

## **TITLE: AN ANALYSIS ON FOOD AND ETHANOL PRODUCTION IN BRAZIL**

**SUMMARY:** This study analyses and reflects on a widely debated topic of simultaneous food and ethanol production in Brazil. On one side, specialists show that an expansion in ethanol production from sugar cane can jeopardize food production in Brazil, especially in the state of São Paulo. On the other hand, the possibility of a harmonious and simultaneous production of ethanol and food using new technology along with well-defined public policies is being debated. For this reason, the main goal of this study was to measure the evolution of food production in Brazil and also evaluate the increase in growth potential for particular products. This is an investigatory study and a theoretical discussion was conducted using the analysis of historical series of production, farmed land area and the Brazilian productivity for some selected products (soy, corn and meat). The possibility of insertion of new technologies to increase productivity was also discussed in this study. The main conclusion of this study is that technological possibilities have to be taken into consideration when discussing the impact that ethanol production may have on food production in Brazil. Along with adequate public policies, it is believed that it is possible for Brazil a simultaneous and competitive production of food and bioenergy.

**Key words:** Food safety; biofuel; productivity

## 1. INTRODUCTION, RESEARCH PROBLEM AND OBJECTIVE

The National council of food and nutritional safety of Brazil –CONSEA, 2008 – (Conselho Nacional de segurança alimentar e nutricional do Brasil) have analyzed the recent crisis in the global food system and their consequences to the safety of food and nutrition in Brazil and in the world. The CONSEA (2008, p1) have identified several reasons to justify the world food crisis, and they are the following:

*“A continued raise in demand for food is one of the main factors for the raise in prices. This was due to the increase in income in developing countries such as China, India and Brazil among others. In addition to this, international food supplying countries suffered harvest problems due to climate changes. This scenario was even more worsened because basic grains such as corn and soy were used for the production of ethanol. In Brazil, the availability of unused or damaged farmable land has been used to justify the monoculture model (sugar cane) and also to hide the fact that in many areas food production is losing ground to agrofuel”.*

Based on this information, the CONSEA, in order to establish safety policies recommends regulating mechanisms to avoid the expansion of monocultures specially the ones allocated to biofuel production. These mechanisms should be used to veto public loans for crops in which their expansion would happen over the areas used for food production.

On the other hand, the potential for biofuel as an alternative to compose the world’s energy matrix has been widely discussed in the world specially when the oil barrel prices reached the highest levels in the first semester of 2008 and an energy world crisis was evident. Because of this, specialists forecast that the production of bioenergy from sugar cane could place Brazil as one of the greatest suppliers of energy. Jank( 2008, P.1);

*“We are talking about totally renewable clean electrical energy with low environmental impact and reduced construction time. It is available in the heart of the centers with the most electrical consumption precisely in the driest months of the year (it makes this energy not only clean and renewable but highly complementary to hydroelectric seasons)...*

*...It is indeed possible to produce, food, beverages, fibers, fuel and electrical energy from agricultural products in a sustained and competitive way eliminating neo-Malthusian traces buried by the history of evolution of agricultural technology”.*

Souza *et al* (2008) believes there are no evidence that the sugar cane crops in Brazil are replacing cattle-raising and soy, but there are evidences that soy crops are entering pastures, sugar cane and corn areas.

In many cases the international discussion about the competition between ethanol production and food production is distorted because of distinct realities in different countries. For this reason, an analysis of the corn ethanol production in the United States is totally different from the analysis of sugar cane ethanol production in Brazil because of land availability, energy conversion rate and the technologies used.

It is noticed that a challenge for the Brazilian agri-business is to supply the demand for bioenergy without affecting food production for the internal market as well as for export. This article intends to show the potential of Brazil, particularly the State of São Paulo, in simultaneously produce food and biofuel to supply the internal and external markets.

The overall goal of this research is to assess the food production evolution in Brazil and the possibility for increase in productivity for some specific products. The specific goals are:

- To analyze the production evolution of soy in Brazil and in the state of São Paulo;
- To analyze the production evolution of corn in Brazil and in the state of São Paulo;
- To analyze the production evolution of meat in Brazil and in the state of São Paulo;
- To analyze some coexisting possibilities in bioenergy and food production in Brazil.

## 2. BIBLIOGRAPHIC REVIEW

In the past years the world has experienced a unique process of economic growth stimulated by advances in the economies of developing countries. According to forecasts from the CIA (Central Intelligence Agency) the world's GNP (Gross National Product) grew approximately 3.8% in 2008. This growth was triggered by the performances of countries such as China (9.8%), India (7.3%) and Russia (7.4%). Such growth demands a large quantity of raw materials such as agricultural commodities.

According to Pinstrup-Anderen *et al* (1999), in 2020 the world population will be 7.5 billion people. This will mean an addition of 73 million people after 1995. A total of 97.5% of this populational growth will happen in less developed countries and the participation of these countries on the global population will move from 79% to 84%.

In his work *“An Essay on the Principle Population as it Affects the Future Improvement of Society, with Remarks on the Speculation of Mr. Godwin, Mr. Condorcet, and Other Writers”* Thomas Malthus stated that *“the growth power of a population is indefinitely greater than the power that land has to produce means of subsistence for the man”*. He considered that *“the population when not controlled grows in geometrical progression while the means of subsistence grows in arithmetic progression”* (MALTHUS, 1983, p.283).

Malthus (1983, p.315) referred to famine in the following way:

*“Famine seems to be the last frightening resource of nature. The power of population growth is greater than the soil's power to produce subsistence for man in which premature death in one way or the other afflicts mankind. The addictions of mankind are active and skilled agents for population reduction. They are the predecessors of the great army of destruction and frequently execute the dreadful job themselves. However when they fail in this war of extermination, periods of diseases, epidemics, pests and plague become active with horrible disposition eliminating thousands and hundreds of thousand of men. When success would be incomplete watchful the gigantic famine with a powerful blow sweeps the population and the food of the world”*.

However, according to Galvão Junior (2008), Malthus remained totally oblivious of the technical progress that was happening and would continue to happen in agriculture. He thought that the world would permanently be near a state of starvation and that a possible increase in agricultural productivity would be followed by fast populational growth which would consume all of the existent production and leave mankind in the same state of poverty.

Malthus concluded that the rhythm of populational growth would be faster than the rhythm for food growth (geometric progression versus arithmetic progression). In addition, he concluded that in the future possibilities for increase in farmed land would not exist because all continents would use their land for cattle-raising and the population would continue to grow. (HENRIQUES, 2007).

On the supply perspective, Malthus did not consider the incredible expansion in agricultural productivity due to advances in technology. On the demand perspective, he also did not consider the success in family planning that would lead to a reduction in the growth of the demographic rate.

In the past decades the technological evolution in cattle-raising has been fast causing structural changes in the market forcing business people to frequently adapt to changes. This evolution happened in several areas such as chemical (herbicides, insecticides, fungicides, veterinarian products and hormones among others); biochemical (vaccines, probiotics); vegetal and animal genetics (hybridization, transgenics, industrial breeding, population selection, cloning, sexed semen); mechanization (subsoil inspection, direct planting, sowing machines); microelectronics (softwares, internet, e-commerce); agricultural handling (direct

planting, super density planting, populational density); new materials (varieties, processed products) and also balanced diet among others (ARAÚJO, 2005).

Also according to Araújo (2005), between 1995 and 2005 regardless of a smaller growth of farmed areas the amount of this area was between 37 and 48 million of hectares. The Brazilian grain production grew annually beginning 1990 with 57.8 million tons and reaching 132 million tons in the 2004/2005 harvest. The small growth in farmed area compares against the fast growth in grain production. Similar situation can be observed in other segments such as cattle-raising and in the fruit culture.

Since Malthus presented his theory, it is common to hear speeches about the relationship between hunger in the planet and populational growth described in very simple terms. For Henriques (2007), the hunger that afflicts more than half of the world's population is a result of bad income distribution and not lack of food production.

In Brazil, food safety depends essentially on the purchasing power of a person to buy these foods. A significant part of the Brazilian population has such low income that they are obviously not safe about food (HOFFMAN, 1995). We can conclude that the problem of hunger in Brazil is not caused by a possible decrease in food availability but basically from demand. This is due to an enormous lack of social equality existing in the country and also the marginalization of great part of the population. (CARVALHO FILHO, 1995).

### **3. METHODOLOGY**

This study shows the result of an exploratory research. As observed by Selltiz *et al* (1967), in researches in which the main goal is to become familiarized or obtain a new understanding of a phenomenon, exploratory studies are the most appropriate. This study is conceptual and analytical and an empirical modeling was not performed.

According to classification proposed by Marconi & Lakatos (2007), this article is a theoretical discussion that analyzes the incompatibility issues between the simultaneous production of food and biofuel in Brazil. Initially, there were favorable and unfavorable arguments about the possibility of coexistence in the production of food and biofuel in the country. Secondary data was collected about production, productivity and farmed land for the cultures of corn and soy. Similar data was also collected for meat. Historical series of information was obtained at CONAB -Companhia Nacional de Abastecimento do Brasil (Supply Agency of Brazil), MAPA Ministério da Agricultura, Pecuária e Abastecimento brasileiro (Brazilian Ministry of Agriculture and cattle-raising) and FNP Intitute. For the grains, the 1976 to 2007 historical series was used while the historical series of 1998 to 2008 was used for meats.

Based on the information of the historical series of farmed land, production and productivity, the potential for the state of São Paulo and Brazil to supply internal demand and part of external demand for food was analyzed. Some alternatives for increasing the production for food without the need to increase new areas were discussed.

### **4. RESULT ANALYSIS**

#### **4.1 The increase in agricultural production in Brazil**

According to forecasts of MAPA 2008 -Ministério da Agricultura, Pecuária e Abastecimento brasileiro (Brazilian Ministry of Agriculture and cattle-raising), the GNP for agribusiness in 2007 was R\$ 564.36 billions while in the year of 2006 the GNP was R\$ 540.1 billions. The participation of agribusiness in the overall GNP of Brazil in 2007 was approximately 23.3%.

Table 1 shows that in Brazil in the period from 1990 and 2007, the cattle-raising business obtained an average growth higher than industries and services. The average annual growth rate for cattle-raising in the same period was 3.09% against 1.78% for services and 1.79% in the industry. In an analysis of a more recent period, the growth rates from the year 2000 to 2007 were higher and cattle-raising was superior to the others (MAPA, 2008).

Table 1: Annual growth rates for the real Brazilian GNP in different sectors (%).

Average for the 1990 decade			
Total	Industry	Services	Cattle
1,73	0,77	1,37	2,48
Average from 2000 to 2007			
Total	Industry	Services	Cattle
2,8	3,08	2,29	3,84
Average from the 1990 decade to 2007			
Total	Industry	Services	Cattle
2,2	1,79	1,78	3,09

Source: Prepared by MAPA based in FGV and IPEA (2008).

According to the Institute of Agricultural Economics (IAE, 2008), no other country in the world, even if they present favorable geographical conditions, soil and climate, possess enough farmable land to satiate the consumption of food for so many people like Brazil. The food export results are so expressive that even when the exchange rate of the dollar reached the lowest levels, the total value exported by the agribusiness sector jumped from US\$52.04 billions in 2006 to US\$ 61.84 billions in 2007. The exports for the sector corresponded to around 35% of the US\$ 160.65 billions exported by Brazil in the last year. The fall of the Brazilian trade balance which due to the rise in imports went from US\$ 46.46 billions to US\$ 40.03 billions in the same period, it can be said that the balance of US\$ 44.73 billions in agribusiness sustained the surplus in 2007.

Data from the agency of international commerce (Secretaria de Comércio Exterior - SECEX, 2008) show that soy export was the highest contributor for the positive result in 2008 totalling more than US\$ 11 billion. Almost 59% of this exported value was in grains, 26% in bran and 15 % in oil.

In the last years the historical Brazilian trend is growth in cattle-raising as shown in figure 1. An interesting aspect to be observed is the boost in grain production (peanuts, cotton, oat, rye, barley, beans, sunflower, castor beans, corn, soy, sorgho, wheat, triticale) was caused by an improvement in productivity of these cultures and not because of the raise in farmed areas.

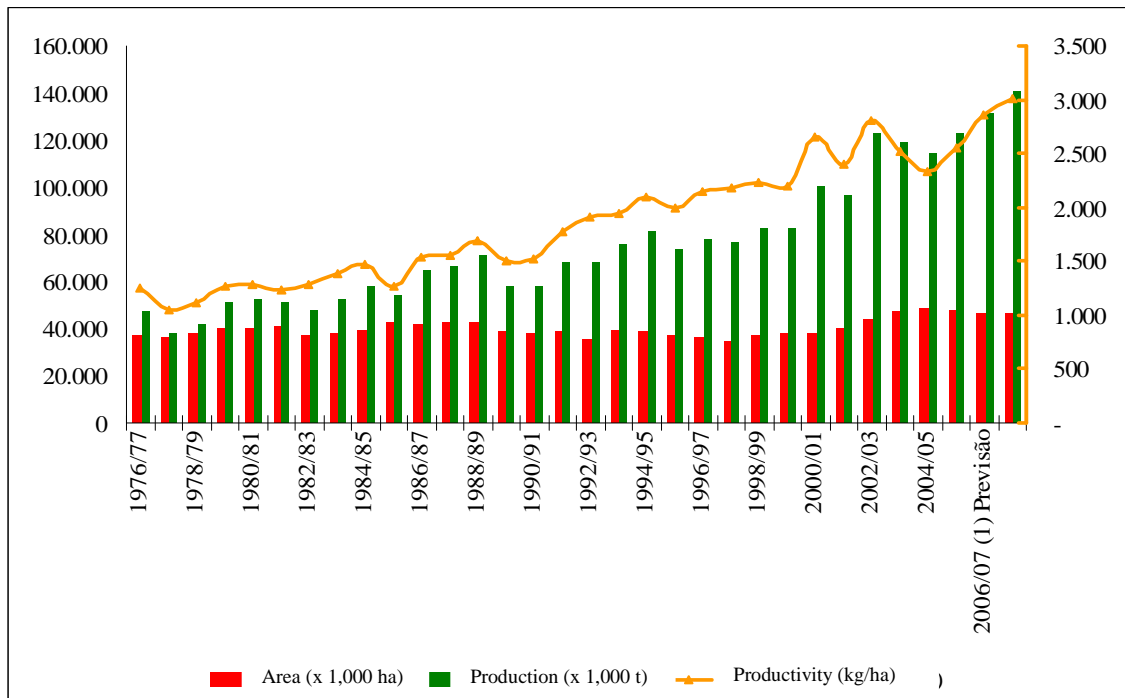


Figure 1: Brazilian grain Production and Productivity from 1976 to 2008\*.

Source: Prepared by the authors based on CONAB data (CONAB, 2008).

\* Estimate

A raise in productivity increased the availability of food from cattle and this was a positive factor and an answer to the world populational growth. As a result, Brazil currently exports a large part of the food it produces supplying not only internal demand but also part of the world's demand. Mapa (2008) estimates point in the direction that Brazil may still supply great part of the external demand for food. For soy beans, for example, in the Brazilian harvest of 2006/2007, 26 million tons out of the 56 tons produced was exported. In 2016/2017, Brazil might produce 93 million tons and export 51 million tons. This will represent a growth in export of almost 100% in the period of ten years.

In regards to the supplying capacity for the internal market, the Brazilian agriculture has also been efficient. In the 1976/1977 harvest, Brazil harvested 47 million tons in grains which represented 470 kilograms per capita. In 2006/2007, 140 million grains was harvested which corresponded to 761 kilograms per capita.

This number shows that the Brazilian production has been increasing in larger proportions if compared to the population growth in the country. This continued growth generates a product surplus to be destined for export.

Simultaneously with grain production, sugar cane production in Brazil has also increased significantly in 30 years jumping from 88.92 million tons in 1975 to 457.98 million tons in 2006. This can be seen in figure 2 according to data from UDOP- (União do Produtores de Bioenergia, 2009)

What is interesting about these figures is that the area for this culture did not expand in the same proportion. It went from 1.9 million hectares in 1975 to 6.19 million hectares in 2006. The increase in production was 515.05% while the increase in area was 325.78%.

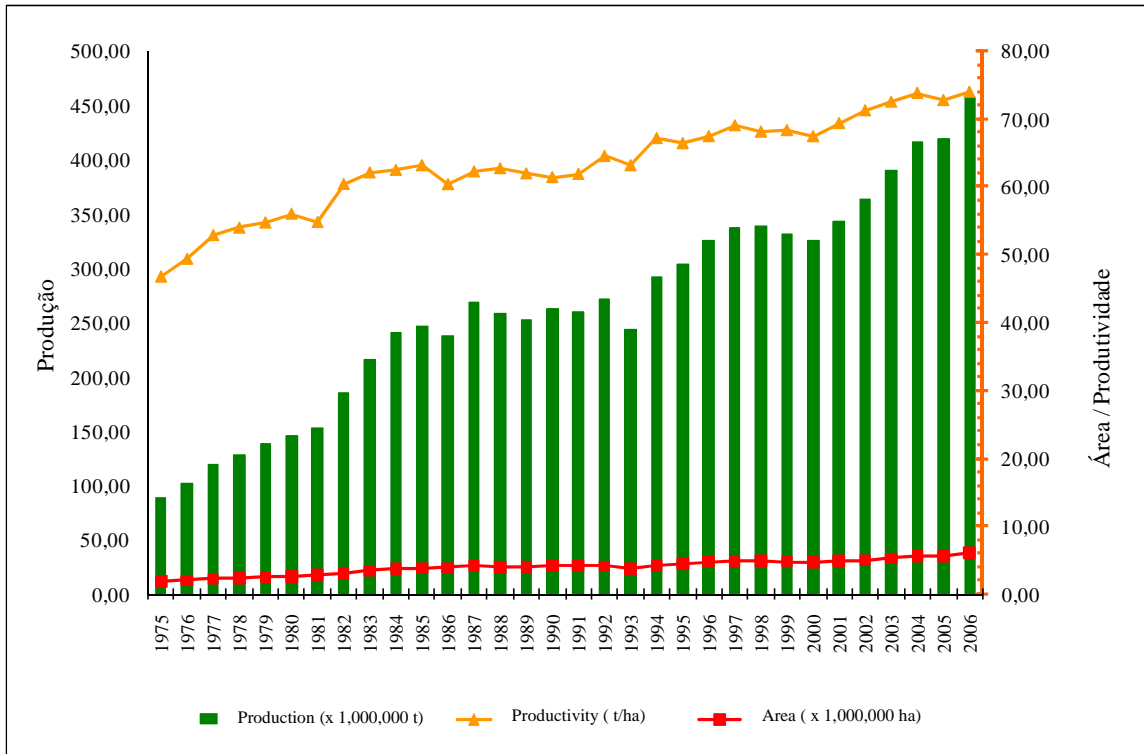


Figure 2: Production, Productivity and total area of Brazilian sugar cane from 1975 to 2006. Source: Prepared by the authors based on UDOP.

Brazil has the potential to grow and supply the needs of the world. The total area of Brazil is approximately 850 million hectares. Supposing that 490 million of these hectares are unusable (roads, the Amazon, lakes, cities), there are still approximately 340 million hectares of farmable land. In this area, 61 million hectares are already farmed with cultures like soy, corn, sugar cane and others. Also in this area there is 200 million hectares with pastures and 80 million hectares of new areas (MAPA, 2008).

#### 4.2 Soy production

The productive chain of soy corresponds to a large part of the Brazilian GNP. This grain is one of the most important among all exported products from Brazil. In 2004, the total amount exported was 19.25 tons of soy in beans, 14.48 million tons in soy bran and 2.5 million in crude or refined soy oil.(CONAB, 2008)

The United States, Argentina and Brazil are among the biggest powers in the soy world market. Considering the total exported value of the soy complex, since mid 1990's Brazil has had a growing participation in the world market. Such permanent growth did not occur in the United States. (SAMPAIO *et al.*, 2006).

According to Data from the Food and Agricultural Policy Research Institute (FAPRI, 2008), in the 2016/2017 harvest the world will produce approximately 279.7 million tons (23% more than the 2006/2007 harvest). Brazil will be responsible for 33% of this production (92.63 million tons), because of countless factors such as area expansion, raise in productivity and better transportation alternatives.

Next, figure 3 shows in tons and hectares the growth of soy production in Brazil in the period from 1976 and 2008 (estimate). Data taken from CONAB (2008). While the farmed area grew around 300% between 1976 (7 million hectares) and 2007 (21 million hectares), the

Brazilian production grew almost 500% (12 million tons in 1976 to 60 million tons in 2007). The greatest advance happened in productivity jumping from 1.78 kg per hectare in 1976 to 2.835 kg per hectare in 2007.

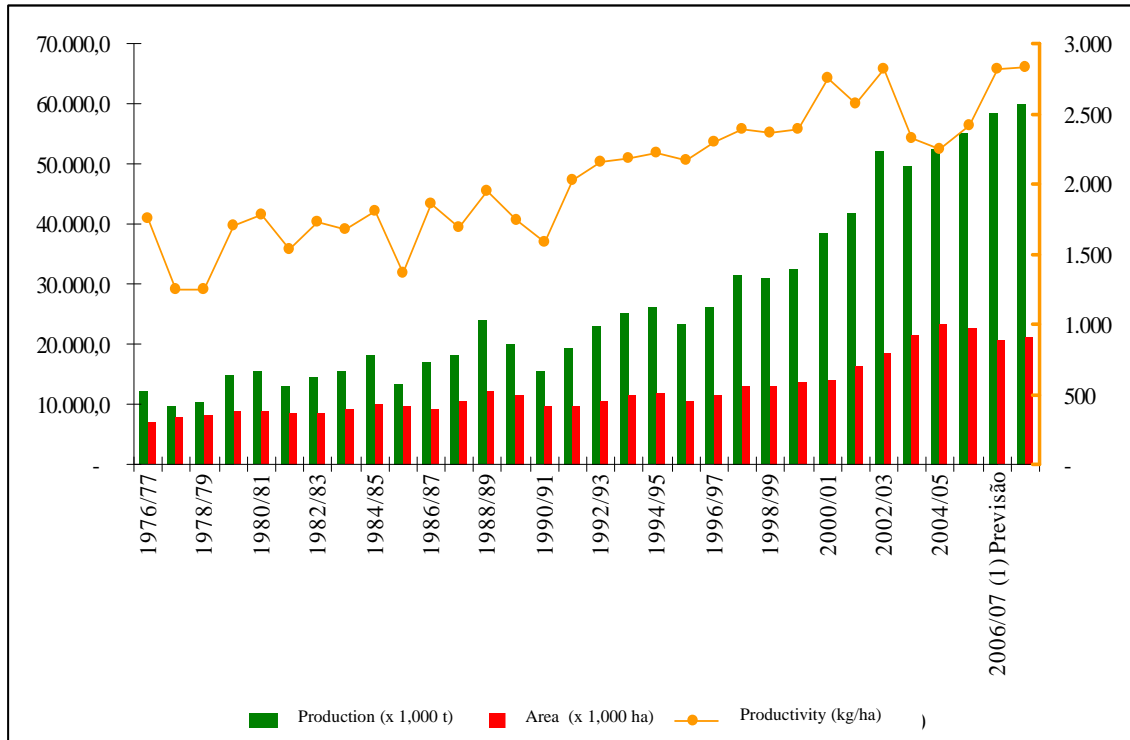


Figure 3: Production and Productivity of soy in Brazil from 1976 to 2008\*.

Source: Prepared by the authors based on data from (CONAB, 2008).

\* Estimate.

Figure 4 shows the production, farmed area and soy productivity in the state of São Paulo where soy rivals with sugar cane. In 12 years the farmed area with sugar cane has increased almost 2 times in this state, from 2,886,000.3 ha in 1995/96 to 5,497,000.1 in 2007/08 (IBGE, 2009). It can be observed that even though this region is dedicated to sugar cane, because of both natural and economical factors, ethanol does not necessarily nullify the production of food.



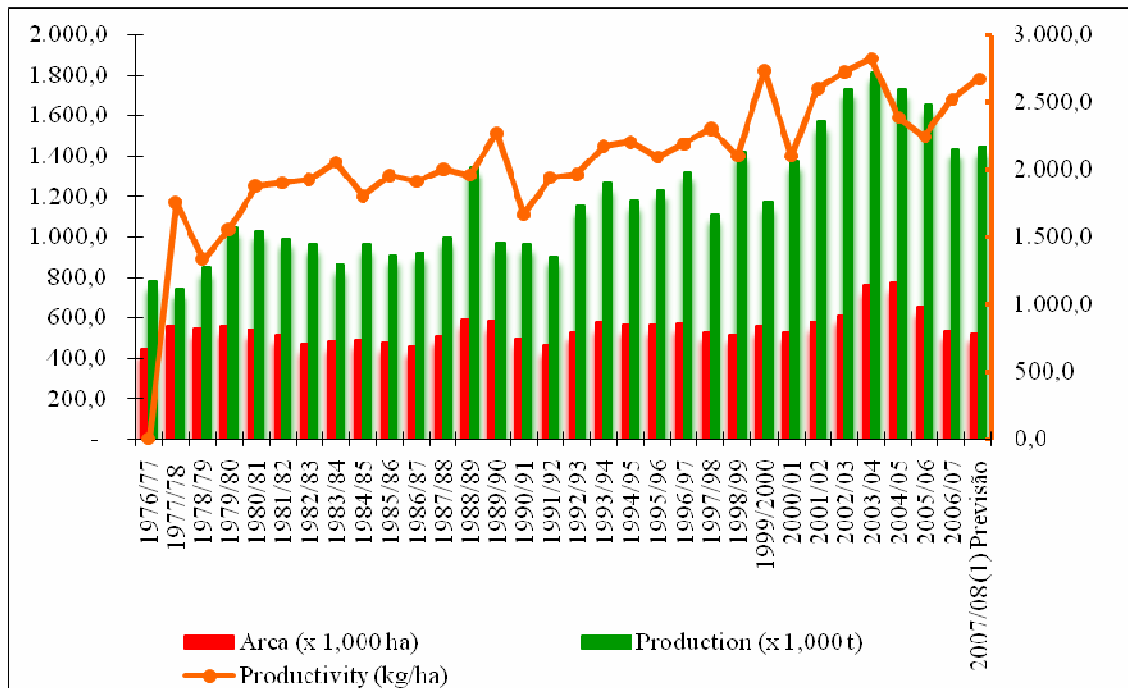


Figure 4: Production and Productivity of Soy in the state of São Paulo between 1976 and 2008\*.

Source: Prepared by the authors based on data from (CONAB, 2008).

\* Estimate.

Because of technological advances in production, the state of São Paulo was able to increase soy production even with the reduction of the soy area in the past 12 years, from 575,000 ha in 1996/97 to 526,000 ha in 2007/08. In addition, because of its leguminous nature, soy farming keeps nitrogen in the soil which is necessary for culture rotation. This culture rotation can benefit the farming of other cultures such as peanuts and beans.

### 4.3 Corn production

The Brazilian corn production is characterized by the division of two stages of planting. The first harvest or summer planting happens traditionally during the raining season which goes from the end of August (south of the country) until October or November (mid-western and southeastern Brazil). In the northeast of Brazil this period occurs in the beginning of the year. Recently, the production obtained in the little harvest (second harvest) has increased. This second harvest is planted extemporaneously in February or March almost always after the early soy. This second harvest is mainly planted in the mid-west region and in the states of Paraná and São Paulo (EMBRAPA, 2008).

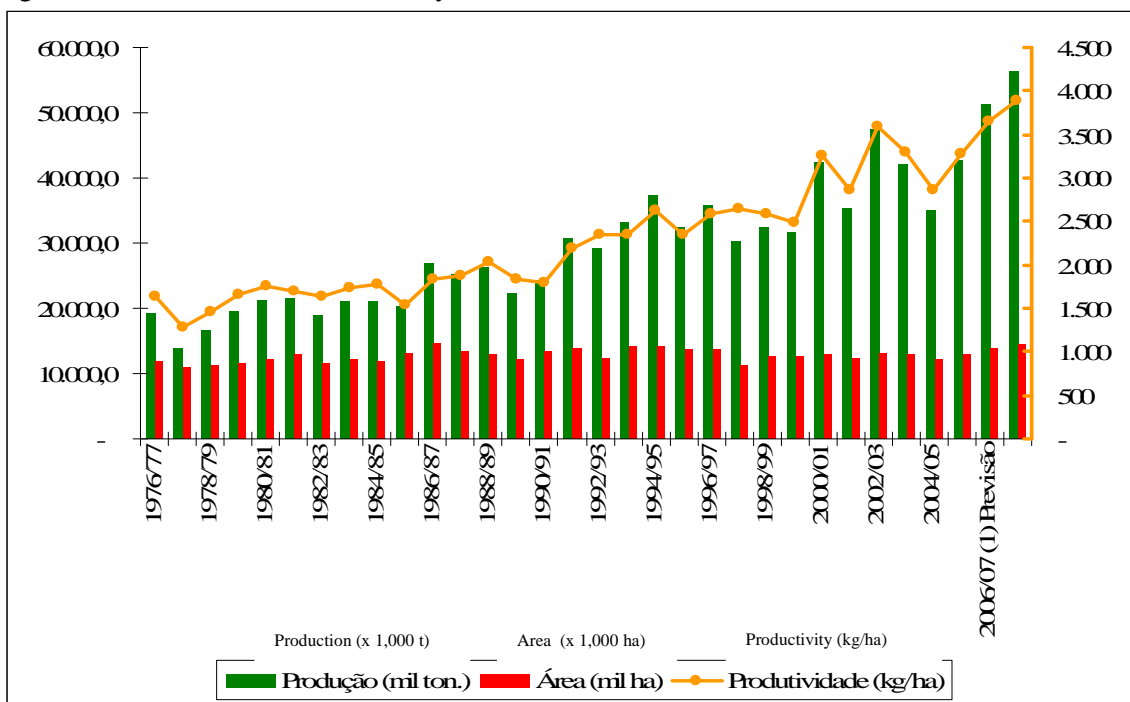
According to forecasts from FAPRI (2008), the world's overall area with corn must grow reaching 156.6 million hectares in the years 2016/2017 mainly caused by an increase in price for this cereal. Due to growth in planted areas and increase in productivity, the production should reach 850 million tons in this same year. This means an increase of 148.4 millions in the next 10 years. In this same period the use of corn for the manufacturing of animal food might increase to 46% while the industrial use and the use for food will increase to 75.9 million tons.

From figure 5 we can understand that this growth in production due to the increase in planted areas and improvement of productivity also occurs in Brazil. In 30 years the Brazilian production of corn increased approximately 32 million tons, going from 19.25 million tons in

1976/1977 to 51.36 million tons in 2006/2007. In the 2007/2008 harvest the production reached 56.23 million tons. Concerning planted areas, the total increase was 2.25 million hectares. It went from 11.8 million hectares in 1976/1977 to 14.04 million hectares in 2006/2007. These numbers show that the increase in production was due mainly because of the increase in productivity which went from 1.6 thousand kilos per hectare to 3.6 thousand kilos per hectare. This numbers were found considering an average of the two annual harvests.

The Brazilian productivity average for the first corn harvest is 4.050 kilos per hectare. It is still low compared to the Argentinean productivity average which is around 6.000 kilos per hectare and the North American average around 4.050 kilos per hectare. With the use of new technologies such as genetically modified varieties, Brazil can increase productivity in both first and second harvests.

Figure 5: Production and Productivity of Corn in Brazil between 1976 and 2008\*.



Source: Prepared by the authors based on data from (CONAB, 2008).

\* Estimate.

In the next decade the forecasts signal growth for the Brazilian production of corn. In 2017/2018 the production will approximately be 64.1 million tons. From this total it is believed that approximately 48.6 million tons will be used for internal consumption and a surplus of approximately 12 million tons will be exported (MAPA, 2008). Consequently, in 2017 Brazil will export almost double of the corn exported nowadays.

Figure 6 shows the production, planted area and productivity of the corn culture in the state of São Paulo where corn competes with sugar cane. It can be observed that there was an increase in corn production from 2.5 million tons to approximately 4.2 million tons in the last decades. From the harvest of 2006/2007 to the harvest of 2007/2008 there was a 4.4% increase in tons while there was a decrease of 1.6% of planted area in the same period. Again, this shows that productivity is the biggest responsible for the growth in production in tons.

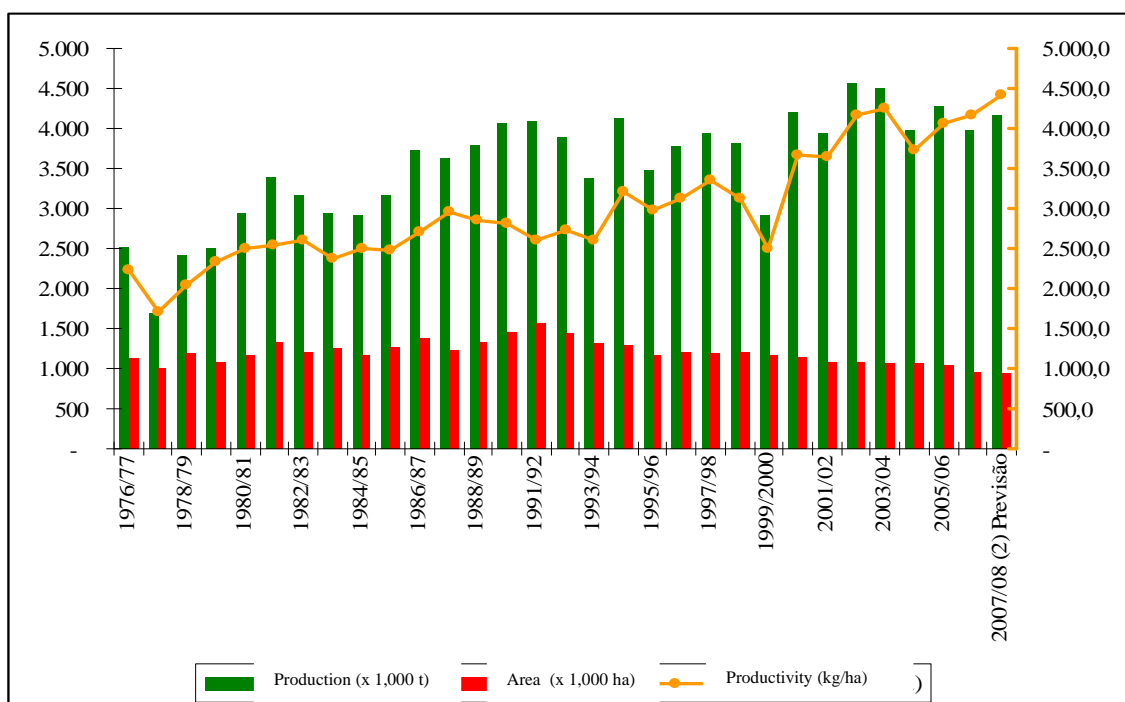


Figure 6: Production and Productivity of corn in the state of São Paulo between 1976 and 2008\*.

Source: Prepared by the authors based on data from (CONAB, 2008).

\* Estimate.

In the figure we can also notice that in the same state where the biggest sugar cane plantations exist, it is possible to grow other cultures such as corn. It is possible to sustain production creating new agricultural borders and increasing productivity using the latest technology.

#### 4.4 Meat Production

In a world scenario where a raise in income and population growth has created competition among exporting countries, Brazil is the main producer and exporter of products of animal source. The Brazilian meat sector is one of the areas with the most dynamic technology and knowledge.

According to Ministry of Development, Industry and International Commerce (MDIIC), currently Brazil is the biggest exporter of beef and poultry in the world and the fourth largest in pork. In 2007 Brazil reached a historical figure of US\$ 11 billions of meat export and was the second highest exported item only behind the soy complex. It is believed that meat export may soon become the leader in sales for the foreign market.

The export of meat has grown in the last years specially poultry and pork. There was also a growth in beef in the last year but at lower rates than the other types of meat. In 2016, the meat production in the world must reach 318.8 million tons. This number is 45.7 million tons more than in 2007. From these 328.8 million tons, 76.4 million will be beef, 129 million pork and 98.5 millions in poultry (MAPA, 2008).

According to FAPRI, in 2016 Brazil, Australia, India, Argentina and New Zealand will lead the exports for meat in the world. These countries will possess 93.8% of the exports

of meat in the world. Among these countries Brazil will continue to be the biggest exporter with 39.2% or 2.840 thousand tons.

For pork, it is estimated that in 2016 the biggest exporters will be the European Union, Canada, the United States and Brazil whereas for poultry the biggest exporters will be the United States and Brazil with 89.4% of the market (FAPRI).

Figure 7 shows that in the last decade the growth in beef production in Brazil was 1.438.062 tons going from 6.688.072 tons in 1998 to 8.126.134 in 2007. In Brazil cattle farming is done mainly in pastures using the extensive system. Even though most of the Brazilian cattle are in other states, production in the state of São Paulo almost remained constant in the last decade. It went from 1.035.836 tons in 1998 to 948.956 tons in 2007.

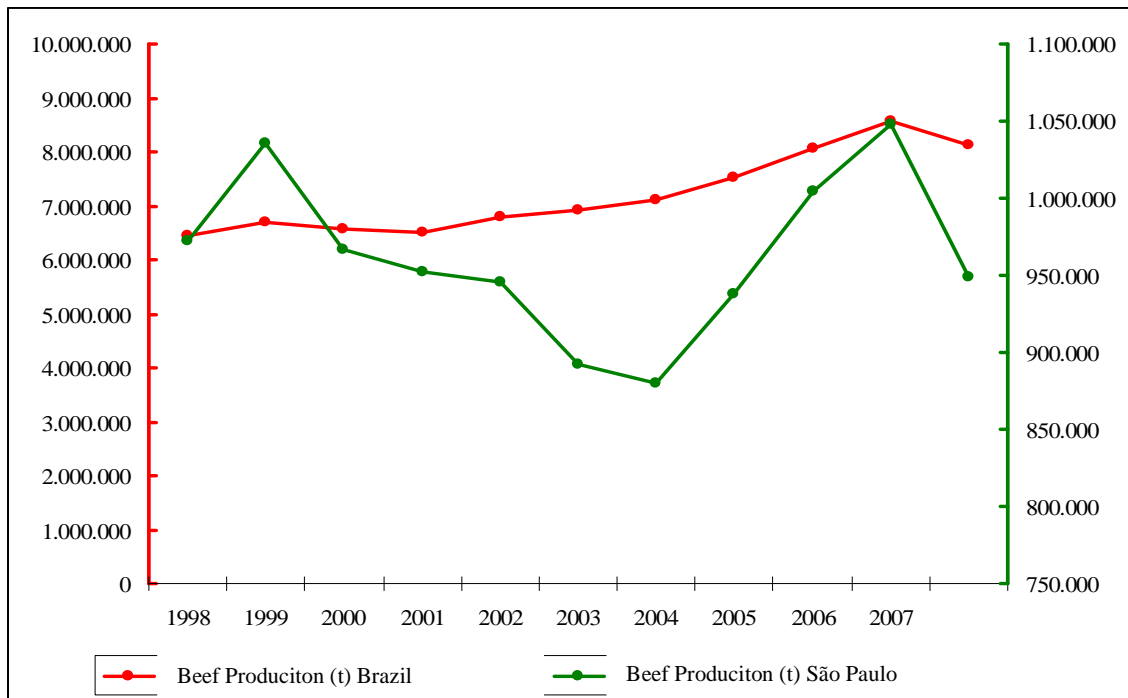


Figure 7: Production of beef carcass equivalent in tons in the state of São Paulo and Brazil. Source: FNP, 2007.

In the case of beef, the relationship between food production and ethanol must be carefully analyzed. The average occupancy rate in Brazil is 0.8 UA<sup>1</sup>/ha which is a very low average. This is due to the use of the extensive system and the little use of technology which is adopted in the country.

According to simulations performed by specialized consulting (SCOT, 2008), today the Brazilian herd is about 201 heads of cattle and it could easily reach 301.5 million heads only by incorporating new technology. Brazil could reach 1.2 AU/ha without the need of increasing pasture areas. With an average occupancy rate of 4 UA/ha, the Brazilian bovine herd would reach 1.02 billion heads and it could become the largest herd in the world. Thus, Brazil has the potential to supply the world's demand for meat without using new areas and not to mention increase occupancy rates even more with confinements.

<sup>1</sup> 1 AU (Animal Unit): an animal unit is the same as 450 kilograms of live weight.

The production forecasts for meat production in Brazil show that this sector will present intense dynamism in the next years. It is estimated that the poultry sector will have the biggest growth rate in the next decade and it will grow at a rate of 3.26% a year. The beef sector will follow the poultry sector with a rate of 2.48% a year. The sector of swine meat will grow at a rate of 1.86% a year which represents a relatively high value because it will be sufficient to supply internal demand and exceed for export.

These indexes show that even with the fear that the production of bioenergy could occupy the space used for the production of food, Brazil will continue to be one of the world's biggest suppliers with space for pastures and the production of grains for animal food.

## **5. CONCLUSION**

This study evaluated the food production and the growth potential in productivity for specific products in Brazil. This analysis was performed with the goal of discussing the possibility for biofuel production and food production in Brazil because this has recently been a widely discussed topic in the last years.

In summary, the main conclusion of this study is that the discussion about the impact of ethanol production on food production in Brazil needs to be considered in terms of technological possibilities. Brazil has a big extension of incorrectly used land, damaged areas and areas with low productivity. Without deforestation, it is possible to increment food and biofuel production in the already existing areas. In order for this to happen, it is necessary to invest in the use of the already existing technologies which can increase productivity. This can be done increasing the occupancy rate (in beef cattle-raising), with the use of biotechnology (for grains and sugar cane), and irrigation among other kinds of technological techniques.

For the state of São Paulo some culture such as soy, beans and peanuts must co-exist with sugar cane because it is important for culture rotation and improvement of soil fertility. Also, sugar cane residues can be used as volume in bovine confining systems.

A food price inflation, which many specialists explained as being a clash between supply and demand, happened at the same time farmers were suffering with the prices paid for many agricultural commodities such as soy, corn, beans among others. It is believed that with the implementation of adequate public policies, it is possible for Brazil to have a competitive and simultaneous production of food and bioenergy. It is worth mentioning that sugar cane is responsible for only 1% of farmable land in the country.

This study is investigatory and it has its limitations. The main goal was to study historical series of some selected products and also study some possibilities to increase productivity. Certainly, other more profound and specific studies will analyze the competition between sugar cane and each product in an isolated way.

## BIBLIOGRAPHICAL REFERENCES

- ARAÚJO, M. J. **Fundamentos de Agronegócios**. 2. ed. São Paulo: Atlas, 2005. 155 p.
- CARVALHO FILHO, J. J. **A produção de alimentos e o problema da segurança alimentar**. Available at: <[http://www.scielo.br/scielo.php?pid=S0103-40141995000200008&script=sci\\_arttext&tlng=en](http://www.scielo.br/scielo.php?pid=S0103-40141995000200008&script=sci_arttext&tlng=en)>. Access in: 12 jun. 2008.
- CIA. Central Intelligence Agency. Available at: <https://www.cia.gov/library/publications/the-world-factbook/geos/xx.html>. Acesso em: 27 mar. 2009.
- CONAB. Companhia Nacional do Abastecimento. **Historical series**. Available at: <<http://www.conab.gov.br/conabweb/>>. Access in: 13 jun. 2008.
- CONSEA. Conselho Nacional de Segurança Alimentar e Nutricional. **Exposição de Motivos**. Available in: <<https://www.planalto.gov.br/Consea/exec/index.cfm>>. Access in: 25 jun. 2008.
- EMBRAPA. **Cultivo de Milho**. Available in: <<http://www.cnpm.embrapa.br/publicacoes/milho/index.htm/>>. Acesso em: 23 jun. 2008.
- FAPRI. Available at: <<http://www.fapri.iastate.edu/>>. Access in: 23 jun. 2008.
- FNP. **Anualpec 2006**: Anuário da Pecuária Brasileira. São Paulo. AgraFNP. 2007. 369 p.
- GALVÃO JUNIOR, P. **Um Ensaio Crítico Sobre a Pobreza: de Malthus a Sachs**. Available in: <<http://www.cofecon.org.br/>>. Access in: 09 jun. 2008.
- HENRIQUES, A. **Thomas Robert Malthus: A Teoria Malthusiana**. Available at: <[http://www.miniweb.com.br/ciencias/artigos/Thomas\\_Robert\\_Malthus.pdf](http://www.miniweb.com.br/ciencias/artigos/Thomas_Robert_Malthus.pdf)>. Acesso em: 02 jun. 2008.
- HOFFMAN, R. **Pobreza, insegurança alimentar e desnutrição no Brasil**. Available at: <[http://www.scielo.br/scielo.php?pid=S0103-40141995000200007&script=sci\\_arttext/](http://www.scielo.br/scielo.php?pid=S0103-40141995000200007&script=sci_arttext/)>. Access in: 12 jun. 2008.
- IEA. Instituto de Economia Agrícola. Available at: <<http://www.iea.sp.gov.br/out/index.php>>. Access in: 15 abr. 2008.
- JANK, M. S. **Cana-de-açúcar: o novo paradigma da energia limpa e renovável**. Available at: <[www.unica.com.br/opinio/show.asp?msgCode={388F00C1-93A1-4752-842F-DEE18769F62E}](http://www.unica.com.br/opinio/show.asp?msgCode={388F00C1-93A1-4752-842F-DEE18769F62E})>. Access in: 25 jun. 2008.
- MACHADO, L. **Grandes Economistas XIII: Malthus e o alerta demográfico**. Available at: <<http://www.cofecon.org.br/>>. Access in: 12 jun. 2008.
- MALTHUS, T. R. **Ensaio sobre a População**. Tradução de: Antonio Alves Cury. São Paulo: Abril Cultural. 1983, 388 p. (Os Economistas). Título original: *An Essay on the Principle Population as it Affects the Future Improvement of Society, with Remarks on the Speculation of Mr. Godwin, Mr. Condorcet, and Other Writers*.
- MAPA. Ministério da Agricultura, Pecuária e Abastecimento. **Projeções do Agronegócio: Mundial e Brasil**. Disponível em: <<http://www.agricultura.gov.br/>>. Acesso em: 13 jun. 2008.
- MARCONI, M. A.; LAKATOS, E. M. **Fundamentos de Metodologia Científica**. 6 ed. São Paulo: Atlas. 2007. 315 p.
- MDIC. Ministério de Desenvolvimento, Indústria e Comércio Exterior. **A Cadeia Produtiva de Carnes**. Disponível em :

<http://www.mdic.gov.br/sitio/interna/interna.php?area=2&menu=855>. Acesso em: 23 jun. 2008.

PINSTRUP, A.; LORCH, R. P.; ROSEGRANT, M. W. World Food Prospects: Critical Issues for the Early Twenty -First Century. **Food Policy Report**. International Food Policy Research Institute. Washington , D.C. 1999.

SAMPAIO, L. M. B.; SAMPAIO, Y.; COSTA, E. F. Mudanças políticas recentes e competitividade no mercado internacional de soja. **Revista de Economia e Sociologia Rural**. Brasília, v. 44, n° 03, p. 383-409, 2006.

SCOT. Disponível em: <<http://www.scotconsultoria.com.br/>>. Acesso em: 28 jun. 2008.

SECEX. Secretaria do Comércio Exterior. Disponível em: <<http://www2.desenvolvimento.gov.br/sitio/secex/secex/competencia.php/>>. Acesso em: 23 jun. 2008.

SELLTIZ, C.; JAHODA, M.; DEUTSCH, M.; COOK, S. W. **Métodos de Pesquisa nas Relações Sociais**. Tradução de: Dante Moreira Leite. 2 ed. São Paulo: Herder, 1967, 687p. Título original: *Research Methods in Social Relations*.

SOUZA, G. S.; ALVES, E.; GOMES, E. G.; GAZZOLA, R.; MARRA, R. Substituição de Culturas: uma abordagem empírica envolvendo cana-de-açúcar, soja, carne bovina e milho. **Revista de Política Agrícola**, Brasília, ano 16, v. 1, p.3-13, 2007.

UDOP, União dos Produtores de Bioenergia. Available at: <http://www.udop.com.br/>. Acesso em: 10 abr. 2009.