geographical indications. Brazilian agriculture is the result of cheap natural resources exploration with successive technological and organizational innovations in the agricultural production systems (BUAINAIN and GARCIA, 2015).

The problem is to combine the animal production expansion and the environmental restrictions, mainly in the Amazon Forest and Cerrados. The productivity augmentation is the target of the researches aiming to avoid the space deforestation. This target consists to combine the environmental and economic approach, typical of the double green revolution that signifies to increase the agricultural productivity with the environmental conservation guidelines. Embrapa develops researches based on green revolution historically, biotechnologies (tendencies), agro-ecologies (tendencies) and double green revolution in less scale in the whole of researches. The private enterprises has increased its participation on agricultural research in the world and particularly in Brazil, offering biotechnologies and machines for the farmers, so the public participation in these markets had decreased.

## **The Brazilian Agribusiness Expansion during the Last Years in the World**

Brazil is known as an agricultural great country in the world. The agricultural production has modified since the last seventy years, changing Brazilian position from food net importer to food net exporter because of several technological innovations in the sector and the big land extension, combining natural resources, the biodiversity and technological innovations.

The country doesn't lose its agricultural characteristics, but its economic structure changed, leaving from an agricultural country condition to an industrialized country. The main export products are not agricultural goods only, but agricultural and industrialized goods. The export products continue to stay in the main positions in the export agenda, considering the soybean, and the animal protein, from bovine meat, chicken meat and pig meat and its industrialized products.

The country has solved the offer production problem in the agriculture with the appearances of the agro-industrial complexes and the agro-industrial system consolidation, but between the 2003 and 2014 years, since Lula Governments, combining an efficient economy and social policies mainly, when the Brazilian population income has increased in real terms, giving a demand capacity of animal protein, resolving the food security problem, almost eliminating the hungry and the extreme poverty. Brazil has left the FAO's Hungry Map in 2014.

## **Methodology**

This paper develops a methodology based on the secondary data from official reviews on animal production and food security related to the country. It does a historical approach about the economic data about the animal production and export in the world, its tendencies and the recent victories to eliminate the hungry in the country, considering the agricultural researches and the organizational capacities to mobilize the people and the public sector to assure a food security.

Therefore, the methodology combines statistical numbers with analysis about agricultural production and export in this period specifically between 2003 and 2016, but considering the agricultural innovations, the rural changings and the agribusiness consolidation since the 1970's.

## **Brazilian Macroeconomic Policies and Conditions between 2003 and 2014**

Between 2003 and 2014, Brazil has featured by the whole of policies, programs and concretes actions destined to decrease the hunger and extreme poverty. There was a great effort among the federal, state government and organized civil society to reach this objective, established by the federal government. The country has obtained a success in a short time.

Between 2003 and 2014, the policy to overcome the hunger and extreme poverty gains the centrality of the federal government agenda with the specific and direct actions. This policy is determined by the Zero Hunger Program, but kept by other policies and a macroeconomic policy more expansive, mainly from 2005 and 2006, with a fiscal expansive policy of the public spending and a monetary policy for the credit expansion of the public spending.

The governments had used to advantage the expansion of the international demand that were favorable in that period and with a Chinese economic growth, and, *a posteriori*, would decrease, but keep the growth rates still high, below of

two percentage points. The foreign exchanges, a growing domestic demand, and the social programs had contributed to the income expansion and the social rise of the class with lowest incomes, from the poverty for the average class, and from the extreme poverty for the poverty.

Statistical data generated showed that more than 20 million of Brazilian people grew socially, forming a new middle class. In the same period, policies destined for the livestock, direct or indirect, were structured in the government programs. This research considers those destined to the rural areas that contributed to overcoming the hunger and extreme poverty and improved the life quality in the rural area.

The public spending is destined, mainly, to the implantation and expansion of the Family Scholarship Program that gets together direct transfer programs of the previous government, keeping the children in the schools, and the attendance of the childhood public health programs, as the vaccination. It is the family scholarship that the woman gets as an additional income to satisfy the three diary meals. It is important to emphasize the great expansion of the Brazilian families that started to receive the family scholarship, who are more than 11 million Brazilian families.

### **Food Security and Agricultural Production**

In 1950 Brazil has a population of 52 million people and the grain agriculture was composed of rice, bean, soybean, corn and wheat production, basically, with 11 million of tons. The country was food net importer with great natural resources. In 2010, the population overcame 200 million of people, an increase of 267% and the rice, bean, corn, soybean, and wheat have counted 150 million of tons, an increase of 1.264%, four times higher, comparing to the increasing percentage of harvested area that jumped of 10.4 million for 45 million of hectares. Brazil became net importer of agricultural goods to net exporter, being one of the most providers of agricultural products in the world (BUAINAIN and GARCIA, 2015).

In the Brazilian agricultural model, there are the both producers related to the modern productive chains, agricultural enterprises, employer producers and family farmers and other kind of family farmers, producing for the survive, its family and local and regional markets or specific markets (BUAINAIN and GARCIA, 2015).

Between 1994 and 2013, the agricultural sector has contributed, in average, to 6% of Brazilian GDP, presenting an average rate of real increase of 3.45% per year, higher than the national rate that was 3%. The agribusiness PIB has reached 1.1 trillion in 2013, representing 22.5% of the national GDP, an accumulated increase of 50% between 1994-2013, with an average rate of annual increase of 2.24% and less than the national rate (3%).

The Brazilian agricultural sector is important in the foreign trade and it is relevant for the corn-soybean complex and meat complex (bovine, swine and chicken). In 2013, the Brazilian agribusiness exports have reached US\$ 100 billion, representing 41% of the total exported in the country, generating the balance for the sector about US\$ 83 billion.

The increase of the agribusiness foreign balance reflects the increase of the country's export, especially for China. The positive balance of the agribusiness, provided by the Chinese purchases has financed the foreign deficit of other sectors (BUAINAIN and GARCIA, 2015).

According to Buainain and Garcia, 2015, the meat bovine productive chain shows the relevance in the currencies generation, being that the bovine meat exported volume has registered an annual rate of expansion of 7% between 2003 and 2013, reaching 1.5 million of tons and U\$ 6.7 billion. The annual rate of exported value of the increase in US\$ has reached 17% in the same period.

The main destinations, in the exported volume in 2013, were Hong Kong (24%), Russia (20%), Venezuela (10%) and Egypt (10%). Brazil is the most exporter of bovine meat: 33% of world trade with projections for the increase of its participation in the world trade

According to Buainain and Garcia, 2015, food security, its quality and the necessity to increase the productivity are the main approaches of the food market related to the livestock productive chain. The meat productive chain in Brazil has the most brut value among the agricultural products. The meat livestock corresponds in 11% of the agribusiness gross domestic product (GDP).

Embrapa has contributed, in a decisive way, for the knowledge and technology generation, adaptation and transfer, related to the tropical pastures, animal genetic, animal sanity, animal nutrition and agriculture-livestock-forest – iLPF, information and communication technology.

Embrapa generates almost 90% of the cultivated tropical forage seeds and 60% of the cultivated forage seed in the tropical world: plus de 33 million of meat bovines, registered in the country are in the dynamic databases, managed by Embrapa and its partners, that has contributed for the evolution of the main bovine breeds.

According to Buainain and Garcia (2015), Brazil export high genetics for the world. The base procedures and sanitary and recommendations of zootechnical and sanitary management of meat and milk bovine is being developed by the enterprise (mineralization, pasture supplementation, phases management, intensification of pasture production and confinement, concept of meat quality, programs of strategic control and diseases, traceability, good practices of bovine productions). The precision livestock, digital hose, balance scale, recombinant vaccines and third generation, advanced diagnosis, mobile applications.

**Table 1.** *Structural Data of Brazilian Agricultural and Livestock Census - 1975-2006*

Structure	1975	1980	1985	1995	2006	var % (1975-2006)
<b>Establishment</b>	4,993,252	5,159,851	5,801,809	4,859,865	5,175,636	3.7
Total Area (ha)	323,896,082	364,854,421	374,924,929	353,611,246	333,680,037	3.0
Occupied people	20,345,692	21,163,735	23,394,919	17,930,890	16,568,205	-18.6
<b>Land Utilization (ha)</b>						
Crops (1)	40,001,358	49,104,263	52,147,708	41,794,455	60,592,576	51.6
Livestock (2)	165,652,250	174,499,641	179,188,431	177,700,742	160,042,062	-3.4
Forest (3)	70,721,929	88,167,703	88,983,599	94,293,598	100,040,934	41.5
<b>Herds</b>						
bovine total	101,673,753	118,085,872	128,041,757	153,058,275	176,147,501	73.2
swine total	35,151,668	32,628,723	30,481,278	27,811,244	31,189,351	-11.3
chicken total	286,810,000	413,180,000	436,809,000	718,538,000	1,143,458,000	298.7

Source: IBGE. Agricultural and Livestock Census. In DIEESE (2017).

Table 1 shows that Brazilian agricultural modernization was conservative because of the maintenance of ancient agrarian structures. The *latifundium* has become a big modernized farm. The total of worked people has decreased among 1975 and 2006 and the area destined to the agriculture, livestock, and forest hasn't increased so much. These economic phenomenal show to us the importance of technological innovations to grow the agricultural and livestock productivity although they don't deny the environmental problems caused by deforestation and agrochemical utilization in the landscape during the soybean, corn and bovine breeding expansion in the *cerrados* and equatorial forests.

### **The Brazilian Innovation System and the Embrapa**

The Brazilian Agricultural Innovation System (AIS) are fundamental and became the country a world reference in tropical agriculture, according to Vieira et al. (2015). Among the AIS results:

- a) development of direct plantation system;
- b) sustainable environmental technologies, as the soybean, bean, corn, wheat, and sugar cane inoculants and biological control agents;

The main objective is to incorporate marginal areas to the other areas, as the *cerrados* (savanne) with grains, fibers and meat and those of semiarid, as fruits.

According to Vieira et al. (2015), the set of organizations and institutions that composes an innovation, the system represents a structure where many agents develop a broad set quantity of activities destined to innovate, which include:

- a) to do the research and development (P&D) by the creation and combination of knowledge;



- b) to build competencies to be used in the P&D activities and in the innovation;
- c) to establish networks and promote the learning among different organizations involved in the innovative process;
- d) to create and to modify institutions (rules, norms and routines) that influence the capacity to innovate the organizations and the own innovative process (intellectual property);
- e) to finance the innovation process and other activities which can facilitate the commercialization and technology and knowledge adoption.

The trajectory of Brazilian agriculture was not based exclusively on the expansion of the agricultural borders. Although the incorporation of new areas had been an important vector between 1970 and 1990 decades, the productivity increase has allowed the country occupy a pride of place in the world agricultural production (VIEIRA et al., 2015).

Between 1975 and 2011, there was an intense growth of agricultural production in Brazil while the increase in land usage became much lower, meaning a yield increase. When the yield grows persistently, it signifies that there were changes of production methods from the farmers; this is the technology employment that is a key factor for the production growth (VIEIRA et al., 2015).

An industry of agricultural machines: the agricultural machines sector comprehends the equipment production for all agro-industrial chain, since the soil preparation, passing for the plantation, harvest toward the storage and agricultural products transportation for the direct consumption or food industry (LEITE, 2015).

The sector is composed of three modalities: wheel tractors, combine harvests and agricultural implements. The development of agricultural machines in Brazil finds the relationship a period worldwide known as green revolution, characterized by the intensification of the industrial inputs in the field (LEITE, 2015).

There is the need to produce with most environmental and social sustainability that has contributed to the results as a bigger production, offer of lower prices and large volumes of currencies for the country.

The innovation in agriculture is more complex and dependent on the general innovation. The investment in agricultural research and development (P&D) in Brazil is smallest among the countries of Organization for Economic Cooperation and Development (OECD), comparing to direct competitors in the world agro-economy. In the Agricultural Innovation System (AIS), the Embrapa is the main agent. According to Vieira et al. (2015), Embrapa has 46 centers for research, composed by:

- 10 themed national centers: Agrobiology, Agro-energy, Food Agro-industry; Tropical Agro-industry; Agriculture and livestock Computing; Instrumentation; Environment; Monitoring by Satellite; Genetic Resources and Biotechnology. Soils;
- 14 national centers for products: Cotton, Rice and Bean; Goats and Ships; Forests; Bovine Meat; Bovine Milk; Vegetables; Cassava and Fruticulture;

Corn and Sorghum, Fish and Aquiculture, Soy-bean, Swines and Chickens, Wheat, Grape, and Wine;

- 17 eco-regions and agro-forest centers: Acre, West Agriculture, and Livestock, Agro-forest-livestock, Amapá, Amazônia Occidental, Amazônia Oriental, Cerrados, Temperate Climate, Cocais, Middle-North, Pantanal, Sud-est Livestock, South Livestock, Rondônia, Roraima, Semiarid, Coastal Tracks;
- 5 services units: Coffe, Territorial Management, Technological Information, Products and Market, Vegetable Quarantine.

The Agricultural Innovation System (AIS) has the support of the Organizações Estaduais de Pesquisa Agropecuária (Oepas) - Agriculture and Livestock Research State Organizations network, allowing the couverture of many environments of the agricultural production in the country and the integration with several actors of the national agricultural sector (VIEIRA et al., 2015).

The Embrapa keeps many agreements with the particular sector for the empirical research and the solution for the short-term problems. The advances in the production, in the productivity/yield and in the world participation in the Brazilian agriculture confirm the AIS success in the last four decades. The progress was obtained mainly in the agricultural and livestock. These have happened in the three sectors: in the supply chains, agricultural and livestock production and agro-industrial sector (VIEIRA et al., 2015).

The improvements have happened in different knowledge areas – in the Mecanics (machines and implements, irrigation and agricultural aviation), in the Chemistry (fertilizers and transgenic), in the Agrarian Sciences (soil preparation and conservation, cultural management, cultivars, planting times, harvests, pre-processing and animal production system), in the agro-industrial process (post-harvest, processing, logistics, specialization, value aggregate) and in the organizational process (management, creation of cooperatives, markets and trade) according to Vieira et al. (2015).

Alves et al. *apud* Leite (2015) have mentioned five areas where the biotechnology is revolutionizing the way to practice the agriculture:

- biodiversity - molecular markers, new molecules, new gens;
- vegetable production and silviculture - genetic improvements, propagation, growth and nutrition, plant defense;
- agro-industry - fermented products, biomass, food processing, energy production;
- environment - bio-monitoring, bio-recovery of degraded ecosystems and biological control.

In Brazil, the public institutes for research and the universities were the main responsible by the adaptation, generation and introduction of new Technologies that made possible to achieve significant productivity earnings in the agricultural sector, being the creation of Embrapa, in 1973, a mark for the build of the national innovation system for the agriculture.

According to Crestana and De Mori (2015) because of the agro-foods tendencies, the agro-industrial process must play some strategic functions, emphasizing the following question:

- improvement of the sensory quality;
- conservation and maintenance of the freshness of foods;
- preservation of the nutritional value;
- more practicality of the products and flexibility for the consumption;
- reduction of the waste and loss;
- increase of the productivity and flexibility in the production;
- improvements in the food security;
- development of the control systems more efficient.

According to Crestana and De Mori (2015), the main technological changes in the agro-food sector:

- growing incorporation of the information, knowledge, and technology in the agribusiness;
- agricultural and livestock products with new functions (incorporation of quality characteristics/health, environmental aspects, geographical localization);
- process destined for the protection and environmental adaptation and meeting specific needs (industry and consumer);
- biotechnology and genetic engineering advances;
- nanotechnology advances;
- growing application and use of information technology, mechatronics, and automation;
- expansion of the precision agriculture concept;
- evolution of the machines and equipment;
- emphasis in the technologies for sustainable economic exploitation;
- forest systems, agro-forests and agriculture-livestock integration for production and environmental services;
- marine agriculture for food and biofuels;
- traceability, identity and quality system;
- enlargement of the concepts and tools for environmental management of rural propriety;
- technology for rural waste reuse, nutrient recycling, and animal wastes disposition;
- increase for storage in farms and evolution of thermodynamics and aeration;
- development of treatments for food sanitation;
- development of active and bioactive packaging.

The green revolution that had happened mainly in the temperate climate countries and the tropical revolution happened in the tropical climate countries has based according to technological approach, in the technics from the Genetics

(plant and animal improvements), from the Chemistry (correction of soil fertility and agrochemical use) and from the Mechanics (substitution of animal traction by machines and implements moved by combustion engines) (CRESTANA and DE MORI, 2015).

The great challenges of sustainable development, technology, knowledge and innovation, require the tender of several disciplines. *Smart agriculture* comprehends electronic use, sensors and applied informatics to the agriculture, searching to develop a more efficient and sustainable agriculture with technology use and internet concept (CRESTANA and DE MORI, 2015).

The convergent technologies comprehend nanotechnology, information and communication technology, biotechnology and cognitive sciences. The size of the nanotechnology global market, in 2007, was US\$135 billion with a prevision of US\$ 693 billion in 2012, and US\$ 2.95 trillion in 2015. It is considered the key-technology of the 21<sup>st</sup> century (CRESTANA and DE MORI, 2015).

According to Crestana and De Mori (2015), the technology fusion and image methods, in three dimensions, with nanotechnology molecular promise a new revolution in the food areas, through molecular manufacturing.

**Table 2.** Participation of Each Sector in Respective Brazilian GDP Branch of Brazilian Agribusiness - 1995, 2005 and 2015 (%)

	Participation of each sector in respective GDP branch				Participation of the sectors in the agribusiness GDP		
	var (1995-2015)	1995	2005	2015	1995	2005	2015
<b>Agribusiness total (A+B+C+D)</b>	<b>52</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>
a) inputs	115	8	11	12	8	11	12
b) farming	90	24	24	30	24	24	30
c) industry	19	35	33	27	35	33	27
d) services	42	33	33	31	33	33	31
<b>Agriculture branch (A+B+C+D)</b>	<b>45</b>	<b>100</b>	<b>100</b>	<b>100</b>	<b>100</b>	<b>100</b>	<b>100</b>
a) inputs	98	7	9	10	5	6	7
b) farming	81	19	19	24	14	13	16
c) industry	23	41	40	35	29	28	24
d) services	39	32	32	31	23	23	21
<b>Cattle breeding branch (A+B+C+D)</b>	<b>69</b>	<b>100</b>	<b>100</b>	<b>100</b>	<b>29</b>	<b>30</b>	<b>32</b>
a) inputs	142	11	14	16	3	4	5
b) farming	102	36	36	43	10	11	14
c) industry	-1	19	16	11	6	5	4
d) services	52	34	33	30	10	10	10

Source: CEPEA-USP/CNA. Elaboration: DIEESE. Subsection Contag.

In Brazil, the research public institutions have difficulty to act in competitive markets and to establish partners with the private sector à cause the legal and restrictive regulatory frameworks that create hindrances to celebrate the contracts and partners, capturing and internalization of private resources for P,D&I: insufficient investments with human resources and infrastructure for P,D&I development in knowledge boarders areas.

Four transnational enterprises have a dominant position in the launch and offer cultivars: Monsanto/Monsoy, Brazil Dupontl/Pionner Seeds, Dow Agrosiences Seeds and Syngenta.

All of the corn cultivars genetically modified were registered in the name of private disclosure and part of them involves different genetics events. This highlights the difficulty of the public sector to participate in the market where the disclosure of new cultivars GM is intense. Table 2 shows the participation of GDP in Brazilian agribusiness.

### **Brazilian Agro-business Projection**

According to Instituto Brasileiro de Geografia e Estatística (IBGE) – Statistic Geography Brazilian Institut, *apud* MAPA (2017), in 2017, 29.7 million cattle heads were slaughtered in all the country. The state of Mato Grosso, Mato Grosso do Sul, Goiás, São Paulo, Minas Gerais, Pará, Rondônia and Rio Grande do Sul lead the slaughter with 76.6% of country slaughters.

In 2014, Brazil had 212.3 million of cattle heads, being 33.5% in the Midwest region, 21.6% in the North region, 18.1% in the Southeast region, 13.8% in the Northeast region and 12.9% in the South region of Brazil. In the Midwest, the biggest head quantity was in Mato Grosso state and in the north region, in the Pará and Rondônia states (MAPA (2017), according to Table 3.

According to OECD-FAO (2015), the meat projections for Brazil show that the sector presents intense growth in the last years, with the growth of meat production in Brazil. The producer prices must increase during the next ten years, especially for swine meat and bovine meat, while the chicken prices must increase with lower rates MAPA (2017).

Among the meats, the meats that Project the biggest production growth rates in 2016/2017 to 2016/2017 period were the chicken meat, increasing to 2.8% annually and for the swine meat with growth projected to 2.1% per year, representing a high value, achieving the domestic consumer and the exports (MAPA, 2015).

**Table 3. National Production and Main Producer States in 2016**

<b>Bovines</b>	<b>Slaughtered animals in 2016 (quantity)</b>	<b>%</b>
National production	29,668,976	100
<b>Mainly producer states</b>		
Mato Grosso	4,577,459	15.4
Mato Grosso do Sul	3,292,279	11.1
Goiás	2,821,463	9.5
São Paulo	2,792,350	9.4
Pará	2,731,398	9.2
Minas Gerais	2,469,873	8.3
Rondônia	2,155,315	7.3
Rio Grande do Sul	1,897,834	6.4
Total	22,737,971	76.6

Source: MAPA (2017). IBGE Pesquisa Trimestral de Abate de Animais (Jan/Dec 2016) – (April/2017).

According to MAPA (2015), the total production of meat in 2016/2017 is estimated in 28.5 million of tons and the projection for the final next decade is to produce 34.3 million of tons of chicken, bovine and swine meats, This variation corresponds to the production increase of 20.5% of bovine meat, 28.6% of swine meat and 33.4% of chicken meat. In table 4, there are the quantity of bovine, swine and chicken productions between 2017 and 2027.

**Table 4. Bovine, Swine and Chicken Production (Thousand Tons)**

<b>Year</b>	<b>Bovine</b>	<b>Swine</b>	<b>Chicken</b>
2017	9,500	3,815	13,440
2018	9,374	3,952	13,817
2019	9,865	4,027	14,601
2020	10,018	4,135	14,689
2021	10,365	4,232	15,293
2022	10,542	4,359	15,512
2023	10,882	4,470	16,235
2024	10,927	4,587	16,402
2025	11,134	4,689	17,053
2026	11,248	4,798	17,237
2027	11,444	4,905	17,930

Source: MAPA (2017). Elaboration of CGEA/DCEE/SPA/Mapa and SGI/Embrapa with data of CONAB and USDA.

The annual project growth for the chicken meat according to MAP (2017) is 2.6% in the 2016/2017 and 2026/2027 period, meaning an increase of 29.5% in the consumption for the next 10 years. The consumption of projected chicken meat for 2016/2027 is 11.9 million of tons, with the projected population by IBGE of

219.0 million of people, having, in the final, a consumption of 54.3% kg/hab/year (MAPA, 2015).

The swine meat is situated in the second place in the consumption growth with the annual rate of 2.4% in the next years. In the lowest level of growth, the consumption projection of bovine meat, of 1.5% per year for the next years. The bovine meat consumption has varied of 15.8%, the swine meat of 28.9% and chicken meat, of 29.5% between 2017 and 2027, according to Table 5.

**Table 5. Meat Production and Consumption (Thousand Tons)**

Annual	Bovine		Swine		Chicken	
	Production	Consumption	Production	Consumption	Production	Consumption
2017	9,500	7,740	3,815	2,917	13,440	9,162
2018	9,374	7,744	3,952	3,058	13,817	9,432
2019	9,865	8,120	4,027	3,176	14,601	9,703
2020	10,018	8,063	4,135	3,264	14,689	9,973
2021	10,365	8,234	4,232	3,312	15,293	10,243
2022	10,542	8,406	4,359	3,370	15,512	10,514
2023	10,882	8,565	4,470	3,441	16,235	10,784
2024	10,927	8,567	4,587	3,529	16,402	11,054
2025	11,134	8,754	4,689	3,612	17,053	11,324
2026	11,248	8,879	4,798	3,690	17,237	11,595
2027	11,444	8,963	4,905	3,761	17,930	11,865

Source: MAPA (2017). Elaboration of CGEA/DCEE/SPA/Mapa and SGI/Embrapa with CONAB and USAD data.

Related to exports, the projections indicate the high growth rates to three types of meats with a favorable frame for the Brazilian exports. The chicken and swine meats lead the annual export growth rates to the next years – the annual rate previewed for e chicken meat is 3.3% and to the swine meat, is 3.5% (MAPA, 2017).

The export growth of bovine meat is situated in an annual average of 3.0%. According to MAPA (2017), the Agriculture Department of United States estimates that Brazil, in 2026, will be the first exporter of bovine meat, being the second, Australia, followed by India and United States. In the exports of swine meat, Brazil is classified in fourth place, behind of United States, European Union, and Canada. About chicken meat, Brazil is the first exporter, followed by the United States and European Union (MAPA, 2017).

The meat exports in 2026/2027 arrive almost 10.0 million of tons, an increase of 37.5%, being 1.6 million of tons that is 61.5% must be chicken meat, 24.0% of bovine meat and 14.0% of swine meat. The biggest consumption market of Brazilian bovine meat is Hong Kong, China, Russia, Iran, Unit Arab Emirates and Hong Kong. For the swine meat, the main markets are Russia and Hong Kong. The exports variation in the period is 35% for the bovine meat, 41.8% for swine meat and 37.6% for the chicken meat (MAPA, 2015), according to Table 6.

**Table 6. Meat Exports (Millions of tons)**

Year	Bovine	Swine	Chicken
2017	1800	900	4280
2018	1874	938	4303
2019	1940	975	4555
2020	2002	1013	4574
2021	2063	1051	4903
2022	2125	1088	4937
2023	2186	1126	5228
2024	2247	1164	5248
2025	2307	1201	5558
2026	2368	1239	5589
2027	2429	1277	5890

Source: MAPA (2017). Elaboration of CGEA/DCEE/SPA/Map and SGI/Embrapa with data of CONAB and USDA.

According to MAPA (2015), the milk production must increase in the next 10 years with an annual rate of 2.1% and 3.0%. These rates mean a production of 34.5 billion of liters in 2017 to 43.0 and 48 billion of liters in the period end of the projections, according to MAPA (2017). The production recuperation is based on the improvement of the exchange relationship between the milk prices and inputs in the Brazilian market. The imports are minors a cause of international prices increase and enhancement of import product and the offer growth will base on improvement in the farm management and animal productivity and less in the lactating cows. In Table 7, there are the total bovine, swine and chicken head types in the 2007 and 2015 with the variation quantity in this period.

**Table 7. Total Year by Herd Types (Brazil) 2007-2015 (Heads)**

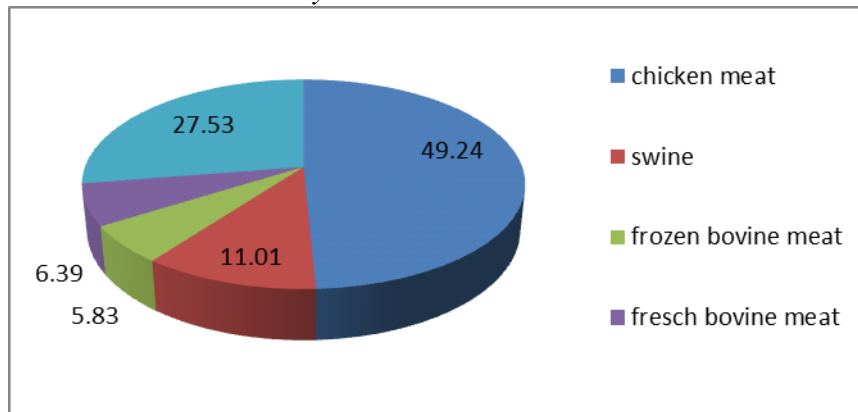
Herd types	Year		Part (%) 2015 per UF	Var (%) 2007-2015
	2007	2015		
<b>Bovines</b>	199,752,014	215,199,488	100	7.7
<b>Swines</b>	35,945,015	40,332,553	100	12.2
<b>Chickens</b>	1,127,658,584	1,332,078,050	100	18.1

Source: DIEESE, 2017. Elaboration: author.

There has been a concentration in the production and incorporation process more accelerated of technologies, especially in the average producers and big producers. The dairy products industry has passed for transformations. The consumption in the next years must be near to the production, is estimated to growth yearly to rate of 2.1% per year during the projection period, being able to arrive 3.3% (MAPA, 2017).



**Graph 1.** *Distribution of Brazilian Exports of Meat Complex by Type – Brazil March 2016 to February 2017*



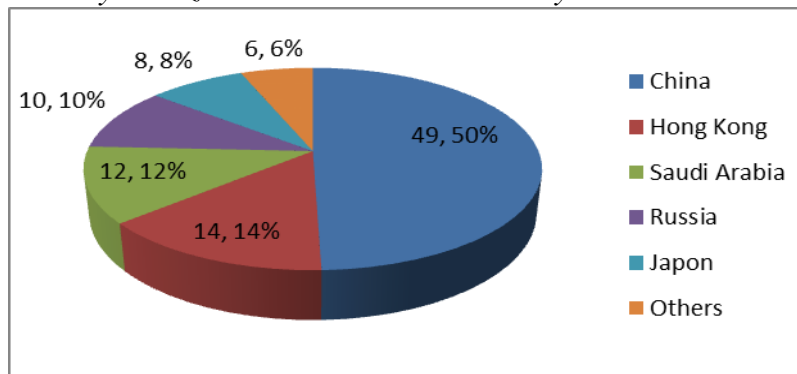
Source: MDIC, Aliceweb. Elaboration: DIEESE.

In the graph 1, Brazil is one of the largest exporters of beef and chicken, selling to more than 100 countries. Among Brazil's client markets, there are those that are most demanding in terms of health control, such as the USA, Europe, and Japan. In 2016, after many years of negotiations and investments, the country once again obtained authorization to export fresh meat to the USA, possibly the market with the highest degree of phytosanitary requirements in the world. The international market is very competitive and, for food marketing, the hygiene, quality, and safety aspects are essential. From mid-2016, Brazil was able to enter the Chinese market, which became Brazil's largest beef importer (DIEESE, 2017).

China, Hong Kong, Saudi Arabia, Russia and Japan accounted for 51.2% of Brazilian exports between March 2016 and February 2017. In Europe, the most notable are Netherlands, Italy, United Kingdom and other European Union countries, totaling 8%. Chile, Venezuela, and Mexico are the main markets in Latin America.

Foreign sales of Brazilian chicken have, as main markets, Saudi Arabia, China and Japan; of frozen beef, China, Hong Kong and Egypt; of swine, Russia, Hong Kong and China; fresh beef, Chile, Netherlands, and Lebanon; other varieties, Hong Kong, Netherlands and United Kingdom, according to Graph 2.

**Graph 2.** *Distribution of Brazilian Exports of Meat Complex – Position by Country - Brazil – March 2016 to February 2017*



Source: MDIC. Aliceweb. Elaboration: DIEESE.

The slaughter of animals grew even more with the increase of internal and external demand for Brazilian meat. The slaughter of cattle grew, between 1997 and 2015, 105.9%; or of chickens, 168.5%; of swine by 188.2%. More than half of the world beef market is in the hands of Brazilian companies (DIEESE, 2017).

There are about one million formal jobs (livestock and industry), more than 275 thousand integrated producers, of which 210 thousand are chickens, 40 thousand are swine and 25 thousand are independent, transportation, distributors, exporters, consultants, veterinarians and sales representatives (DIEESE, 2017).

In the Gross Domestic Product (GDP) of agribusiness, calculated by the Center for Advanced Studies in Applied Economics, University of São Paulo (Cepea/USP), livestock represents 32% of the total in 2015, showing an increase in share of total GDP, between 1995 and 2015, from 29% to 32% (DIEESE). In Table 8, there are the milk production, consumption, import and export quantities projection between 2016 and 2027.

**Table 8.** *Milk Production, Consumption, Import and Export (Million of Litres)*

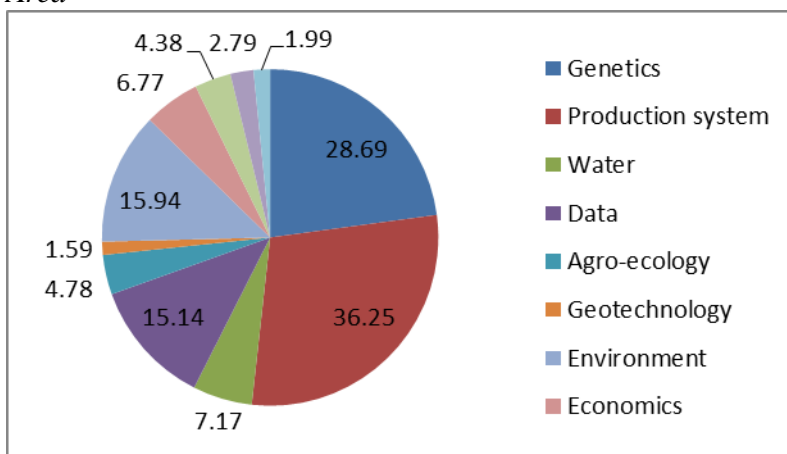
Annual	Production	Consumption	Export	Import
2016/17	34520	35974	245	1909
2017/18	35334	36776	254	1937
2018/19	36149	37612	264	1966
2019/20	36963	38454	273	1995
2020/21	37778	39298	282	2023
2021/22	38593	40142	291	2052
2022/23	39407	40986	300	2080
2023/24	40222	41830	310	2109
2024/25	41036	42675	319	2138
2025/26	41851	43519	328	2166
2026/27	42666	44363	337	2195

Source: MAPA (2017). Elaboration of CGEA/DCEE/SPA/Map and SGI/Embrapa with data IBGE.

In the Brazilian GDP, calculated by the IBGE, the agriculture and cattle ranch corresponds to approximately 5% of the total. The offer growth in the last 20 years was almost 4% per year, there have been the need of technology incorporation with impacts for the flock productivity, as Balde Cheio Program and Educampo Program that spread technologies. The OECD, in 2015, estimates that the milk domestic prices and milk derivatives must increase from 6% to 8% during the projection period. The milk production, consumption, export and import variations in the period were, respectively, 23.6%, 23.3%, 37.5% and 15.0% (MAPA, 2015).

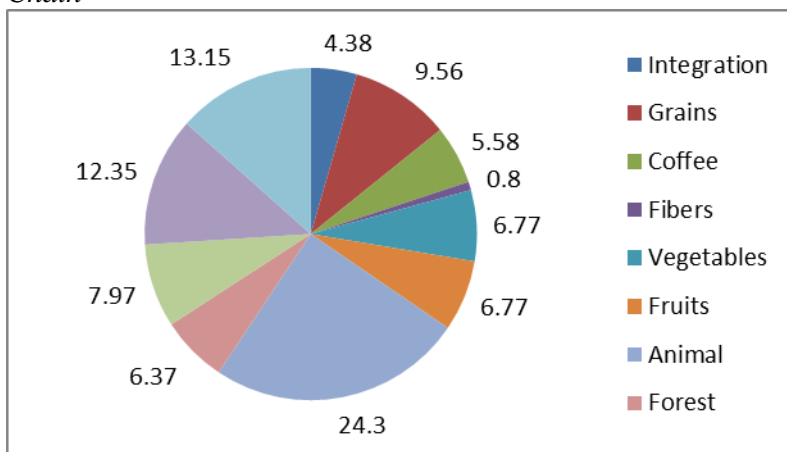
In Embrapa, 28.69% of the research is destined to the Genetics knowledge; 36.25% to production system; 15.94% to Environment; 7.17 to water and 6.77% to Economics. Related to productive chain type, 24.3% is destined to animal production; 9.56% to grains; 6.77% to vegetables; 6.77 to fruits and 7.97% to energy, according to graph 3. In Graph 4, there is the distribution of project sample of Embrapa according to productive chain.

**Graph 3.** *Distribution of Project Sample of Embrapa according to Knowledge Area*



Source: Own elaboration of data of Embrapa (2015b) *apud* Vieira et al. (2015).

**Graph 4.** *Distribution of Project Sample of Embrapa according to Productive Chain*



Source: Own elaboration with data of Embrapa (2015b) *apud* Vieira et al. (2015).

In addition to being one of the largest producers and consumers in the world of meat, Brazil stands out in the participation in world trade, even though the majority of the production goes to the domestic market (80.0%). It is one of the largest producers of soy and corn in the world, linked to the meat production chain because they are inputs to the feed. In beef and meat market, Brazil ranks second in production and first in export. In chicken market, it is the third largest producer. In the swine market Brazilian production and exports occupy the fourth position. In the soybean chain, Brazil was the second largest producer, becoming first in 2018, and the largest exporter and, in the corn market, the country is the third largest producer in the world and the second largest exporting country in the world, according to Table 9.

**Table 9. Brazil Position in the World Production and Export, 2016**

	Production		Export	
	Position	% in relation to total	Position	% in relation to total
Bovines	2°	15.40%	1°	20.10%
Chicken	2°	15.60%	1°	38.60%
Swine	4°	3.50%	4°	10.90%
Soybean grains	2°	30.60%	1°	42.00%
Corn	3°	8.70%	2°	20.30%

*Source:* production, supply and distribution (PSD) - October (2016) - USDA.

The operation of the Federal Police, known as Weak Meat Operation, held in mid-2017, aimed to clear a supposed scheme of tips that benefited refrigerators and other establishments directly connected to the supply chains of the large meat companies in Brazil. The problems identified were excess water, non-compliance with the appropriate temperature of the cold rooms, signatures of export certificates outside the company's headquarters and the Ministry of Agriculture, Livestock and Food Supply (MAPA), without on-site verification, and the sale of meat unfit for human consumption (DIEESE, 2017).

There are 4.837 industrial establishments in the livestock sector in Brazil, almost all of them frequently inspected and with internationally recognized certifications. The operation investigated 21 slaughterhouses, 0.4% of establishments, with the involvement of 34 employees, from a universe of 2.500 MAPA inspectors (DIEESE, 2017).

There is a short-term impact on external product sales, as this is the type of occurrence that allows meat importing countries to place trade safeguards or "phytosanitary barriers", used not only as protection against surveillance issues but as a form of commercial protection (DIEESE).

## Conclusions

We can conclude that the Brazilian agribusiness has grown because of the expansion of the agricultural border with environmental problems, but with the set of innovations of the green revolution during the forty decades and Embrapa has a great role in Brazilian agricultural research, being the leader of this process, coordinating the agricultural innovation system.

In fact, Embrapa combines different perspectives for the agriculture research, having several researchers in many knowledge areas that develop the investigations based on green revolution paradigm, agro-ecology, biotechnology or doubly green revolution paradigms. The agriculture-livestock-forest integration is an example of a double green revolution paradigm. The agro-ecology projects exist but are less considered in the whole of the projects, although it is increasing. The statistical data show the meat, chicken, and swine production expansion, becoming the country the main producers and exporters in the global market, being in the first positions.

The meat sector grew due to the strategy of creating global players, with resources from the National Bank for Economic and Social Development (BNDES) through companies such as JBS, BRF, and Marfrig. It focused on expanding production, increasing market concentration, forming an oligopson, expanding sales, and fusion and acquiring several competing companies. This occurred through an increase in domestic production capacity and in the acquisition of companies from other countries. The actions of the Weak Meat Operation implied the suspension of the commercialization of meat for some countries, with impacts on the fall in revenues and in the labor market.

The agrarian structure continues to be concentrated so this modernization is known for some researcher as conservator modernization that did not modified the land concentration. This modernization was possible by the green revolution with all technological packages, maintaining the best lands for the big producers. Brazil is the one of the main soybean producer in the world.

Nowadays Brazil combines a big agricultural production, recognizing as potency, with food security policies to increase the family incomes to buy food goods. Some government programs were conceiving to the family in the extreme poverty to avoid the hungry, through the government transfers as Family Scholarship, social security benefits, the increase of the real minimum salary. In 2014, FAO has removed Brazil of the Hungry Map. So the country has had success in the agricultural offer approach and demand approach with the food security policies in the last years.

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