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Biodiesel in Brazil: analysis of the first decade of production

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Introduction

At the end of the 20th and early 21st century, agricultural systems incorporate a new mission: to generate energy for a world population that continues to grow and whose way of life demands not only food, but also energy with low environmental impact. In this sense, biofuel policies emerge in various countries originated from the deals made in the agenda 21 during the Rio Summit in 1992 (Silveira, 2013). Various chapters of the agenda are about promoting the energy offer by way of more efficient technologies, through the use of renewable/alternative energies for human settlements, in order to reduce the negative impacts of production and use of fossil energy in human health and on the environment (UN, 1992).

In December 2004 the Brazilian Biodiesel production program (PNPB) was created, and besides the requirement for mixing biodiesel and diesel, had as a goal the creation of new jobs and income in poor rural areas through the use of a wide range of oily seeds (especially castor bean). The case of Brazil is no different from that of other countries, which wished to promote the production of biodiesel with social, environmental and technological purposes. However, in the contexts where various countries created programs there is an increasing concern regarding their sustainability (Rathmann et al., 2012).

In March 2005, Brazil produced its first 49 barrels of pure biodiesel (B100) and began its addition to mineral diesel. From January 2008 the blending of B100 to diesel oil at a 2% level became mandatory, being increased to 3% in July 2008. Between July and December 2009 the level was increased to 4%, going up again in January 2010 to 5% and maintaining this level up to June 2014. Between July and October 2014 the blend was leveled at 6% and is currently of 7% (ANP, 2015)

Soybean oil continued to be in 2013 the main raw material for the production of B100 being responsible for 76.4% of total production. When considered the period between 2006 and 2013, it was responsible for 82.4% of the production of B100. The second raw material was animal fat (19.8% out of total production) whose production increased 26.3% when compared to 2012, followed by cotton oil (2.2% out of total production) and other fatty materials. Thus, biodiesel production in Brazil is almost completely originated from two sources: soybean and animal fat. In 2013 industrial nominal capacity for the production of B100 was of about 8 million m^3 and national production was 2.9 million m^3, which corresponds to 36.4% of the capacity installed (ANP, 2014).

Despite the significant increase in production along the 1960s, it was in the ‘70s that soybean was consolidated as the main crop of Brazilian agribusiness, going from 1.5 million tons (1970) to

over 15 million tons (1979). In this period, over 80% of the volume produced was concentrated in the southern region of Brazil (EMBRAPA, 2006).
KOHLHEPP (2010) has highlighted that there are certain points to be considered from ecological and social perspectives on the use of soybean. He considers planting monocultures by landowners, concentration of property and massive oppression against small producers and numerous land conflicts, overuse of agrochemicals and consequent contamination of water, high mechanization and little hand demand work, as well as competition for land use with the producers of basic foodstuffs. Moreover, it has been proved that the homogenization of the agrarian landscape leads to the emptying of the countryside and strengthens the migration of the excluded to the circuit of urban poverty.
The goal of this paper is to analyze the impacts of the first decade of biodiesel production in Brazil.

Material and Methods

The number of hectares used for the cultivation of rice, bean, corn and soybean, main crops that compete for land use during spring/summer periods were obtained from the historical series database from the Companhia Nacional de Abastecimento (CONAB, 2015). The use of data regarding area planted serves as an indicator of the farmer's decision on "what to produce", so factors that lead to higher or lower production each year, such as climate, sanitary and economic conditions have been removed from the analysis, which focuses on farmer decision.
The data that refers to biodiesel production was obtained from the Boletim Mensal do Biodiesel, which is made available by the Agência Nacional do Petróleo (ANP, 2015). The monthly production of biodiesel is presented in number of barrels, which is equivalent to 159 liters, being that one hectare of soybean produces an average of 400 liters of biodiesel.

Results and Discussion

In foresight about the Brazilian energy matrix, Tolmasquim et al. (2007) declare that since the Industrial Revolution economic competitiveness between countries and its citizens' quality of life are intensely influenced by energy. In a global market and in face of growing concerns regarding the environment this influence has revealed itself increasingly decisive. In this context, the economies that best position themselves regarding access to energy sources with low cost and low environmental impact obtain important comparative advantages. This matter presents itself to Brazil as a challenge and as an opportunity at the same time. As a challenge because economic and social development will demand an expressive amount of energy and thus a high degree of energy reliability and sustainability. It is also an opportunity due to the fact that Brazil disposes of very special conditions of renewable energy resources and technology to transform its natural riches into energy, aggregating value to its production of wealth.
One of the main goals of the Biodiesel program, which was to develop the production of oily seeds by small farmers in order to create jobs and income in poor regions of the country, particularly in the northeast, was not achieved. Despite of tax incentives conceded by the federal and state governments such as Bahia, Ceará and Piauí to set biodiesel refineries in the region, only 15% of the units in the country are located in the region (Rathmann et al., 2012). Thus, in 2013 the Central-West region was still the largest biodiesel producer, followed by the South (ANP, 2014), being that both achieved the 82.29% mark of total produced in the country (ANP, 2015). This participation is a reflection of the fact that Biodiesel has as its main production source soybean and animal fat, being these regions the largest producers of these raw materials.
In Table 1 an increase in the area cultivated with soybean can be observed, as well as the direct relation between the increase in the production of B100 in Brazil and the increase in the area cultivated with soybean destined for the production of energy. It can be verified that up to 2010

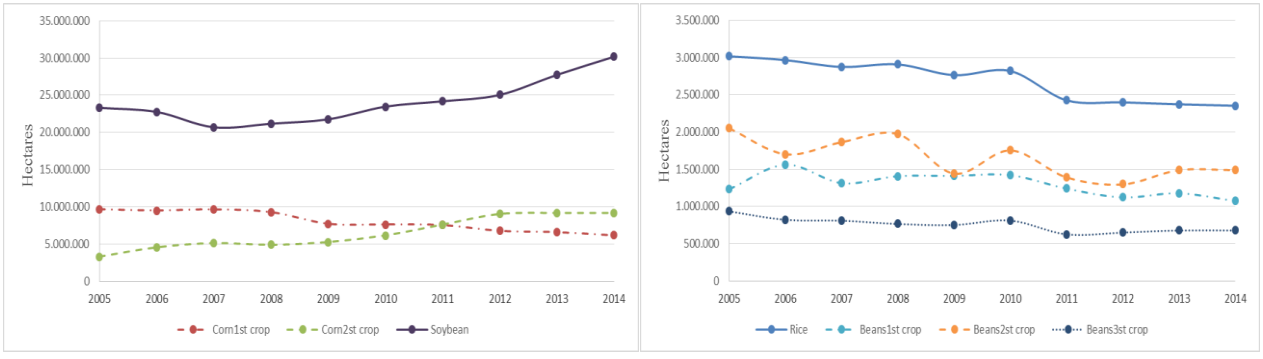
the area destined for the production of B100 has increased in percentage in relation to the area cultivated with soybean, subsequently stabilizing. The area planted with soybean increased in 6.871.434 hectares out of which 6.429.536 were used for the production of B100. Thus in 2014 the area destined for use as a food source was 23.743.564 ha, that is, a number very close to that cultivated in 2005 (23.301.666 ha), year in which B100 began to be produced. Therefore when we consider only soybean it can be inferred that the cultivation for the means of producing Biodiesel has not affected food production, one of the questions referring to biofuels policy, the competition between energy production and food (Kohlhepp, 2010).

Table 1. Biodiesel production and its relation to the area for the production of soybean in Brazil.

	Year	Biodiesel Barrel	Percentage soybean source in Biodiesel	Soybean Hectares Total	Soybean Hectares to Biodiesel	Percentage Hectares to Biodiesel
Brazil	2005	4,670	30.71	23,301,666	570	0.00
	2006	437,749	95.29	22,749,666	165,816	0.73
	2007	2,565,064	86.58	20,686,393	882,737	4.27
	2008	7,404,263	82.14	21,174,721	2,417,575	11.42
	2009	10,203,997	77.44	21,761,782	3,141,192	14.43
	2010	15,139,312	82.94	23,467,094	4,991,323	21.27
	2011	16,955,989	81.23	24,181,410	5,474,960	22.64
	2012	17,239,715	77.43	25,042,559	5,305,812	21.19
	2013	18,508,546	76.39	27,736,100	5,620,395	20.26
	2014	21,658,989	74.68	30,173,100	6,429,536	21.80

Source: elaborated by the author based on data from CONAB (2015) and ANP (2015).

On figure 1 apart from second harvest corn all other crops suffered a reduction in this period, indicating a direct effect of the farmer's decision on "what to produce". First harvest corn was reduced in an area equivalent to 3.474.400 ha, which clearly shows the prioritization of soybean crop adopted by farmers. However, second harvest corn increased its area in 5.871.600 ha due to the fact that during this period soil use does not compete with soybean, thus emerges the soybean-corn binomial, especially in the Central-West region. In the annual balance the area dedicated to corn crop increased 2.397.200 ha.



Source: elaborated by author based on data from CONAB (2015).
Figure 1. Areas cultivated with rice, bean, corn and soybean in Brazil between 2005 and 2014.

The impact on rice and bean crops, considered essential to the Brazilian diet, was clearly negative with a reduction of 663.926 ha (22%) and 1.026.500 ha (24.3%) respectively. Data endorses Kohlhepp´s (2010) predictions about the competition between food and energy.
Therefore, in the last five years soybean is clearly the energy source stimulated by government policy to increase the presence of B100 in diesel. Of course, this large increase in area aimed at direct energy production in the last ten years could only have two origins: increase of agricultural borders or advancing over areas that were used for other crops or for animal production. Impacts on the use of land were described by Lapola et al. (2010).

Conclusions and Outlook

Biodiesel policy in Brazil has led to an enlargement of the area used with soybean crop over rice and bean crop. It should also be considered that the impact regarding biomes and different states should be studied, as is the case of the state of Rio Grande do Sul for example, which has become the largest B100 producer in Brazil. In this state the soybean advance happens over natural pasture of the Pampa Biome where social and environmental impacts have scarcely been studied.

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