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Towards the B20? An Analysis of the Capacity and Potential of Biodiesel Production in Brazil

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Abstract

Biodiesel production in Brazil started with the advent of the National Program for the Production and Use of Biodiesel (PNPB). A program that established specific standards for the production and commercialization of biofuel and institutionalized the percentage of biodiesel blend in diesel, initially set at 2%. In few years, the government policy had developed, culminating in the current blend percentage of 8%. Therefore, the main goal of this research was to analyze the capacity and potential of biodiesel production in Brazil, in order to achieve eventual compulsory demand for B20. A study was carried out regarding the installed production capacity, as well as regarding the effective production of biodiesel in the country, from the production of diesel and the compulsory demand established in Law. The research also analyzed the need to expand the soybean planted area in order to meet this eventual demand. The results demonstrated that for a supposed use of 20% biodiesel in diesel, in terms of manufacturing capacity, Brazil would not have problems in achieving it, since the industries work with extensive idle capacity. However, when simulated the need to produce biodiesel with what was actually manufactured during a historical series from 2006 to 2015, it can be noted that there is a worrisome growing gap between these numbers, revealing that if the country does not invest in alternative raw materials and greater regional distribution of industrial plants, adapted to their respective local characteristics, it may face supply problems in the biodiesel chain.

Keywords: Biodiesel, Installed Capacity, Production Potential, Renewable Energy, Clean Production.

1.0 Introduction

Renewable energies, in their most diverse aspects, among them solar, wind and biomass energy, have been studied by several segments of society. Scientists, public officials, entrepreneurs and investors are aware that this is an important path in the quest for a sustainable energy economy. Among these resources, biodiesel stands out as a viable alternative to fossil fuels.

Biodiesel is a biofuel made up of esters of fatty acids, obtained through the chemical reaction of vegetable oils and animal fats with an alcohol in the presence of a catalyst. Its environmental benefits, according to Lima (2005) and Buainain and Batalha (2006), are already known to the point of it being considered an advanced fuel, since it reduces the emission of greenhouse gases (GHG) by at least 57% compared to its direct competitor, diesel, making it one of the most practical and cost-effective ways to combat the climate change process.

In Brazil, attention turned to Biodiesel with the creation of the National Program for the Production and Use of Biodiesel (PNPB; created in December 2004). With the goal of reconciling a strategic program, PNPB involves energy generation with social inclusion. According to Martins and Fortuna (2015), the project institutionalized the normative basis for the production and commercialization of biofuel in the country and developing tax advantages for companies that purchased raw materials from Family Agriculture.

Despite some constraints caused by the initial requirement to use raw materials exclusively from small producers, which do not have conditions in terms of scale to supply the biodiesel producing industries, adjustments were made and the market has developed. Proof of this is the evolution of the PNPB. As of 2008, according to the National Agency for Petroleum, Natural Gas and Biofuels (ANP), the blend of pure biodiesel (B100) to diesel oil became mandatory in 2% (B2), between July 2008 and June 2009 it was of 3%, between July and December 2009 it was of 4% and between January 2010 and June 2014 it was of 5%.

In 2014, with the approval of the Provisional Measure 647 (converted into Law No. 13,033) which amended Law No. 9,478 of 1997 regarding the production and commercialization of biodiesel in the country, instituted B6 as of July 2014 and B7 as of the month of November of the same year. More recently, in March 2017, through the Presidential dispatch with the approval of Resolution No. 11 of the National Energy Policy Council (CNPE), the blend was increased to 8%. (PORTAL BRASIL, 2017).

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According to the agency, as of March 1, 2018 and March 1, 2019, the resolution foresees an increase of the blend to 9% and 10% respectively. With the current percentage, Brazil stands out as the second largest producer of Biodiesel in the world, behind the United States alone and ahead of traditional producers in Europe (such as Germany). According to Portal Brazil (2017), merely with the addition of the B7, the installed production capacity reached 7.2 billion liters per year. It is more than enough to meet the compulsory demand for B10, which is estimated at six billion liters, when valid, scheduled for 2019. In view of this perspective, the questioning of this research arose: Does Brazil has the capacity and potential to reach eventual compulsory demand for the B20? To answer this problem, the general goal of this research is to analyze the capacity and production potential of biodiesel in Brazil.

In the specific scope, it is intended to (1) evaluate the current production capacity of biodiesel in Brazil, (2) verify the current demand for biodiesel in the national territory as a function of diesel consumption, and (3) verify the production potential of biodiesel from available raw materials as well as estimate the need for oilseeds necessary to meet an eventual B20 demand.

2.0 Installed Capacity for Biodiesel Production versus Current and Future Biodiesel Demand in Brazil

The term 'installed capacity' can be defined as the production limit or the maximum production capacity of a manufacturing, commercial or service unit. In Brazil, according to ANP (2006), there are 53 industrial plants authorized to produce biodiesel, 25 in the Central-West Region; 14 in the South Region; nine in the Southeast Region; four in the Northeast Region and only one in the North Region. **Table 1** below compiles this information and adds the production capacity in m^3 per year of each Brazilian region.

Table 1: Number of biodiesel industrial plants per Region with their respective installed production capacities.

Region	Industrial plants	Annual production capacity in m^3/year
Central-West	25	3,176,321,3
South	14	2,774,850,5
Southeast	9	9,673,96,0
Northeast	4	4,822,12,5
North	1	3,2850,0
Total	53	7,433,630,3

Source: ANP (2016).

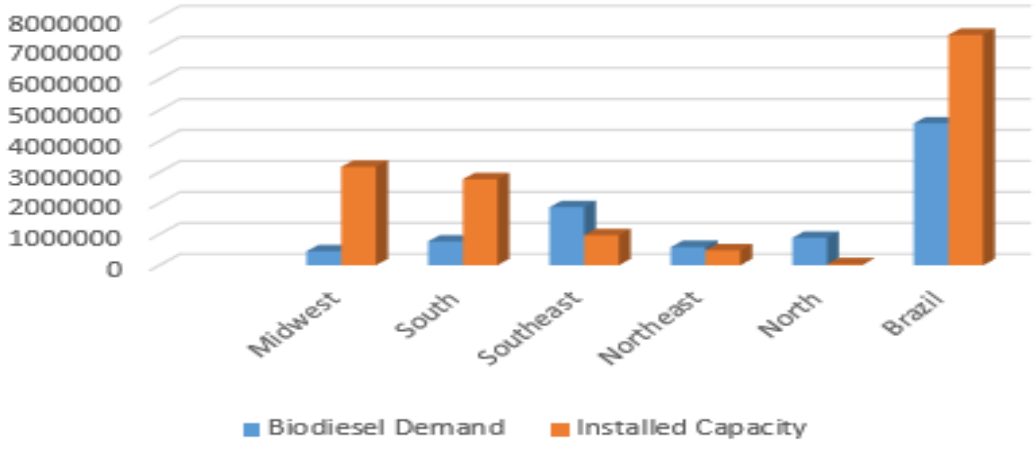
The installed capacity, shown in **Table 1**, according to Portal Brazil (2017), is more than enough to meet the compulsory demand for B10. Despite the expressiveness of the numbers, there is a certain disparity between the regions.

The Central-West Region leads the ranking with 47% of companies and 43% of production capacity. Next we have the South Region, with 26% and 37%, respectively.

The Northeast and North Regions have the lowest number of industries, with 7.5% and 1.9%, and 6.5% and 0.45% of installed production capacity.

The analysis of this disparity is important, since some regions of the country have difficulty in meeting their internal demand.

By verifying the situation of each particular area, according to the ANP's data for 2016, it can be seen that the North, Northeast and Southeast regions are deficient in relation to their domestic biodiesel demand, needing to import this biofuel in order to meet the compulsory blend. In contrast, the South and Center-West regions have installed capacity above their needs. **Figure 1** below shows the dimension of these heterogeneities.



Source: ANP (2016).

Figure 1: Regional disparities between the demand for biodiesel and installed capacity by Regions in the year 2016 in Brazil.

Despite regional disparities, when observed only from the point of view of installed production capacity, Brazil does not have problems to meet its compulsory demand.

However, observing the country's actual production of biodiesel, it can be seen the presence of extensive idle capacity. To get an idea, for B8 with a compulsory demand of 4,576,869.63 m3, the actual production of biodiesel in the country in 2015 was 3,937,269 m3. (ANP, 2016).

According to the ANP (2016), in 2016, the situation became worse, indicating a production of 3,801,339 m3 of biodiesel, or 3.45% less than the production of 2015.

Figure 2, below, makes a parallel between the production of diesel oil, from 2008 to 2016[1] , period in which the blending started to be mandatory, with the effective production of biodiesel and the compulsory demand for biofuel.

Source: ANP (2016).

Figure 2: Production of diesel oil, biodiesel and biodiesel demand between 2008 and 2016.

With Figure 2, it is possible to identify that, during the periods 2008 and 2016, the compulsory demand for biodiesel was very close to its production, even surpassing it (in the years 2010, 2012-13, and 2015-16 estimation). Despite this apparent problem, the Brazilian biodiesel industry has an extensive idle capacity, which offers an opportunity to expand production and blending percentages. In 2016 alone, the installed capacity was 7,433,630.30 m^3, with a demand of only 4,576,869.63 m^3, that is, an idle capacity of approximately 38%.

In the short term, therefore, the production of biodiesel would be guaranteed, at least when related to the installed capacity of the industry. However, performing an estimation using Microsoft Excel, and assuming that the blending percentages would increase period after period, a percentage unit, culminating in B20 in the year 2029, as shown in **Table 2** below, as of 2020, when supposedly the percentage of the blending would be at 11%, the current structure of the national industry would no longer be enough to produce at the level of compulsory demand.

Table 2: Estimation of diesel production as well as biodiesel production and demand from 2008 to 2029 in m^3.

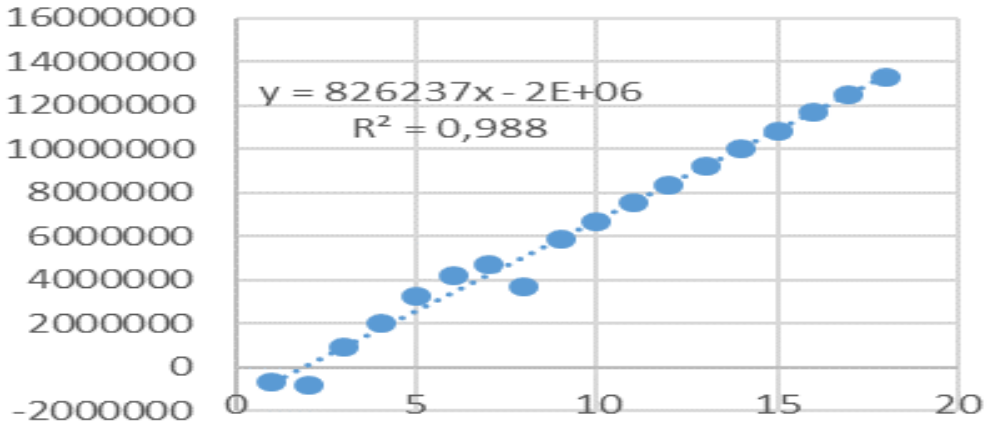
PERIOD	Biodiesel Production	Biodiesel Demand	Diesel Production
2008	44·763·952,31	1·119·098,81	1·167·128,42
2009	44·298·464,00	1·550·446,24	1·608·448,42
2010	49·239·039,00	2·461·951,95	2·386·398,52
2011	52·263·911,58	2·613·195,58	2·672·759,92
2012	55·900·363,67	2·795·018,18	2·717·483,49
2013	58·572·495,08	2·928·624,75	2·917·488,27
2014	60·031·617,59	3·301·738,97	3·422·209,90
2015	57·210·870,37	4·004·760,93	3·937·268,53
2016	63·361·750,70	4·435·322,55	3·801·339,00
2017	65·712·119,93	5·256·969,59	4·390·029,42
2018	68·062·489,15	6·125·624,02	4·720·690,32
2019	70·412·858,37	7·041·285,84	5·051·351,22
2020	72·763·227,60	8·003·955,04	5·382·012,11
2021	75·113·596,82	9·013·631,62	5·712·673,01
2022	77·463·966,04	1·007·0315,59	6·043·333,90

2023	79·814·335,27	1·117·4006,94	6·373·994,80
2024	82·164·704,49	1·232·4705,67	6·704·655,70
2025	84·515·073,71	1·352·2411,79	7·035·316,59
2026	86·865·442,94	1·476·7125,30	7·365·977,49
2027	89·215·812,16	1·605·8846,19	7·696·638,39
2028	91·566·181,38	1·739·7574,46	8·027·299,28
2029	93·916·550,60	1·878·3310,12	8·357·960,18

Source: Research data (2017).

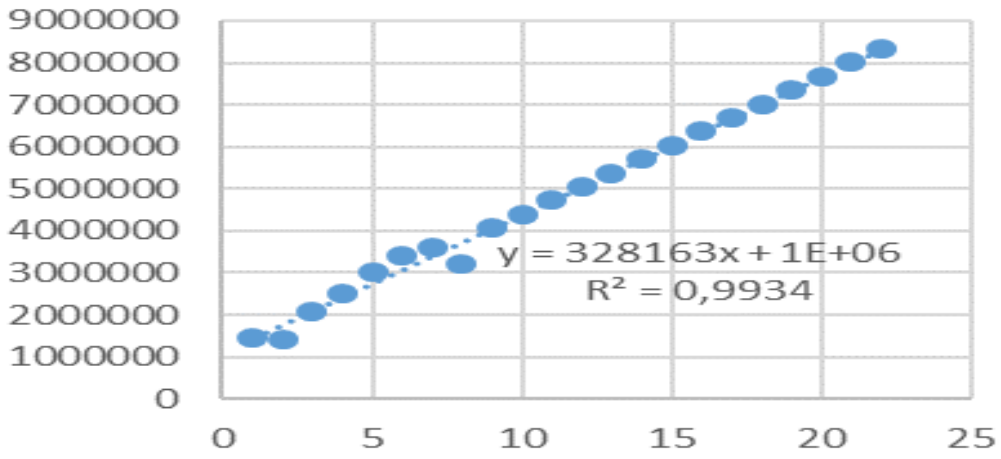
Regarding the biodiesel production (year-by-year in **Table 2**), it can be seen a gradual increase of the distance between the demand and the actual production of the biofuel under study. Statistically modeling the projections (**from Table 2**), there is a 94% correlation between diesel production and biodiesel demand and 99% correlation between diesel and biodiesel production.

In addition to the high correlation index, indicating the associations between the variables, high levels of determination (98% and 99% respectively) were also found among them, thus suggesting a high level of cause and effect between them. **Figures 3** and **4** below demonstrate such correlations, as well as their respective determination coefficients.



Source: Research data (2017).

Figure 3: Correlation between diesel production and biodiesel demand.



Source: Research data (2017).

Figure 4: Correlation between diesel production and biodiesel production.

Based on the analysis of the installed capacity (already scheduled for 2019), it can be seen that Brazil, in the short and medium term, has no difficulties in delivering the percentage of the B10 blending. However, if larger percentages are adopted, according to the adopted projections, the installed capacity of the mills will have to be increased as of 2020. As for the current and future demand for biodiesel production in relation to current and future demand, problems begin to arise, as with the course of the periods and the amplification of the blending, the production does not accompany the compulsory demand. This difficulty will be analyzed in the next section of the research.

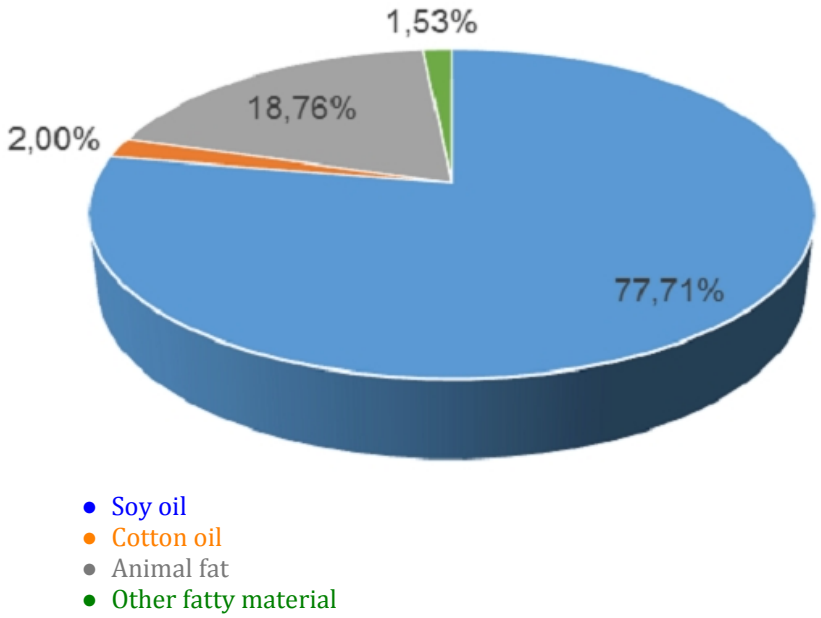
[1]For the year 2016 an estimate value was used, calculated using Microsoft Excel, since the data for that period were not available in the ANP statistical yearbook (Authors' Note).

It will address the potential of biodiesel production from the expansion capacity of the available oilseed agriculture areas, as well as estimate the need for supplies needed to meet an eventual B20 demand.

3.0 Potentiality of Biodiesel Production in Brazil from the Capacity of Oleaginose Expansion

Biodiesel can be produced from a multitude of raw materials. There is a possibility of obtaining biofuel from vegetable oils, animal fats and waste products, such as used frying oil. According to BIODIESELBR [6], in several countries there is a greater reliance on a few crops because of their viability. In Europe, for example, there is a dependency, almost exclusively, for colza, while the United States relies on soybean.

In Brazil, despite many oleaginous raw materials being part of the portfolio of supplies capable of being transformed into biodiesel, there is a predominance of soybean in their manufacture. According to ANP (2016), in 2015 soybean accounted for 77.71% of biodiesel production in the country, followed by beef tallow with a share of 18.76%. More distant, the third most used crop was cotton, with 2% of representativeness and, finally, other fatty materials with only 1.53% (**Figure 5**).



Source: ANP (2016).

Figure 5: Main raw materials used in the manufacture of Biodiesel in Brazil in 2015.

The major advantage of soybean is the Brazilian experience with the crop. The Brazilian Agricultural Research Company (EMBRAPA) has been studying this crop for more than 30 years, which has favored the learning curve of the oilseed by making the country the second largest producer of the grain in the world. With a production of 95,631 million tons, Brazil is behind the United States - that alone produced 106.934 million tons of soybean in the 2015/2016 harvest (2016 data obtained from the National Supply Company (CONAB, 2016).

Given the importance of soybean and their high percentage participation in the production of biodiesel, this research will be limited, in this section, to analyzing the production potential of the biofuel under study from the capacity of expansion of this crop. In comparison to soybean, the second raw material most used is animal fat and the other oilseeds together do not even compute 4% of the current production.

3.1. The Soybean Crop in Brazil

The planted soybean area in Brazil today is of 33.177 million hectares (ha) with a yield of 2,882 kg/ha (w.r.t 2015/2016 crop data released by CONAB, 2016). According to the Company, biodiesel productivity is equivalent to 0.483 m^3 per hectare. Considering the average utilization of soybean for manufacturing as 81%, calculated according to information from the ANP (2016), according to a database that ranged from 2006 to 2015, the biodiesel production potential would be of approximately 12.978 million m^3 of biodiesel. By analyzing the aspect of compulsory demand, calculated in section two of the study, it would only reach this level in 2025.

However, from the perspective of actual production analysis, the situation is critical. Carrying out an estimation exercise, as of 2017, which has a mandatory percentage of the blend in B8, until 2029, when the research presupposes the use of the compulsory percentage in B20, the soybean planted area should grow 1,103%, compared to the present day. **Table 3**, below, demonstrates this behavior. **Table 3** shows a substantial increase in the soybean planted area over the periods, considering a yield of 0.483 m3 per cultivated hectare, as well as a historical average (2006 to 2015) of soybean utilization in the Brazilian biodiesel production in a magnitude of 81%.

The estimated numbers, if confirmed, demonstrate a growing need of the planted area of the oleaginous in question, which potentially can encourage justified debates on food security and environmental impacts, given the volume of agrochemicals, pesticides and water to be used, as well as the emissions generated during the harvesting, processing as well as transportation phases.

Table 3: Expansion need of the soybean planted area, considering growth of the B8 to B20 blending in hectares.

Blending percentual	Period	Biodiesel Demand	Biodiesel Production	Production Need	Expansion need of the soybean planted area
B8	2017	5·256·969,59	4·390·029,42	866·940,17	339·173,00
B9	2018	6·125·624,02	4·720·690,32	1·404·933,70	549·652,21
B10	2019	7·041·28,84	5·051·351,22	1·989·934,62	778·522,12
B11	2020	8·003·955,04	5·382·012,11	2·621·942,92	1·025·782,73
B12	2021	9·013·631,62	5·712·673,01	3·300·958,61	1·291·434,04
B13	2022	1·007·0315,59	6·043·333,90	4·026·981,68	1·575·476,04
B14	2023	1·117·4006,94	6·373·994,80	4·800·012,14	1·877·908,75
B15	2024	1·232·4705,67	6·704·655,70	5·620·049,98	2·198·732,15
B16	2025	1·352·2411,79	7·035·316,59	6·487·095,20	2·537·946,25
B17	2026	1·476·7125,30	7·365·977,49	7·401·147,81	2·895·551,06
B18	2027	1·605·8846,19	7·696·638,39	8·362·207,80	3·271·546,56
B19	2028	1·739·7574,46	8·027·299,28	9·370·275,18	3·665·932,76
B20	2029	1·878·3310,12	8·357·960,18	1·042·5349,94	4·078·709,66

Source: ANP (2016), CONAB (2016).

Table 3 shows a substantial increase in the soybean planted area over the periods, considering a yield of 0.483 m3 per cultivated hectare, as well as a historical average (2006 to 2015) of soybean utilization in the Brazilian biodiesel production in a magnitude of 81%. The estimated numbers, if confirmed, demonstrate a growing need of the planted area of the oleaginous in question, which potentially can encourage justified debates on food security and environmental impacts, given the volume of agrochemicals, pesticides and water to be used, as well as the emissions generated during the harvesting, processing as well as transportation phases.

4.0 Final Considerations

The PNPB, despite some initial obstacles, was able to foment the production of biodiesel in Brazil. Proof of this is the growth of the learning curve of the program, which in a few years increased the blending percentage from 2% to the current 9%.

However, despite the advances some bottlenecks have not been solved, such as the equitable distribution of production units and especially the definition of a raw material that does not compete with essential markets such as food, as is the case of soybean. Still on this subject, to rely only on an oilseed for a strategic national policy, such as the generation of energy, is not comfortable for the country, since despite being a major world soybean producer, it is at the mercy of international market prices.

In addition to the question of the monopoly on the use of soybean, another concern was highlighted by the study: biodiesel production is not following the compulsory demand. The answer to this problem should be better studied by analyzing if the reason for this occurrence, that is, the increase of the idle capacity of the industrial plants is related, specifically, to the difficulty of finding raw materials in enough quantity and quality for the biodiesel production. In the view of these issues and in order to collaborate with the development of research related to the production of energy from biomass, below are some suggestions that may help to broaden this debate:

A. Review of the current policy, which requires mills to buy a minimum of 20% of the raw materials from small family farmers;

B. Provide government incentives to small farmers, mainly in the North and Northeast Regions, in order for them to produce other oil sources, such as jatropha or palm, expanding and promoting the mix of supply of oilseeds related to the energy policy;

C. Incentives to alternative and with great potential supplies, such as bovine fat, which currently occupies the second position among the materials that are being used in the production of biodiesel;

D. Undertake studies, based on the partnership between Government-Business-University, regarding the economic and financial viability of the attractiveness of the implantation of power plants in diversified regions of the country. These studies should also consider the use of co-products such as glycerin as a source of revenue for companies.

These measures could help the country to take advantage of the benefits of the production of the biofuel under study, such as job creation, increase in tax revenues, improvement of the balance of trade and raising the country to the level of the world's largest producer of biodiesel.

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