Production systems – An example from Brazil

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\textbf{A B S T R A C T}

Important information about the Brazilian agribusiness, population and economy are presented in this paper, as well as details of beef production, market, industry and production system, to inform people involved in meat industry about details on demography, production, economy and production systems of a country that is the largest player in beef exports in the world and that uses, mostly, Bos indicus based bovine population, reared under pasture conditions, for meat production purposes. Herd size, genetic evaluation programs, quantity of beef produced and market is informed, with figures about the global and major players’ production. Some discussion related to environmental concerns, methane emission and carbon fixation is also presented, as well as meat quality. Meat quality of fed animals is also compared with beef from animals that are raised in pasture conditions.

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\textbf{1. Introduction

1.1. Brazil and its agriculture production

Brazil, the largest south-american country, has a population of 190.8 million inhabitants (IBGE, 2008), an area of 8,514,876.6 km\textsuperscript{2}, equivalent to 47% of South American territory, close to 12% of the fresh water reserves of the planet, a growth rate of 1.4% p.y., a gross national product (GNP) in 2008 of US$1.30 trillion (RS$2.9 trillion, \textit{Instituto Brasileiro De Geografia Estatística (IBGE)}).

2009, \textit{www.ibge.gov.br}). The per capita GNP was, in 2009, around US$6,830.00 (R$15,240), according to the same official source. Close to 23% of population (43 million people) works with Brazilian livestock and agriculture production is important when compared to other countries. According to \textit{FAO} (2009) and United States Department of Agriculture (USDA) (2009) data, based on 2005 crops and 2004 exports, the country has very important production in several crops, besides beef. As related to broiler, Brazil is responsible by 15.5% of production and
40.7% of exports. In the pork business, the country accounts to close to 3% of world’s production, but is the 4th largest exporter, with 15% of international market. The country is the bigger exporter of several agriculture products like soybean (24% of world’s production and 33.4% of total trade), sugar cane (32.5% of production and 42.4% of exports), orange juice (29.7% of production and 57% of exports), and coffee (28.3% of production and 23% of exports). Brazilian agribusiness was responsible for 31% of the GNP, 37% of the jobs and 42% of the total exports in 2003. More details on the Brazilian economy can be found in <http://www.ipeadata.gov.br>.

Livestock production in Brazil is important to the world’s food commerce. The population size of different livestock is: beef and dairy cattle: the estimated herd size varies from 191.37 million animals (Scot Consultoria, 2006) to 199.7 million heads, at the end of 2007, according to IBGE (2008), swine: 32.39 million (CONAB, 2006), goats and sheep (9.09 million and 14.18 million; FAO, 2009), water buffaloes: 1.13 million heads (IBGE, 2008) and poultry: 1.127 million (IBGE, 2008).

Brazilian beef production is the second largest in the planet. It produced 9.7 million t carcass weight equivalent (CWE) in 2008, when USA produced a little over 12 million t, EU-27 around 8.1 million t, Australia and Argentina, between 2 and 3 million t and India, that did not appear in statistics before, around 2.5 million t CWE (ABIEC, 2009);

Regional distribution of the Brazilian cattle herd is 12% in North, 13% in Northeast, 21% in the Southeast, 15% in South and 39% in the Center-West (midwestern region). More than 160 million heads are located in areas free of foot-and-mouth disease (FMD), with vaccination. The major beef production of the country is done in medium to low fertility soils, in regions similar to savanas, called “cerrados”, where African grasses, specially Brachiaria spp. and Panicum spp. adapted very well. The strong growth of the Brazilian beef production is based in the triploid Nellore-Cerrado-Brachiaria, after 1970.

Brazilian beef production has low cost, estimated to be 60% lower than in Australia and 50% lower than in the United States. The average slaughter age is 4 years and the slaughter rate is around 21%, compared to 2 years and 37% in the United States (Dyck & Nelson, 2003), and that means that the Brazilian beef industry is less efficient.

2. The importance of beef production: breeds and crosses used in Brazilian production systems

The country has the second largest bovine herd in the world, following India, but has the biggest commercial herd. Important information about the Brazilian beef and dairy business (Fries & Ferraz, 2006; Rosa, 1977 and Instituto Brasileiro De Geografia Estatística (IBGE), 2009) are presented in following lines:

- 80% of that herd has influence of zebu cattle (Bos indicus), according to the Brazilian Zebu Breeders Association (ABCZ, <http://www.abcz.org.br>);
- Although around 80% of the Brazilian herd has B. indicus contribution, only less than 7,000 purebred Zebu animals have been imported from India in 19th (beginning in 1870) and 20th century. The importation from India was forbidden around 1962.

From 1870 to 1930, only 1904 B. indicus animals were imported from India. Between 1952 and 1962, 565 bulls were imported from India (Santiago, 1987).

- The Brazilian B. indicus population was, mostly, produced by “grading up”, mating Bos taurus cows, brought to America by Portuguese and Spanish colonizers to B. indicus bulls, imported from India or animals with ancestry of imported animals (Santiago, 1987);
- The beef breed that has the largest number of animals in Brazil is Nellore (standard/horned and polled), followed by Gyr and Guzerath, with some Oncolo (Nellore), decreased sharply in number of animals. Details of those breeds can be seen in <http://www.ansi.okstate.edu/breeds/cattle> and, also, in the website of the Brazilian Zebu Breeders Association (ABCZ: <http://www.abcz.org.br>);
- A newer Brazilian B. indicus breed, that has growing numbers is a pooled breed, Tabapuá (<http://www.tabapua.org.br>);
- Purebred Bos taurus is raised in Southern Brazil, a temperate region. Some of that meat, due to better quality, specially tenerness and marbling, is exported and other part supply special niche domestic market;
- Crossbreeding is used in all regions of the country, but the higher the percentage of Bos taurus contribution, the poorer the adaptability to tropical environment, especially to ecto parasites (flies and ticks), what causes an important impact in production costs, in insects control;
- The major European breeds that are used in beef crossbreeding are Angus and Red Angus, Simmental, Charolais, Pollled Hereford, Limousin and Braunvieh, among others;
- Synthetic breeds, like Brangus, Braford, Canchin/Charbray and Santa Gertrudis are also used. In the last decade, Bos taurus breeds, adapted to tropical environment, like the Brazilian Caracu, showed renewed interest. Breeds like Senepol and Bonsmara were introduced and, also, composite programs (e.g. Montana Tropical) started to grow in the country;
- Uses 140 million hectares of land (all other crops, together, use 75 million hectares);
- Is produced in 1.8 millions farms. The small beef enterprises raise less than 500 head per household per year. The so-called medium specialized beef operations on average produce over 1000 head annually. The last category is called commercialized beef production enterprises with over 4000 head per year (Somwaru & Valdes, 2004).
- Generates 6.8 million direct or indirect employees (8.3% of the 82 million employment positions);
- 40.5 million head were slaughtered in 2008, with offtake rate of 21.2% (CNPC,2009);
- Roughly 150 million animals are used for beef production and 40 million for dairy and dual-purpose.
- The herd has around 64 million cows, 50 million of them used in beef production and the rest in dual purpose or dairy production;
- There are close to 3 million bulls what leads to a need of around 450,000 young replacement bulls per year;
- Between 5% and 7% of beef cows are inseminated. Since less than 5% of these replacement bulls were selected based on EPDs (estimations of the animals’ breeding value, expressed in Expected Progeny Differences) or performance data one can conclude that more, better and larger breeding programs are needed.
- The Brazilian beef industry exports over US$1.1 billion in leather and US$1 billion in shoes, produced in 4200 shoe companies and 560 tanning plants.
3. The Brazilian beef production systems and genetic evaluation programs

The normal production system in the country is to produce animals under pasture condition. A small amount of animals, around 2.7 million in 2008, that corresponded to 6.7% of slaughtered animals were fed in feedlots (ASSOCON, 2008). According to the same source, that number was larger than the number of animals in feedlot in 2008 in Australia, that fed 2.13 million animals in the same year, as informed by the Meat and Livestock Australia. The leader country in feeding beef is the USA.

Normally, purebred Zebu have higher dressing percentages and finish 6–12 month later then crossesbreds but have better fat cover for the market, at the same weights as continental crossbred animals. Those animals that have better genetics and potential to grow faster are kept in pastures until 18–21 month and part of them are fed, with diets of average growth potential and medium level of energy by only 3–4 months, being slaughtered between 21 and 25 month. Those diets’ basic composition is corn, sorghum or grass silage, ground sugar cane, sugar cane by-products (mainly molasses and dried hydrolyzed bagasse) and soybean meal, with very little, if any, grain addition, just for finishing and backfat deposition. That means that that kind of animals stayed more than 82% of their lives in pasture conditions, exercising, walking freely, searching for water, etc., what help animal’s welfare (Paranhos da Costa & Cromberg, 1997; Quintilliano & Paranhos Da Costa, 2008).

In the rest 18% of their lives under feedlots (of only 6.7% of the total production of the country), those animals are kept in fiber-rich, medium energy level diets. That has major implications in the Brazilian beef quality. Animals raised under technologies that are more adequate to production systems and environment, considering animal and human health, nutrition, genetics and sanity, are, normally, certified by independent companies and sent to exports for their plants. However, due to problems in currency parity, sanitary troubles and other risks, the amount of animals kept in feedlots at 8 months of age and 240 kg live weight, where feedlots use a low percentage grain ration, composed of maize, sorghum or grass silage, sugar cane and agriculture by-products. Animals used in that system are in general crossbreds.

There is currently a strong movement in ownership concentration of processing plants with the few companies that share the internal and export market investing strongly in their own feedlots, in order to regulate prices, meat quality and regularity of supply for their plants. However, due to problems in currency parity, sanitary troubles and other risks, the amount of animals kept in feedlots decreased by 20% from 2004 to 2005.

An interesting review about Brazilian genetic improvement programs was presented by Fries and Ferraz (2006). The authors stated that during the last 50 years there has been an unprecedented growth in the cattle population and important increases in productivity in spite of the restrictive economic environment.

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An interesting review about Brazilian genetic improvement programs was presented by Fries and Ferraz (2006). The authors stated that during the last 50 years there has been an unprecedented growth in the cattle population and important increases in production and productivity in spite of the restrictive economic environment. Imported genetic technologies also contributed heavily although after initial import most technologies were adapted for local use. The advent of a program of the Brazilian Ministry of Agriculture, called “CEIP – Certificado Especial de Identificação e Produção”, that allowed superior breeding stock from commercial herds to attain the same status as the seedstock sector (pedigreed animals), cannot be ignored. That program assures that
the best 20–30% of animals controlled by approved genetic evaluation programs pay the same taxes as breeders association registered animals. For the future, one can foresee full integration of quantitative and molecular technologies with both scientific communities working in harmony. Better understanding of genotypic elements and their interaction with the environment will support new strategies for planned crossbreeding.

Brazilian beef agribusiness is getting organized (Fries & Ferraz, 2006). A very strong progress can be verified, especially since the 80’s, when several genetic evaluation programs were established and EPDs and focused/oriented mating systems started to be used in beef companies. The results very quickly changed the marketing of genetics in the country. Ferraz and Fries (2004) reviewed the history and comprehensively describe, in English, existing beef breeding programs in Brazil, including Bos taurus, B. indicus and synthetic breeds and beef composites.

4. The Brazilian beef market

The Brazilian domestic market absorbs close to 7.03 million t CWE, with a per capita consumption of 37 kg CWE/person/year (CNPC., 2009). That means that 72.5% of total production is absorbed by the internal market.

Brazil is the largest beef exporter in the world. Exports of 2.163 million t CWE in 2008, with revenues of US$5.325 billion and an average of US$3.824.27/t. (ABIEC, 2009; CNPC,.2009). The amount exported decreased 15% over 2007, but the value increased around 20% over the same time.

In the same year, Australia around 1.4 million t, USA exported under 1 million t CWE, India a little less than USA, New Zealand, around 500 thousand t, and Uruguay around 400 thousand t, EU-27 around 100 thousand t CWE and Argentina was almost out of market in that year (ABIEC, 2009). Brazilian beef business is responsible by around 1/3 of beef trades in the world.

The number of beef processing plants and abattoirs is around 750. Some huge plants, that processes more than 2000 animals/day, with very modern equipment are in operation, mainly in midwestern part of country.

Part of the internal market is still supplied as carcasses and another part as deboned boxed beef. Animals finished in feedlots are sold in niche markets, normally deboned and vacuum packed, branded special cuts. Those cuts are sold in supermarkets, and, specially, restaurants called churrascarias, the typical Brazilian steak houses that serve rodizio, a all-you-can-eat typical brazilian system or serving barbecued beef.

In last years, branded meat market is starting to grow. Programs like Angus Beef, Nelore Natural, Hereford beef, Bonsmara beef and several other brands try to commercialize special cuts, in Brazil and other countries, adding value to products. These branded beef focus, mostly, is barbecue cuts, like ribs (boned or deboned), rump, rump heart (baby beef), rump cap (the famous picanha in Brazil, that is more expensive than tenderloin), tenderloin and striploin. A very interesting catalog of Brazilian beef cuts was issued in 2006, by the Brazilian Association of Beef Export Industries (ABIEC, 2006).

According to USDA (1999), the world’s beef consumption grew from close to 20,000,000 t (carcass weight equivalent, CWE) early 1960’s decade to around 60,000,000 t at the end of the first decade of the 21st century, an increase of 175% in less than 50 years. In the same period, Brazil’s production increased from roughly 1.2 million t CWE to close 10 million t, while domestic consumption enlarged from 1.2 to 7.5 million t. When considering only the last 15 years, the countries’ beef production increased around 60%, while the internal consumption, only 30%. The surplus of beef in Brazil is, currently, larger than 2000 t/year.

Brown (2007), from Gira – Consultancy & Research Prospective et Stratégie presented, in a conference in Sao Paulo, Brazil, projections that indicate that gross national product will increase the next years and so will be meat consumption, reaching, in beef, around 70 million t CWE. In same presentation, the author indicates China, followed by USA, Japan and even India, as the countries that will have larger increase in beef consumption.

5. Risks of Brazilian beef industry

According to Fries and Ferraz (2006), the Brazilian beef industry has its weaknesses and strengths. Among the limitations, there are the sanitary risks of FMD that are being controlled with vaccination, and other animal health problems intrinsic to business that increases the cost of production. Beef quality also can be included in the weak points, as the high level of Zebu genes decrease tenderness of beef. Also, the proportion of unofficially slaughtered animals in the country is greater than 30% and all that beef goes to internal market. Another weak point of that producing chain is the lack of organization and the low use of genetically evaluated bulls in several layers of the business.

But there are strong points too: the cost of production on Brazilian beef is the lowest in the world and the trend is to keep it that way. Although feedlots are growing in Brazil, the Brazilian beef production system still can be considered “grass-fed animals”, since animals are in the feedlot for a very short period and the amount of roughage in feed is very high (e.g. sorghum, corn or even grass silage). That feeding system eliminates the risk of BSE in the Brazilian beef herd what constitutes a very powerful commercial tool, especially with the worries on food safety. The official efforts in controlling FMD led to the fact that more than 80% of the Brazilian herd being reared within zones free of FMD, with vaccination.

Government and producers are working together on other strategies e.g. traceability. Taken all together, Brazilian beef productivity can be considered low compared to higher input systems but this system generates a product that is healthy, tasty and genuine and has a good chance to stand the test of time.

6. Grass-fed animals and beef quality

For international standards of meat quality, the amount of intramuscular fat or marbling deposited in Longissimus muscle is the major determinant of carcass value and predictor of palatability. But currently, fat composition and a fat profile of beef that assures healthier food is becoming more and more important.

Marbling fat is comprised of over 20 individual fatty acids. Six of them contribute over 92% of the total fatty acid content. Those fatty acids in beef marbling fat that are more important are linoleic, oleic, palmitic, palmitoleic, myristic and stearic acids. Marbling also contains unique fatty acids as a result of ruminal biohydrogenation of lipids from diets. One of these products is conjugated linoleic acid (CLA) that was first recognized as an antarcinogen in experiments investigating compounds generated during the cooking of hamburger. CLA is produced in ruminant animals in the process of biohydrogenation of linoleic acid in food, by rumen bacteria such as Butyrivibrio fibrisolvens (Khanal & Dhiman, 2004; Kim, 2003). Besides that, stearic acid seems to be converted to oleic acid after dietary ingestion. That fatty acid can influence serum cholesterol compared to other saturated fats (Duckett, 2003; Medeiros et al., 2005).

Forage fed animals has a trend to present lower percentage of marbling and leaner carcasses. When considering fat profile, however, beef from forage or grass fed animals with have higher CLA content and PUFA concentration, what means healthier beef. Saturated fat seems to increase level of cholesterol, but not all unsatu-
rated fatty acid does that. Comments on details on growth of farm animals and product value for human consumption can be found in Lawrence and Fowler (2002). Many studies on beef quality and grass × concentrate fed animals can be found in literature, pointing the importance of the subject (French et al., 2001; Mandell, Buchanan-Smith, & Campbell, 1998; Muir, Beaver, & Bown, 1998, among many others).

There are differences due to breed effects in fat profile of beef. Crossbred animals B. indicus × B. taurus seem to produce beef with more saturated beef (Metz et al., 2009). Progeny of Angus-Hereford cows, sired by Wagyu bulls animals produce more mono-unsaturated fat than Angus sired ones (Xie et al., 1996), indicating small differences in fatty acid profiles between breeds and among sires.

7. Meat quality differences among breeds used in Brazil

There are differences in meat quality among breeds, specially the use of B. indicus and it’s impact on beef quality, according to several studies held in countries that can be considered as important players in the international beef market (e.g. the classical papers by Crouse, Cundiff, Koch, Koohmaraie, & Seideman, 1989 and Wheeler, Cundiff, & Kock, 1994).

Although Thompson (2002), considered that for the Australian production system B. indicus is an important critical control point, Sherbeck, Tatum, Field, Morgan, and Smith (1995), stated that results suggest that including Hereford crossbred steers with 50% Brahman breeding would adversely affect the tenderness of Certified Hereford Beef. However, Hereford crossbreds with 25% Brahman breeding could be allowed in the Certified Hereford Beef Program without significantly increasing the risk of decreased product tenderness.

Several research projects were completed about the subject (Bonin, 2008; Hadlich, Morales, Silveira, Oliveira, & Chardulo, 2006; Pereira, 2006; Rezende, 2009; Rubensam, de Felicio, & Termignoni, 1998), and the general conclusion is that there are, really, influence of breeds or bulls in meat quality. But, usually, traits on meat quality are measured in the Longissimus muscle, especially tenderness and acceptable levels of tenderness are achieved after 7–14 days of ageing. When fresh beef is exported by Brazilian industries, that phenomenon occurs during transportation and Brazilian beef reaches the market, mainly European, with satisfactory quality grades (Dr. Pedro E. de Felicio, personal communication).

8. Environmental impact: methane production and beef production in Brazil

According to USEPA US. (2008, chap. 6), methane emission in agriculture in USA is responsible to 6.4% of all emissions. Satellite sensors indicate that the problem is much worse in rice fields in Asia than in Brazil or the rest of South America. However, the same sensors show that the problem of methane production is typical of tropical areas, including amazon region and other rain forests areas, but also for USA, EC and Asia, where there are mid and high level areas of methane production. That should be considered as a major concern not only for Brazil, but, also for any tropical country or region, including Africa and developed countries.

Barioni, Zen, Guimarães, and Ferreira (2007) reported very interesting projections of the Brazilian beef herd from 2007 to 2025, in terms of number of cows, herd size, number of heads slaughtered, beef production (t of carcass equivalent), and methane emission, indicating that, although the number of cows will probably decrease 3.6% (from 64.3 to 62.0 million production females), herd size will increase 7.4% (up to a total herd of 223.4 millions head), beef production will increase 25.4%, reaching 11.08 million t, but methane emission will increase only 2.9%. That very important paper suggests that methane emission in Brazilian beef production is not a major concern.

However, in pastures that fix nitrogen, the potential of CO2 incorporation is really large and increase beef production in pastures can be very good to help control of greenhouse effect.

Measures directed to water conservation, CO2 fixation, nitrogen fixation, control of erosion, preservation of trees around rivers, ponds and creeks, would be very useful to sustainability of beef production, not only seeking global environmental conditions, but, and mainly, local conditions and increase of productivity.

Technology more adequate to environment conservation will, absolutely, reduce or even eliminate deforestation and forest burn up and contribute to global environment and, also, to improvement of income and profitability to Brazilian farms. Better grass fed animals will have healthier beef and worldwide consumers will get that benefit.

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