UNIVERSITAT POLITÈCNICA DE VALÈNCIA

Análisis del sector del biodiesel en Brasil: sistema de certificación y evolución estructural

TESIS DOCTORAL DEL PROGRAMA DE DOCTORADO EN ECONOMÍA AGROALIMENTARIA

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Valencia, Septiembre de 2017

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A mis padres/ Aos meus pais

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"... Nela, até agora, não pudemos saber que haja ouro, nem prata, nem coisa alguma de metal ou ferro; nem lho vimos. Porém a terra em si é de muito bons ares...
Águas são muitas; infindas. E em tal maneira é graciosa que, querendo-a aproveitar, dar-se-á nela tudo, por bem das águas que tem. Porém o melhor fruto, que dela se pode tirar me parece que será salvar esta gente. E esta deve ser a principal semente que Vossa Alteza em ela deve lançar..."

"... En ella (tierra brasileña), hasta ahora, no pudimos saber si hay oro, plata o cosa alguna de metal o hierro; ni lo vimos. Pero la tierra en si es de muy buenos vientos...
Aguas hay muchas, infinitas. Y en tal manera es agraciada que, queriendo aprovecharla, te da ella todo, por las aguas que tiene. Pero el mejor fruto, que de ella se puede sacar me parece que será salvar a esta gente. Y esta debe ser la principal semilla que Vuestra Alteza en ella debe sembrar..."

Pero Vaz de Caminha, 1 de mayo de 1500.

Fragmento de "La Carta de Caminha" al Rey de Portugal D. Manuel I.

RESUMEN/ ABSTRACT/ RESUM/ RESUMO

Resumen/ Abstract/ Resum/ Resumo

RESUMEN

El biodiesel es una fuente de energía renovable alternativa a los combustibles fósiles producida a partir de aceites de distintos orígenes. La cadena productiva del biodiesel tiene un desarrollo relativamente reciente en el mundo y se ha impulsado con el fin de reducir la dependencia de los combustibles fósiles y las emisiones de gases contaminantes. A diferencia de los países desarrollados, que ponen énfasis en los objetivos medioambientales en su política de biocombustibles (como ocurre en Europa), Brasil divulga la inclusión social como un pilar fundamental de su política, además de la diversificación de la matriz energética por medio de la utilización de materias primas regionales.

La producción de biodiesel en Brasil es fomentada por el Estado a través del Sello Combustible Social (SCS), un sistema de certificación vinculado al Programa Nacional de Producción y Uso de Biodiesel (PNPB) destinado a promover el desarrollo económico y sostenible. Centrada en la inclusión social, la certificación —y con ella una serie de beneficios fiscales— se concede a las industrias procesadoras de biodiesel que se abastecen con materias primas procedentes de las pequeñas explotaciones agrícolas.

El objetivo de esta Tesis es analizar el sector del biodiesel en Brasil, prestando atención a la estructura industrial y también a la interdependencia entre agricultores, cooperativas agrícolas e industrias, intensificada a través de políticas de certificación. Para ello, se analizaron los efectos que dichas políticas generan en la cadena de valor del biodiesel, abordando aspectos económicos y de gobernanza.

El primer artículo se centra en el análisis de la evolución de la concentración de las industrias en el sector del biodiesel brasileño. Para ello se calcularon varios índices de concentración y se observó cómo han evolucionado desde que se puso en marcha este sector. El estudio se complementó con varias técnicas de análisis multivariante como el análisis de correspondencias múltiples (ACM) y el análisis cluster, con el fin de comprender los rasgos estructurales básicos de las industrias que operan en el sector del biodiesel en Brasil en la actualidad.

En el segundo estudio fueron analizados los efectos ocasionados por el SCS en las relaciones entre la industria del biodiesel y los pequeños productores en diversas regiones de Brasil. A partir de una revisión bibliográfica de publicaciones científicas y de estudios realizados por agencias nacionales, se hizo un mapa de la actual situación de la cadena del biodiesel en las diversas regiones del país. Los resultados muestran que el SCS ha permitido avanzar en la inserción de agricultores familiares en la cadena de valor y el desarrollo rural sostenible. Sin embargo, la literatura también señala lagunas en la consecución de estos objetivos, como la ocurrencia de fallos en el cumplimiento de contratos entre agricultores familiares e industrias y dificultades en la diversificación de materia prima (oleaginosas utilizadas en la producción del biodiesel).

En una tercera fase se hizo un análisis del funcionamiento del SCS, para el cual la información secundaria se completó con evidencia empírica obtenida por medio de trabajo de campo. El estudio de caso se centró en el estado de São Paulo y la información primaria se obtuvo a través de entrevistas semi-estructuradas a técnicos de industrias, agricultores, cooperativas y especialistas del sector. El objetivo era investigar los efectos de la certificación sobre los actores participantes de la cadena del biodiesel, y los resultados se recogen en la publicación nº 3. En este artículo se discutió el funcionamiento del SCS, los ajustes institucionales realizados en este instrumento político a lo largo de su funcionamiento y los logros y disfunciones que han tenido lugar en su aplicación práctica. Los resultados ponen en cuestión la realización del objetivo de inclusión social y alertan sobre la sostenibilidad del papel de los agricultores familiares en el programa.

La tesis se ha estructurado en tres capítulos. Luego de la Introducción (Capítulo 1), cada uno de ellos corresponde a una publicación y aborda un aspecto específico de la investigación, con el fin de cumplir el objetivo general propuesto. Los resultados fueron obtenidos a través de metodologías cualitativas y cuantitativas, expuestos en las publicaciones citadas. Finalmente, se presentan las conclusiones generales referentes a los 3 estudios publicados en el Capítulo 5.

***Palabras clave**: Brasil, cadena de valor del biodiesel, estructura industrial, Sello Combustible Social, agricultura brasileña.*

ABSTRACT

Biodiesel is an alternative renewable source of energy to fossil fuels generated by oils from several origins. Biodiesel productive chain has a relatively recent development in the world, and it prospered aiming at reducing dependence on fossil fuels and emission of pollutant gases. Differently from developed countries that emphasize the environmental aims (as in Europe), Brazil divulges social inclusions as a fundamental pillar of its policy, besides the diversification of energy matrix by making use of regional raw materials.

Biodiesel production in Brazil is sponsored by the government by means of the Social Fuel Seal (SCS, in Portuguese), a certification system linked to the National Programme for the Production and Use of Biodiesel (Programa Nacional de Produção e Uso de Biodiesel – PNPB) aiming at promoting economic and sustainable development. Focused on social inclusion, the certification and a series of tax benefits are granted to biodiesel processing industries that purchase raw materials from small agricultural properties.

The aim of this Thesis is to analyse biodiesel in Brazil focusing both industrial structure and interdependence among farmers, agricultural cooperatives and industries stimulated by certification policies. Thus, the effects that the aforesaid policies have on the biodiesel value chain were analysed, tackling economic and government aspects.

The first article is focused on the analysis of the evolution of the concentration of industries of the Brazilian biodiesel chain. So, several indexes of concentration were calculated and it was noticed how these indexes have evolved ever since biodiesel chain started in Brazil. The research was completed with several multivariant analytical techniques such as multiple correspondence analysis (MCA) and cluster analysis aiming at understanding the basic structural characteristics of the industries that operate in the biodiesel chain in Brazil at present.

The second study analysed the effects caused by the Social Fuel Seal on the relationship between biodiesel industry and small producers in several regions of Brazil. Based on a bibliographic review of scientific publications and researches carried out by national agencies, a map was made of the present situation of the biodiesel chain in several regions in Brazil. The results show that the Social Fuel Seal allowed the improvement in the insertion of family farmers in the value chain and in the sustainable rural development. However, the literature also points out gaps to attain these objectives such as incomplete compliance with employment legislation between family farmers and industries and difficulties concerning the diversification of raw materials (oleaginous seeds used in the production of biodiesel).

During the third phase, an analysis performance was made, when of the Social Fuel Seal performance when secondary information was obtained with empirical evidence obtained during field research. The aforesaid analysis was mainly made in the state of São Paulo, and primary information was obtained from semi-structured interviews with industrial technicians, farmers, cooperatives and specialists in this sector. The aim was to investigate the effects of the certification on the participants in the biodiesel chain, and the results are shown in publication nº 3. In this article, the Social Fuel Seal, institutional arrangements, achievements and dysfunctions were discussed. The results call in question the fulfilment of the aim of social inclusion and the sustainability of the role of family farmers in the Program.

The Thesis was divided into three chapters. After the Introduction section (Chapter 1), each one of the followings chapters refers to one peer-reviewed article and tackles a specific aspect of investigation, aiming at fulfiling the proposed general objectives. The results were obtained from qualitative and quantitative methodologies shown in the aforesaid publications. Finally, general conclusions are presented regarding the 3 studies published in Chapter 5.

***Keywords**: Brazil, biodiesel value chain, industrial structure, Social Fuel Seal, Brazilian agriculture.*

RESUM

El biodièsel és una font d'energia renovable alternativa als combustibles fòssils produïda a partir d'olis de distints orígens. La cadena productiva del biodièsel té un desenvolunpament relativament recent en el món, i s'ha impulsat a fi de reduir la dependència dels combustibles fòssils i les emissions de gasos contaminants. A diferència dels països desenvolupats, que posen èmfasi en els objectius mediambientals en la seua política de biocombustibles (com ocorre a Europa), Brasil divulga la inclusió social com un pilar fonamental de la seua política, a més de la diversificació de la matriu energètica per mitjà de la utilització de matèries primeres regionals.

La producció de biodièsel a Brasil és fomentada per l'Estat a través del Segell Combustible Social (SCS), un sistema de certificació vinculat al Programa Nacional de Producció i Ús de Biodièsel (PNPB) destinat a promoure el desenvolupament econòmic i sostenible. Centrada en la inclusió social, la certificació —i amb ella una sèrie de beneficis fiscals— es concedix a les indústries processadores de biodièsel que s'abastixen amb matèries primeres procedents de les xicotetes explotacions agrícoles.

L'objectiu d'esta Tesi és analitzar el sector del biodièsel a Brasil, prestant atenció a l'estructura industrial i també a la interdependència entre agricultors, cooperatives agrícoles i indústries intensificada a través de polítiques de certificació. Per aquest motiu, es van analitzar els efectes que dites polítiques generen en la cadena de valor del biodièsel, abordant aspectes econòmics i de governança.

El primer article se centra en l'anàlisi de l'evolució de la concentració de les indústries en el sector del biodièsel brasiler. Per això es van calcular diversos índexs de concentració i es va observar com han evolucionat des de que es va posar en marxa aquest sector. L'estudi es va complementar amb diverses tècniques d'anàlisi multivariant com l'anàlisi de correspondències múltiples (ACM) i l'anàlisi cluster, a fi de comprendre els trets estructurals bàsics de les indústries que operen en el sector del biodièsel a Brasil en l'actualitat.

En el segon estudi van ser analitzats els efectes ocasionats pel SCS en les relacions entre la indústria del biodièsel i els xicotets productors en diverses regions de Brasil. A partir d'una revisió bibliogràfica de publicacions científiques i d'estudis realitzats per agències nacionals, es va fer un mapa de l'actual situació de la cadena del biodièsel en les diverses regions del país. Els resultats mostren que el SCS ha permés avançar en la inserció d'agricultors familiars en la cadena de valor i el desenvolupament rural sostenible. No obstant això, la literatura també assenyala llacunes en la consecució d'aquestos objectius, com l'aparició de errades en el compliment de contractes entre agricultors familiars i indústries i dificultats en la diversificació de matèria primera (oleaginoses utilitzades en la producció del biodièsel).

En una tercera fase, es va fer una anàlisi del funcionament del SCS per al qual la informació secundària es va completar amb evidència empírica obtinguda per mitjà de treball de camp. L'estudi de cas es va centrar en l'estat de São Paulo, i la informació primària es va obtindre a través d'entrevistes semi-estructuradas a tècnics d'indústries, agricultors, cooperatives i especialistes del sector. L'objectiu era investigar els efectes de la certificació sobre els actors participants de la cadena del biodièsel, i els resultats s'arrepleguen en la publicació nº 3. En aquest article es va discutir el funcionament del SCS, els ajustos institucionals realitzats en aquest instrument polític al llarg del seu funcionament, i els èxits i disfuncions que han tingut lloc en la seua aplicació pràctica. Els resultats posen en dubte la realització de l'objectiu d'inclusió social i alerten sobre la sostenibilitat del paper dels agricultors familiars en el programa.

La tesi s'ha estructurat en tres capítols. Cadascú d'ells correspon a una publicació i aborda un aspecte específic de la investigació, a fi d'acomplir l'objectiu general proposat. Els resultats van ser obtinguts a través de metodologies qualitatives i quantitatives, exposats en les publicacions esmentades. Finalment, es presenten les conclusions generals referents als 3 estudis publicats en el Capítol 5.

Paraules clau*: Brasil, Cadena de valor del biodièsel, estructura industrial, Segell de Combustible Social, agricultura brasilera.*

RESUMO

O biodiesel é uma fonte de energia renovável alternativa aos combustíveis fósseis produzida a partir de óleos de origens distintas. A cadeia produtiva do biodiesel tem um desenvolvimento relativamente recente no mundo, e se impulsionou com a finalidade de reduzir a dependência dos combustíveis fósseis e as emissões de gases contaminantes. Diferentemente dos países desenvolvidos, que enfatizam os objetivos meio-ambientais dos biocombustíveis (como ocorre na Europa), o Brasil divulga a inclusão social como um pilar fundamental de sua política, além da diversificação da matriz energética por meio da utilização de matérias-primas regionais.

A produção de biodiesel no Brasil é promovida pelo Estado através do Selo Combustível Social (SCS), um sistema de certificação vinculado ao Programa Nacional de Produção e Uso de Biodiesel (PNPB) destinado a promover o desenvolvimento econômico e sustentável. Centrada na inclusão social, a certificação —e com ela uma série de benefícios fiscais— são concedidos às indústrias processadoras de biodiesel que se abastecem com matérias-primas procedentes das pequenas propriedades agrícolas.

O objetivo desta Tese é analisar o setor do biodiesel no Brasil, prestando atenção à estrutura industrial e também à interdependência entre agricultores, cooperativas agrícolas e indústrias intensificada através de políticas de certificação. Para isto, foram analisados os efeitos que ditas políticas geram na cadeia de valor do biodiesel, abordando aspectos econômicos e de governança.

O primeiro artigo centra-se na análise da evolução da concentração das indústrias no setor do biodiesel brasileiro. Para isto foram calculados vários índices de concentração e observou-se como estes evoluíram desde que foi iniciado o setor do biodiesel no país. O estudo se complementou com técnicas de análise multivariante como: análise de correspondências múltiples (ACM) e análise cluster, com a finalidade de compreender características estruturais básicas das indústrias que operam no setor do biodiesel no Brasil na atualidade.

No segundo estudo foram analisados os efeitos ocasionados pelo SCS nas relações entre a indústria do biodiesel e os pequenos produtores em diversas regiões do Brasil. A partir de uma revisão bibliográfica de publicações científicas e de estudos realizados por agências nacionais, foi feito um mapa da atual situação da cadeia do biodiesel nas diversas regiões do país. Os resultados mostram que o SCS permitiu o avanço na inserção de agricultores familiares na cadeia de valor e o desenvolvimento rural sustentável. Entretanto, a literatura também sinaliza lacunas na consecução destes objetivos, como a ocorrência de falhas no cumprimento de contratos entre agricultores familiares e indústrias e dificuldades na diversificação de matéria-prima (oleaginosas utilizadas na produção do biodiesel).

Em uma terceira fase, fez-se uma análise do funcionamento do SCS para a qual a informação secundária se completou com evidência empírica obtida por meio de trabalho de campo. O estudo de caso se centrou no estado de São Paulo, e a informação primária se obteve através de entrevistas semi-estruturadas a técnicos de indústrias, agricultores, cooperativas e especialistas do setor. O objetivo era investigar os efeitos da certificação sobre os atores participantes da cadeia do biodiesel, e os resultados se mostram na publicação nº 3. Neste artigo foi discutido o funcionamento do SCS, os ajustes institucionais realizados neste instrumento político ao longo de seu funcionamento, as realizações e as disfunções que ocorreram na sua aplicação prática. Os resultados colocam em questão a realização do objetivo de inclusão social e alertam sobre a sustentabilidade do papel dos agricultores familiares no programa.

A tese foi estruturada em três capítulos. Cada um deles corresponde a uma publicação e aborda um aspecto específico da investigação, com a finalidade de cumprir o objetivo geral proposto. Os resultados foram obtidos através de metodologias qualitativas e quantitativas, expostos nas publicações citadas. Finalmente, se apresentam as conclusões gerais referentes aos 3 estudos, publicadas no Capítulo 5.

Palavras-chave*: Brasil, Cadeia de valor do biodiesel, estrutura industrial, Selo Combustível Social, agricultura brasileira.*

ACRÓNIMOS

ABIOVE: Asociación Brasileña de las Industrias de Aceites Vegetales

ANP: Agencia Nacional del Petróleo, Gas Natural y Biocombustibles

CONAB: Compañía Nacional de Abastecimiento

COP 21: Conferencia de las Partes de la Convención Marco de las Naciones Unidas sobre el Cambio Climático – CMNUCC

CVG: Cadena de Valor Global

EMBRAPA: Empresa Brasileña de *Pesquisa* (Investigación) Agropecuaria

EPE: Empresa de *Pesquisa* (Investigación) Energética

FAO: Organización de las Naciones Unidas para la Alimentación y la Agricultura

IBGE: Instituto Brasileño de Geografía y Estadística

MATOPIBA: Unión de las sílabas iniciales de cada uno de los 4 estados brasileños: Maranhão, Tocantins, Piauí y Bahia

MDA: Ministerio del Desarrollo Agrario

MME: Ministerio de Minas y Energía

OPEP: Organización de Países Exportadores de Petróleo

OVEG: Programa de *Oleos* (Aceites) Vegetales

PMR: Precio Máximo de Referencia

PNPB: Programa Nacional de Producción y Uso de Biodiesel

PROALCOOL: Programa Nacional del Alcohol

PROBIODIESEL: Programa Brasileño de Desarrollo Tecnológico de Biodiesel

PRONAF: Programa Nacional de Fortalecimiento de la Agricultura Familiar

PRO-OLEO: Producción de *Oleo* (Aceites) Vegetales para Fines Energéticos

REN 21: Renewable Energy Policy Network for the 21st Century

SCS: Sello Combustible Social

SFS: Social Fuel Seal

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CAPÍTULO I. INTRODUCCIÓN Y OBJETIVOS

CAPÍTULO I. INTRODUCCIÓN Y OBJETIVOS

1. EVOLUCIÓN Y SITUACIÓN DEL SECTOR DEL BIODIESEL EN BRASIL

Brasil es uno de los mayores productores de biodiesel en el mundo. De acuerdo con el REN 21, 2015 (Renewable Energy Policy Network for the 21st Century), Brasil ocupaba el segundo lugar (3,4 mil millones de litros), junto con Alemania, y solamente detrás de Estados Unidos, con 4,7 mil millones de litros. Esta posición revela un crecimiento en relación con el año de 2013, cuando Brasil ocupaba el tercer con 2,9 mil millones de litros, detrás de E.E. U.U. y Alemania. Según los últimos datos publicados (REN 21, 2016), los principales países productores de biodiesel en todo el mundo siguen siendo Estados Unidos, Brasil, Alemania y Argentina. Tras una producción en 2014 de 30,4 mil millones de litros, la producción mundial de biodiesel disminuyó ligeramente en 2015 a 30,1 mil millones de litros. El descenso se debió a la limitación de la producción en Argentina e Indonesia, en particular. La producción estadounidense de biodiesel aumentó un 2% en 2015, llegando a cerca de 4,8 mil millones de litros. En Brasil, la producción aumentó un 15%, alcanzando 3,9 mil millones de litros. El crecimiento de la demanda brasileña de biodiesel fue estimulado por un aumento en el mandato de mezcla de biodiesel al 7%. La producción europea de biodiesel aumentó un 5%, correspondiendo a 11,5 mil millones de litros. Alemania fue nuevamente el mayor productor europeo (2,8 mil millones de litros), seguido de Francia (2,4 mil millones de litros).

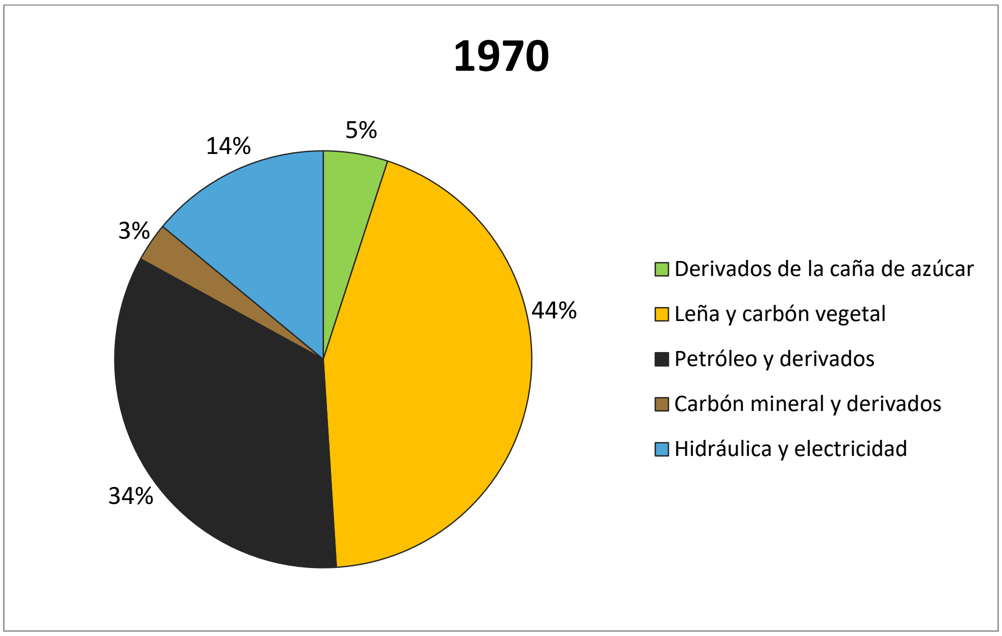
Actualmente, la cuestión energética global junto con la crisis del medio ambiente, ocasionada principalmente por el calentamiento global y la contaminación de los recursos naturales ocasionados por la emisión de gases contaminantes provocados por el uso de combustibles fósiles, son cuestiones que afectan y preocupan al mundo. En este contexto —la seguridad del suministro energético y la cuestión del cambio climático— el biodiesel se ha convertido en un combustible alternativo y menos contaminante. El biodiesel es una fuente de energía renovable producida a partir de aceites de distintos orígenes, un combustible alternativo a los combustibles fósiles. La cadena productiva del biodiesel tiene un desarrollo reciente en el mundo y su uso como energía biocarburante disminuye la dependencia de los combustibles fósiles y las emisiones de gases contaminantes. La menor emisión de gases contaminantes es una de las principales ventajas del uso de biodiesel. Barnwal y Sharma (2005) analizaron la emisión de gases en la combustión de biodiesel y diésel mineral y obtuvieron que, para el biodiesel, el SO_2 es totalmente eliminado, el hollín disminuye en 60% y el monóxido de carbono y los hidrocarburos disminuyen en 50%, los hidrocarburos poli aromáticos se reducen en más de 70% y los gases aromáticos disminuyen en 15%.

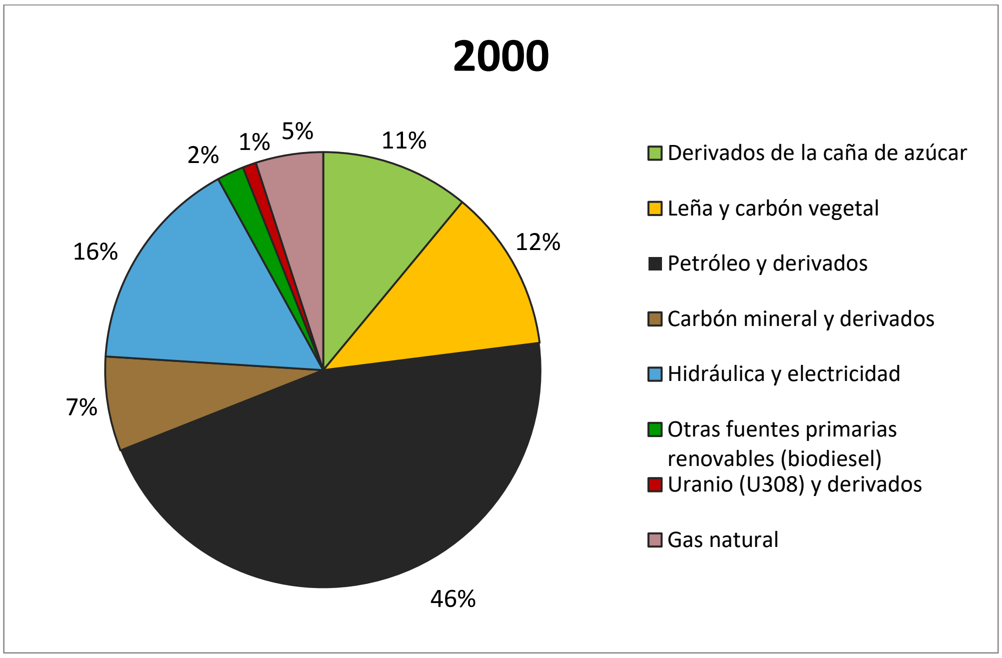
Las políticas que regulan la producción de biocombustibles en general se centran en aspectos como el cambio climático, la seguridad energética, la sostenibilidad social y ambiental. Según Milazzo *et al.* (2013), en la Unión Europea y en los E.E. U.U. la sostenibilidad y la seguridad del suministro de energía son las principales preocupaciones con respecto a la producción de biodiesel, mientras que en Brasil se destaca el aspecto socioeconómico. Brasil es uno de los actores más influyentes en la agenda ambiental discutida en la COP 21 (Conferencia de las Partes de la Convención Marco de las Naciones Unidas sobre el Cambio Climático - CMNUCC) celebrada en París en 2016.

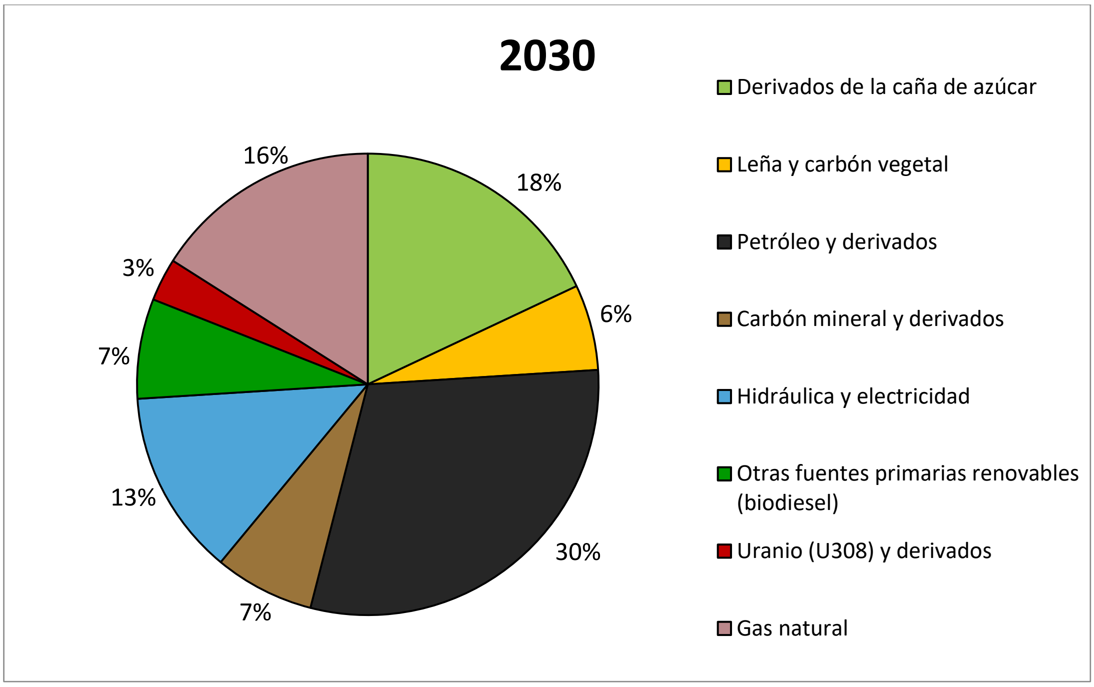
El país se caracteriza por su matriz energética diversificada y relativamente limpia en relación con la media mundial. Tolmasquim *et al.* (2007) enfatizan la tendencia de diversificación de la matriz energética brasileña. En la década de 1970, dos fuentes de energía, petróleo y leña representaban 78% del consumo, mientras en los años 2000 tres fuentes concentraban 74% del consumo: petróleo, leña y la energía hidráulica. Para 2030 se espera un escenario en el cual cuatro fuentes serán necesarias para satisfacer el 77% del consumo: petróleo, energía hidráulica, caña de azúcar y gas natural — con reducción de la importancia relativa de la leña. Esta última, juntamente con el carbón vegetal, pasa de una participación de 44% de la matriz energética brasileña en 1970 para 12% en los años 2000 y con proyección de tan solo 6% para 2030. Contrariamente, los derivados de la caña pasan de 5% en 1970 a 11% en 2000 y una proyección de 18% para 2030.

El biodiesel aparece en la matriz en los años 2000, identificado en el gráfico que sigue en la categoría: "Otras fuentes primarias renovables", que pasarán de 2% en los 2000 a 7% en 2030.

Gráfico 1. Evolución de la estructura de la oferta de energia en Brasil – 1970 a 2030.







Fuente: adaptado por la autora a partir de Tolmasquim *et al.*, 2007, extraído de EPE (Empresa de Pesquisa Energética)

Los estudios sobre la cadena de biodiesel contemplan mayormente los aspectos ambientales y energéticos, prestando menos atención a la temática socioeconómica. Dada la importancia que tiene esta área, menos investigada a fondo en la literatura, el tema planteado para esta tesis fue analizar la actividad de la industria del biodiesel vinculada a la agricultura, la dependencia mutua entre estos sectores intensificada a través de políticas de certificación, considerando casos a nivel local, regional y nacional en Brasil.

La inclusión social a través de la producción de biodiesel en Brasil es fomentada por el gobierno a través del Sello Combustible Social, un sistema de certificación vinculado al Plan Nacional de Producción y Uso de Biodiesel (PNPB) destinado a promover el desarrollo económico y sostenible (más adelante se realiza una descripción más detallada de esta certificación). Centrada en la inclusión social, la certificación —y con ella una serie de beneficios fiscales— se concede a los procesadores industriales que se abastecen con materias primas procedentes de las pequeñas explotaciones agrícolas. Antes de detallar la justificación y los objetivos de esta tesis, se realiza en esta introducción un breve resumen histórico del desarrollo de la producción del biodiesel en Brasil, seguido de una breve exposición de algunos aspectos conceptuales. Estos elementos constituyen la base para, a continuación, plantear los objetivos generales de la presente tesis que son desarrollados de forma más específica a lo largo de los tres artículos que componen este trabajo.

1.1. Evolución histórica del biodiesel en Brasil

En Brasil, desde 1975 el gobierno militar mantenía el Plan de Producción de Aceites Vegetales para Fines Energéticos (PRO-OLEO), un programa similar al Programa Nacional del Alcohol (PROALCOOL), con foco en la búsqueda de una alternativa nacional al diésel importado. Ambas iniciativas fueron diseñadas para intentar blindar el país contra *shocks* en los precios del petróleo como el de 1973, cuando una reducción en la oferta de los países de la OPEP hizo que el precio del barril de petróleo se disparara (*Biodieselbr*, 2015).

Figuras 1 y 2. Planta industrial de biodiesel en el estado de Ceará y autobús movido a biodiesel en los años 80

Fuente: extraído de la página web brasileña Fortalbus. Disponible en: http://www.fortalbus.com/2011/09/concepcao-do-biodiesel.html

PRO-OLEO fue sucedido por el Programa de Aceites Vegetales (OVEG), que permaneció activo hasta 1985. Aun así, pasaron prácticamente 20 años hasta que el biodiesel saliese de los laboratorios brasileños, debido a la relación poco favorable entre los precios del diésel convencional y del producto renovable.

En esta época, Brasil aún no era un gran productor de soja. En 1985, el área plantada con soja en el país era poco mayor que 10 millones de hectáreas y la producción llegaba a 18,2 millones de toneladas. Tres décadas más tarde, estas cantidades fueron multiplicadas por 3 y 5 respectivamente.

En los años 90, Brasil no lograba vender todo el aceite que producía, generando excedentes. En los años 2000, la tonelada de aceite de soja costaba cerca de US$ 300, un precio muy bajo que perjudicaba a todos los productores. En este contexto, volvieron los planes para el biodiesel, alentados por la preocupación por el cambio climático a nivel mundial.

A pesar de las investigaciones realizadas en las últimas décadas en este tema, sólo en 2002 se lanzó el PROBIODIESEL (Programa Brasileño de Desarrollo Tecnológico de Biodiesel) para dar soporte a investigaciones para obtención de biodiesel a partir de aceite vegetal (Ordenanza nº 702, 2002). En 2004 fue lanzado oficialmente por el gobierno un sistema de certificación para consolidar el mercado del biodiesel, que actuaría juntamente con el nuevo programa, PNPB (Programa Nacional de Producción y Uso de Biodiesel). Con el fin de fomentar la inclusión social, el Sello Combustible Social (SCS) se concede por el "Ministerio do Desenvolvimento Agrário" (MDA, 2006) a los productores de biodiesel que obtienen la materia prima de los agricultores familiares. Por medio de un contrato, los procesadores de biodiesel están comprometidos a proporcionar asistencia técnica a los agricultores y reciben como beneficio una reducción de impuestos (que varía según el tipo de materia prima y de la región en la que se obtiene) y un subsidio para participar en subastas de biodiesel organizadas por la ANP (Agencia Nacional de Petróleo), en las que se compra el biodiesel de estos procesadores industriales. En la mayoría de las subastas de la ANP (80%), las ventas están destinadas a las empresas que tienen el SCS.

Figura 3. Sello Combustible Social

Fuente: MDA, 2006 (Ministerio del Desarrollo Agrario), Brasil

1.2. El biodiesel y su cadena de valor

El uso del biodiesel trae beneficios de diversa naturaleza: medioambientales, económicos y sociales, siendo importante para la sostenibilidad del uso de la energía. Ambientalmente, el uso del biodiesel disminuye las emisiones de gases de efecto invernadero reduciéndolas en un 5% em comparación al diésel mineral, considerando el caso del B7 (mezcla de 7% de biodiesel en el diésel); -7,5% considerando el B10 (mezcla de 10% de biodiesel en el diésel) y -15% de los gases de efecto invernadero considerando el B20 (mezcla de 20% de biodiesel en el diésel) (Abiove, 2015).

En síntesis, según Klein (2015), los aumentos paulatinos en la mezcla de biodiesel en diésel a lo largo de los años de implementación del programa del biodiesel en Brasil (detallado posteriormente), tenían como objetivos generales:

- Alcanzar beneficios para el medio ambiente, con la disminución de las emisiones que causan contaminación;

- Conseguir efectos positivos para la salud humana;

- Lograr mayores beneficios para los agricultores familiares y cooperativas por ellos integrados, debido al compromiso de asistencia técnica y suministro de insumos por las empresas titulares del Selo Combustible Social;

- Aumentar el empleo y la renta;

- Disminuir las importaciones de diésel, con consecuentes mejoras en la balanza comercial; y,

- Estimular a toda la cadena productiva.

Además de reducir la dependencia de diésel importado, el uso del biodiesel estimula la industrialización de la soja, que alcanzó la marca de 96,2 millones de toneladas en la cosecha 2014-2015, según la serie histórica de CONAB (2017) y cuyo aceite es utilizado como materia prima mayoritaria para la producción de biodiesel.

Brasil es el segundo mayor productor de soja del mundo y exporta más de la mitad de lo que produce sin industrializar. La evolución del PNPB estimula el aplastamiento del grano en el país, agregando valor al complejo de la soja, con generación de empleo e internalización de la industria.

Para contextualizar el tema de investigación propuesto, es necesario considerar los factores que vinculan e integran los actores de una cadena de valor; en el caso de la cadena productiva del biodiesel, la integración desde la agricultura familiar hasta las industrias. Para esto, se hace útil definir conceptos importantes como Cadena de Valor y Gobernanza.

La **Cadena de Valor Global (CVG)** enfoca el análisis sobre la estructura, los actores y las dinámicas de cadenas de valor, incluyendo tipologías y localización de actores de la cadena y las relaciones entre ellos (Bolwig *et al.*, 2010).

Siguiendo el enfoque de los aspectos que impactan una cadena de valor, poco se ha estudiado de la integración entre aspectos analíticos horizontales y verticales, de cómo el funcionamiento de dichas cadenas está relacionado a **factores sociales, locales, históricos y ambientales** (Jarosz, 2008). Es necesario integrar analiticamente los elementos verticales y horizontales de las cadenas de valor que afectan pobreza y sostenibilidad con foco en la participación de pequeños productores y otros actores en la cadena de valor agroalimentaria en paises en desarrollo (Riisgaard *et al.*, 2010).

En una cadena, los elementos verticales enfocan relaciones verticales entre compradores, proveedores y el movimiento de bienes o servicios del productor al consumidor (Bolwig *et al.*, 2010). La cadena puede tener diferentes conexiones, de acuerdo con su producto, como por ejemplo, en el caso del programa de biodiesel brasileño, una diferente configuración institucional, con presencia de subasta.

La **gobernanza** se puede definir como el acto que organiza y atribuye división funcional de trabajo en una cadena de valor, asignando reservas y distribuciones, que puede incorporar o excluir actores, o incluso asignar actividades de valor añadido. (Gereffi, 1994; Gibbon *et al.*, 2008). Los actores externos pueden tener un papel importante, como por ejemplo agencias gubernamentales y agencias de certificación (Ponte, 2007; Riisgaard, 2009).

Para el mejoramiento de la productividad (producción x tiempo x recursos) de la cadena, se pueden reorganizar procesos, productos o funciones o incluso aplicar competencias adquiridas en otros sectores o cadenas. En el caso de buscar una mejora en la participación de los pequeños productores en una cadena de valor, hay que considerar aspectos horizontales y verticales, con el objeto de aumentar recompensas y disminuir riesgos (abordados posteriormente).

1.2.1 Certificaciones y estandarización

Según la FAO (2014), los estándares afectan a la participación de los pequeños productores en los diferentes mercados. Los estándares voluntarios pueden ser establecidos por los gobiernos, organismos públicos y privados de normalización u organizaciones inter-gubernamentales o del sector privado, incluidas las organizaciones de productores y minoristas.

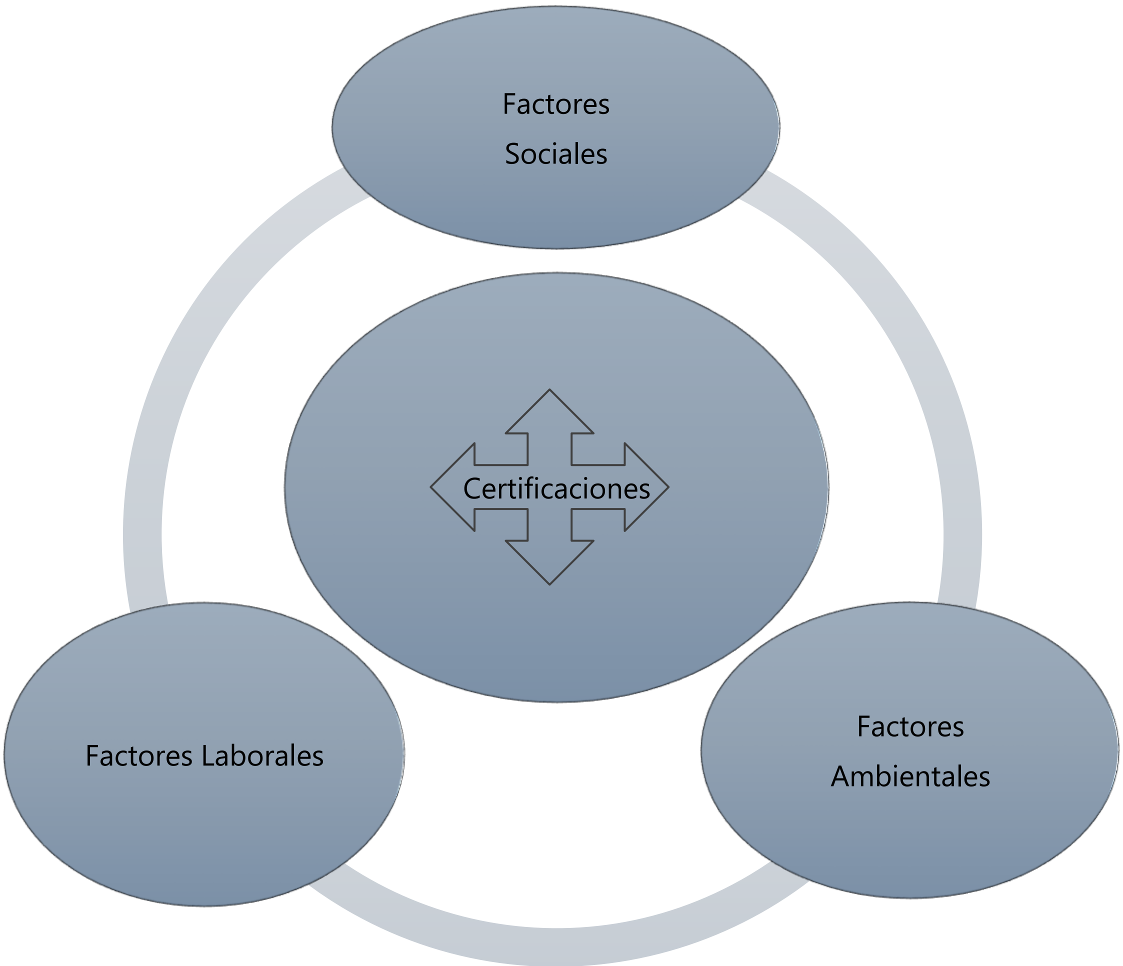
Contrariamente a las normas gubernamentales obligatorias, los actores son libres de elegir si se adhieren a las normas voluntarias o no, incluso si la norma voluntaria puede ser obligatoria de facto para el acceso a ciertos segmentos del mercado (como es el caso del mercado del biodiesel brasileño, que será detallado más adelante). Las normas voluntarias tienen un efecto directo sobre la forma en que los pequeños agricultores pueden participar en las cadenas de valor certificadas.

Los **estándares y certificaciones** son una manera de integrar aspectos verticales y horizontales, considerando factores **sociales, laborales y ambientales** (Bolwig *et al.*, 2010).

Los pequeños productores que optan por no participar en una cadena de valor global y eligen producir para mercados locales por menos lucro, pero con menor riesgo, pueden tornarse marginales; sin embargo, pueden experimentar relativo crecimiento en el mercado (Tapela, 2008). Siendo así, aspectos de riesgo y vulnerabilidad deben ser considerados a la hora de analizar la participación de estos actores en una cadena, además de aspectos más obvios como por ejemplo los ingresos.

Los **contractos con agricultores** pueden evitar la exclusión de pequeños productores de las cadenas de valores y son vistos como una solución para problemas como la disminución de inversiones públicas y privadas, en la medida en que esto aumente la economía de escala y reduzca costos privados (Warning y Key, 2002).

Diagrama 1. Las certificaciones y sus factores



Fuente: elaborado por la autora, basado en conceptos de Bolwig *et al.*, 2010

En la cadena del biodiesel brasileño, los contratos con los agricultores familiares forman parte de su proceso de certificación (SCS).

1.3. La agricultura familiar en Brasil

Los agricultores familiares, según la definición del Manual Operacional del Crédito Rural Pronaf (2011/12), son aquellos los productores rurales que cumplen los siguientes requisitos:

- Ser propietarios o arrendatarios de la Reforma Agraria;
- Residir en la propiedad o en local cercano;
- Tener, como máximo 4 (cuatro) módulos fiscales de tierra, cuantificados conforme la legislación en vigor;
- Como mínimo, el 80% de la renta bruta familiar debe venir de la explotación agropecuaria o no agropecuaria del establecimiento; y,
- La base de la explotación del establecimiento debe ser el trabajo familiar.

Brasil tiene cerca de 4,13 millones de agricultores familiares y representan 85,2% de los establecimientos rurales del país. De éstos, 49,6% están en la región Nordeste, siendo los más pobres (*Biodieselbr*, 2014).

Los agricultores familiares son responsables por aproximadamente 40% del valor bruto de la producción agrícola, 80% de las ocupaciones productivas agrícolas y de ganadería; además de parte significativa de los alimentos que llegan a la mesa de los brasileños, como frijoles (70%); mandioca (84%); carne de cerdo (58%); leche (54%); maíz (49%); aves y huevos (40%).

Estos productores han sufrido a lo largo de los años un proceso de reducción en sus rentas, llegando a la exclusión de trabajadores rurales de casi 100.000 propiedades agrícolas por año, de 1985 a 1995 (IBGE, Censo Agropecuario 1995/96). Gran parte de este proceso de empobrecimiento puede ser explicada por la poca oferta y baja calidad de los servicios públicos ofrecidos para los mismos, los cuales podrían viabilizar la inclusión socioeconómica de estos agricultores.

La literatura recoge las oportunidades de integración en las cadenas de valor agroalimentarias como mecanismo de mejora de la situación de los pequeños productores agrarios, en particular en los países del sur. Son numerosos los factores que pueden ser considerados para regular la participación de la agricultura familiar en las cadena de valor, que varían desde factores geográficos (concentración espacial/distancia al comprador), hasta culturales (educación y experiencia), conocimiento y la capacidad (prácticas agrícolas, negocio, gestión, etc.), pasando por otros como: pertenencia a grupos, disponibilidad del trabajo, fuentes de ingreso alternativas, activos (incluyendo tamaño de la explotación y tenencia de la tierra), rentabilidad de participación para los agricultores.

Sin embargo, para mejorar la participación de los pequeños productores en la cadena son requeridas acciones de elevados niveles de toma de decisiones, dentro o fuera de la cadena. Las relaciones entre actores de la cadena son con frecuencia altamente competitivas y potencialmente conflictivas. Intervenir en un punto de acción frecuentemente requiere influencia política, financiera y recursos humanos además de la capacidad de los pequeños productores y movilización como recursos de fuentes externas son esenciales para mejorías (Bolwig *et al.*, 2010).

Una vía de acción es precisamente la certificación. La FAO (2014) muestra cómo la certificación facilita el acceso a los mercados de los pequeños productores agrarios, así como mejora su acceso a la información de mercado y de crédito. En este sentido, existe un papel para los gobiernos en normas voluntarias. Ha habido un cambio en la literatura de referencia a las normas voluntarias como mecanismos puramente privados al reconocimiento de las sinergias y los modelos híbridos de la gobernanza mediante el cual las normas voluntarias interactúan con las instituciones públicas (SKASC, 2012).

Se sugiere que los impactos más positivos se encuentran en estas interacciones entre las iniciativas públicas y privadas. De este modo, los gobiernos actúan como "facilitadores" que pueden fomentar las condiciones para alentar al sector privado a crear valor en las cadenas a través de la inclusión de los pequeños agricultores. Los marcos institucionales son un medio importante a través del cual los pequeños productores son capaces de participar en la certificación de mercados. Aunque cada país tiene un enfoque diferente a la promoción de este entorno propicio basado en las prioridades y capacidades nacionales, modelos híbridos de asociaciones público-privadas para la prestación de este tipo de servicios son cada vez más comunes. Una correcta legislación que regule las asociaciones de agricultores, cooperativas y programas de pequeñas plantaciones es también necesaria para el funcionamiento de la cadena de valor.

Según la FAO (2014), en general, se sabe poco acerca de los impactos de certificación y cómo programas de diseño pueden contribuir para maximizarlos. En primer lugar, la atención debería centrarse menos en los costos y precios y más en cómo y cuándo la certificación puede tener efectos indirectos, así como sus impactos en el largo plazo.

El sistema de certificación del Sello de Combustible Social responde a esta modalidad híbrida y ha llevado a que la agricultura familiar haya sido un gran aliado para el mercado de biodiesel en Brasil. Cerca de 30% del combustible renovable del país es originado a partir de materia prima producida por agricultores familiares. Solamente en 2015 fueron adquiridos por industrias fabricantes del biocombustible aproximadamente R$4 mil millones, lo que equivale a 3,9 millones de toneladas de materia prima, provenientes de cerca de 75 mil familias. Más de 100 cooperativas de agricultores familiares ya están habilitadas a comercializar en el ámbito del Programa Nacional de Producción y Uso del Biodiesel (PNPB).

Los agricultores interesados pueden participar del Programa estableciendo contratos directamente con las industrias productoras de biodiesel, o por medio de sus cooperativas. Los contratos son celebrados entre las propias cooperativas y las industrias. Ellos deben ser firmados antes de la siembra de los cultivos, además de establecer la forma, la cantidad de adquisición y el local de entrega de la materia prima producida. También debe estar en el contrato la forma de ejecución de la asistencia técnica para el agricultor.

1.4. Agricultura, materia prima y cultivos energéticos

Brasil explora menos de un tercio de su área destinada a la agricultura, lo que constituye la mayor frontera para expansión agrícola del mundo. El potencial es de cerca de 150 millones de hectáreas, siendo 90 millones referentes a nuevas fronteras y otros 60 referentes a tierras de pastos que pueden ser convertidas en explotación agrícola a corto plazo (*Biodieselbr*, 2006). El Programa del biodiesel pretende utilizar solamente tierras inadecuadas al cultivo de géneros alimenticios.

Según el geógrafo Pena (2017), la frontera agrícola representa un área más o menos definida de expansión de las actividades agropecuarias sobre el medio natural. En Brasil, sobre todo a lo largo del siglo XX, las prácticas agrícolas se expandieron de manera más intensa en el interior nacional, en función tanto de la política de "Marcha para el Oeste", implementada por el entonces presidente Getúlio Vargas y en el marco de la política de sustitución de importaciones promovida por Juscelino Kubitschek. En estos dos gobiernos, productores del Sur y del Sureste del país migraron para Centro Oeste (estados de Goiás, Mato Grosso y Mato Grosso do Sul), los cuales se convirtieron en grandes productores de cereales y deforestaron gran parte de la vegetación original (El Cerrado). Actualmente, la nueva frente de expansión agrícola se encuentra direccionada a la región Centro-Norte del país (Portal Brasil, 2011), principalmente en los estados de Maranhão, Tocantins, Piauí y Bahia, denominada "MATOPIBA" (conjunción de las sílabas iniciales de cada uno de los 4 estados).

Hay también una gran diversidad de opciones para la producción de biodiesel, con materias primas tales como (ver Figura 4):

- la palma y el babasú en el norte;

- la soja, el girasol y el maní en las regiones sur, sudeste y centro-oeste; y,

- las semillas de ricino, que además de ser la mejor opción del semi-árido nordestino, se presenta también como alternativa a las demás regiones del país.

La producción de oleaginosas en explotaciones familiares destinadas al biodiesel constituye una alternativa importante para la erradicación de la pobreza en el país. En la región semi-árida nordestina viven más de 2 millones de familias en pésimas condiciones de vida. La inclusión social y el desarrollo regional, especialmente vía generación de empleo y renta, deben ser los principios orientadores básicos de las acciones dirigidas al biodiesel, lo que implica decir que su producción y consumo deben ser promovidos de forma descentralizada y no excluyente en términos de rutas tecnológicas y materias-primas utilizadas (*Biodieselbr*, 2014).

El cultivo de la soja genera empleo directo para 4,7 millones de personas en diversos segmentos, de insumos, producción, transporte, procesamiento y distribución en las cadenas productivas de cerdos y aves.

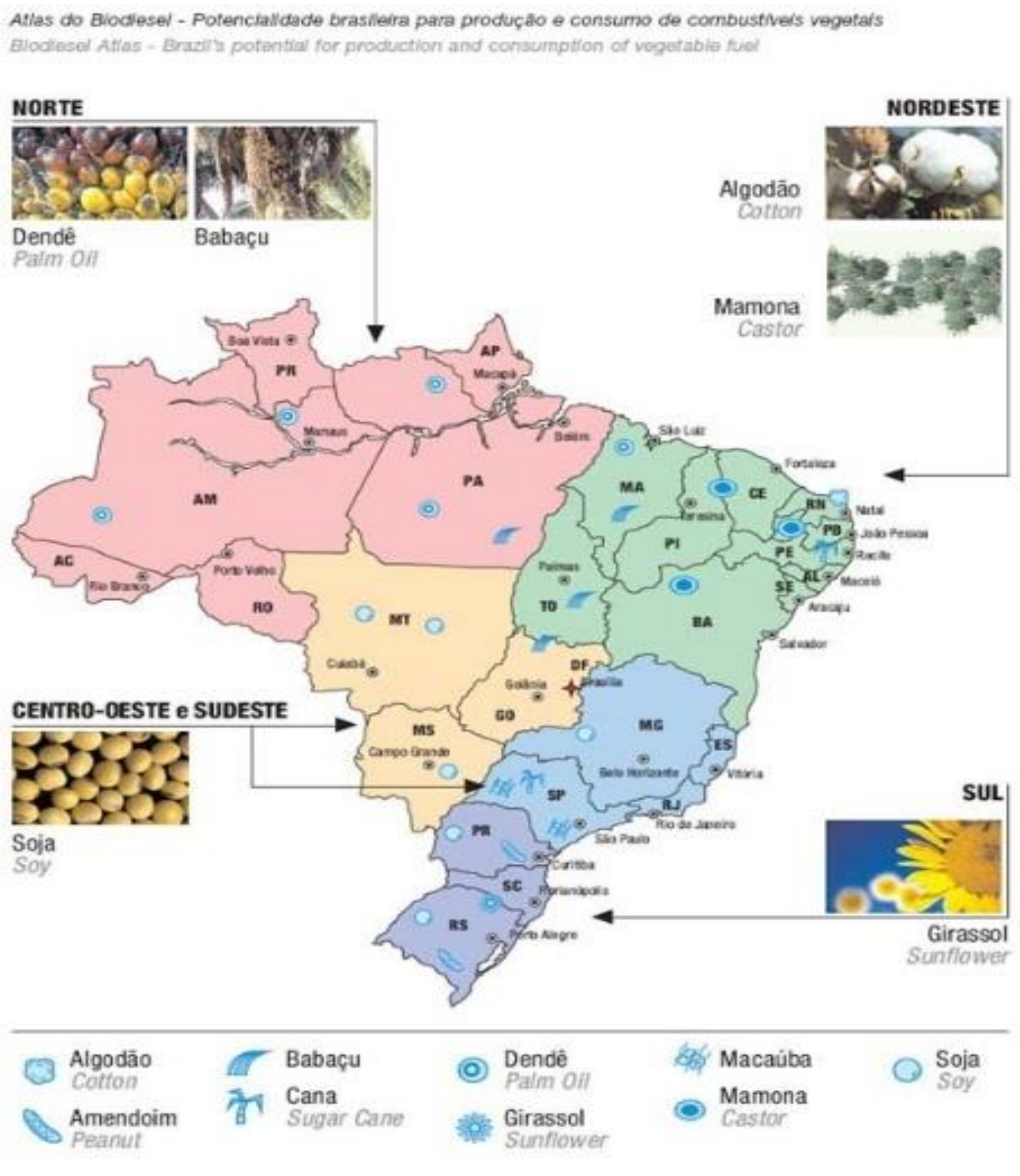
A diferencia de lo sucedido en otros países (como, por ejemplo, en Malasia, donde viabilizó la reforma agraria), el cultivo de la palma[1] ha sido escasamente explorado en Brasil. Las áreas de mayor potencial productivo en Brasil están mapeadas por EMBRAPA. Existe un área de 69,9 millones de ha con alta/media vocación para el cultivo de la palma (áreas de selva amazónica degradadas). Malasia es el segundo país

[1] En Brasil, la palma se cultiva convencionalmente en la región amazónica. Esta región tiene una amplia diversidad de plantas nativas de aceite, buen suelo y condiciones climáticas adecuadas para una alta productividad de la palma aceitera, además de las ventajas ambientales y sociales. Debido a estas condiciones favorables, de las muchas variedades de oleaginosas existentes para la producción de biodiesel, la palma se determinó como el cultivo ideal para el Norte de Brasil (César *et al.*, 2013).

productor mundial de aceite de palma —solamente detrás de Indonesia— (*Biodieselbr*, 2016b).

La utilización del biodiesel puede ser dividida en dos mercados distintos: usos de automoción e instalaciones de generación de energía eléctrica. Cada uno de estos mercados posee características propias y pueden ser subdivididos en sub-mercados.

Figura 4. Mapa oleaginosas en Brasil



Fuente: extraído de "*Atlas do Biodiesel – Potencialidade brasileira para produção e consumo de combustíveis vegetais*"

2. JUSTIFICACIÓN

La regulación de la cadena de valor del biodiesel en Brasil se sustenta, básicamente, en cuatro pilares: (i) la obligación de añadir porcentajes cada vez mayores al diésel convencional para su comercialización; (ii) el sistema público de subastas, en el que la Agencia Nacional de Petróleo (ANP) adquiere en carácter de monopsonio el biodiesel producido y ofertado por las compañías privadas; (iii) el Sello Combustible Social (SCS) que concede el Ministerio do Desenvolvimento Agrário (MDA, 2006) a los productores de biodiesel que obtienen la materia prima de los agricultores familiares; y, (iv) el intento de promover una diversificación de las materias primas agrícolas utilizadas para la producción de biodiesel. Aunque a lo largo de los artículos que componen este trabajo se vuelve sobre estos tres aspectos, es útil introducirlos en este apartado.

En primer lugar, tal como recogen Stattman y Mol (2014), el Plan Nacional de Producción y Uso de Biodiesel (PNPB) forzó la introducción del biodiesel en la matriz energética brasileña a través del establecimiento de obligaciones de mezcla (cuantidades porcentuales de biodiesel a mezclar en el diésel tradicional). De un porcentaje inicial del 2% (B2) se pasó a una meta del 5% (B5) a ser alcanzada en julio de 2010. Más tarde, el porcentaje requerido de biodiesel mezclado con diésel pasó de 5% a 6% a partir de julio de 2014, al 7% a partir de noviembre de 2014 y 8% a partir de marzo de 2017. Estos incrementos graduales explican buena parte del notable crecimiento de la producción de biodiesel en el país a lo largo de ese período, tal como se verá más adelante.

En segundo lugar, la cadena del biodiesel en Brasil utiliza un sistema de **subastas**. El proceso es dividido en tres partes. En la primera etapa las industrias ofrecen tres lotes con diferentes descuentos sobre el precio de referencia de la ANP. En la segunda y tercera etapas – una exclusiva para industrias con Sello Social y otra sin esta restricción – las distribuidoras disputan los volúmenes ofertados por medio de la plataforma virtual de subastas, la Petronect. Las distribuidoras pueden comprar cuanto biodiesel quieran y de las industrias que deseen, sin la interferencia restricciones regionales.

La medida por lo tanto beneficia las empresas que tienen la combinación más favorable de logística, precio y atendimiento.

Después de la primera fase de compra en la subasta, con participación exclusiva de industrias con el Sello, hay una segunda etapa. Participan de la representación los proveedores del Sello cuyo volumen no fue completamente vendido en la etapa anterior, así como los proveedores sin Sello. En la representación los precios deben ser siempre iguales o menores a los previamente presentados. Hasta la 25ª subasta, las industrias productoras de biodiesel vendían su producción directamente para la Petrobras, la cual —posteriormente— revendía el producto a las distribuidoras de combustibles. A partir de junio de 2012 las compras empezaron a ser realizadas directamente entre industrias y distribuidoras y la relación entre ellas se quedó más cercana. Actualmente, las propias distribuidoras pueden elegir de cuáles industrias desean comprar el biodiesel a ser mezclado al diésel mineral. De esta forma es posible reducir costos logísticos y obtener la calidad deseada del producto. Siendo así, esta medida beneficia los ofertantes que tienen sus industrias más cercanas de los mercados consumidores y con costos fijos más bajos.

La legislación sigue beneficiando la participación de las empresas que tienen el SCS. Estas poseen una reserva de mercado de 80% del volumen comercializado en las subastas. Por lo tanto, en las primeras fases de subasta están destinadas solamente las empresas titulares del Sello. En la segunda ronda, todas las empresas concurrentes están autorizadas a disminuir sus precios de venta para que estén disponibles para las distribuidoras en una nueva etapa de la subasta. El volumen sin Sello seleccionado por los adquirentes en la Etapa 3 de la subasta no podrá ser superior a 25% del volumen previamente seleccionado de proveedores con el Sello, en la etapa anterior. Este límite aplica, también, a los clientes del adquirente, cuando manifiesten su interés. Por lo tanto, mantiene así la división actual de hasta 20% sin el SCS y 80% con SCS en el volumen total negociado en la subasta.

Cada oferta podrá tener, como resultado final, más de una distribuidora ganadora, hasta el límite de volumen ofertado, una vez que este puede ser divisible. Para los ofertantes existe un PMR (Precio Máximo de Referencia, por región) que deberá ser respetado al presentar la cantidad ofertada. No obstante, quienes oferten a precios más bajos tendrán la posibilidad de ser los primeros a elegir por los adquirentes.

En tercer lugar, un componente importante del sistema es el Sello Combustible Social (SCS), que concede el Estado a los productores de biodiesel que obtienen la materia prima de los agricultores familiares y que persigue fomentar la inclusión social de estos productores a través de su incorporación a la cadena de valor de biodiesel. El SCS fue introducido en 2004. Por medio de un contrato, los procesadores de biodiesel están comprometidos a proporcionar asistencia técnica a los agricultores y reciben como beneficio una reducción de impuestos (que varía según el tipo de materia prima y de la región en la que se obtiene) y un subsidio para participar en subastas de biodiesel organizadas por la ANP (Agencia Nacional de Petróleo), en las que se compra el biodiesel de estos procesadores industriales. En la mayoría de las subastas de la ANP (80%), la empresa que vende posee el SCS. La formación de cooperativas entre los agricultores también es estimulada para catalizar las transacciones entre productores agrícolas e industrias, tal y como afirman Stattman y Mol (2014). Los requisitos para la obtención del SCS difieren según la región, que serán detallados en la publicación nº 3 (Capítulo 4).

En cuarto lugar, las exenciones e incentivos fiscales federales también se diferencian según la materia prima utilizada y la región de producción, lo que busca promover la diversificación en las materias primas utilizadas. Como Pereira *et al.* (2012) confirman, hay numerosas plantas distribuidas en todo el Brasil y el aceite procesado proviene de diferentes cultivos, como la soja, palma, ricino, babasú, girasol y maní. Todos estos aceites son adecuados para la producción de combustible renovable, materias primas que representan alrededor del 75% de los costos de producción de biodiesel en Brasil, según la Compañía Nacional de Abastecimiento (CONAB). La elección de la materia prima está influenciada por el potencial de las diferentes semillas oleaginosas para cada región geográfica, tal y como sostiene Khalil (2006). Aceite de palma y palma babasú son más apropiados para la región norte, mientras que la colza, el girasol y el algodón son más favorables en el sur. Sin embargo, la producción total de aceite de soja es la mayor en Brasil (81,36% de la producción total), seguida por grasa bovina (13,36%) y aceite de semilla de algodón (4,11%). La producción de cultivos alternativos es pequeña y de base local, como han señalado Leonardi *et al.* (2009). De hecho, a pesar de los esfuerzos realizados para diversificar las materias primas para la producción de biodiesel, la producción de monocultivos de soja a gran escala, con poca demanda de mano de obra (gracias a la mecanización) y una fuerte conexión con los mercados de productos básicos, es utilizada masivamente como materia prima a pesar de su bajo rendimiento de aceite por hectárea. Mientras tanto, los cultivos como *Jatropha curcas*, ricino y palma, con un alto contenido de aceite, no experimentan una gran expansión en la producción de biodiesel. Las plantaciones de soja ya ocupan el 35% de las tierras cultivadas en Brasil, según el IBGE (2009).

Según Conab (2017), Brasil es el segundo mayor productor de soja del mundo, con una producción de 96,2 millones de toneladas en la campaña 2014/2015, con proyecciones de 105,5 millones de toneladas para la cosecha 2016/17. Esta producción está dirigida por los estados de Mato Grosso, Paraná, Rio Grande do Sul y Goiás (29%, 20%, 15% y 11% de la producción nacional, respectivamente), y se está expandiendo a los estados orientales de Maranhão, Tocantins, Piauí y Bahía (MATOPIBA).

Para terminar esta caracterización preliminar del sector de biodiesel en Brasil y del marco regulador que lo ha auspiciado en los últimos años, es necesario comentar el momento de reforma que está experimentando en estos momentos. En efecto, la industria brasileña de biodiesel se está preparando para entrar en un nuevo ciclo de expansión. De volúmenes poco inferiores a 325 millones de litros – media mensual desde del comienzo del B7 –, las industrias deben fabricar más de 510 millones de litros al mes a partir de la llegada del B10 en marzo de 2019. Eso representa un 82% adicional a la actual capacidad instalada de las industrias brasileñas con capacidad de comercialización (*Biodieselbr*, 2016a).

Para el gobierno el sistema de comercio de biodiesel en Brasil tiene que pasar por cambios para adecuarse a los nuevos volúmenes que se pretende comercializar. Afirman (*Biodieselbr*, 2016a) entretanto que las perspectivas para los próximos años son muy buenas, ya que en marzo de 2017 el B8 ya entra en vigor y también la economía nacional debe salir de la recesión económica. Según las proyecciones, serán años de crecimiento constantes.

Según el nuevo director de biocombustibles en el MME (*Biodieselbr*, 2016a), pasada una década del programa de biodiesel en Brasil, ya hay un equipo fuerte en conocimiento técnico-científico del sector, así como en aspectos de gestión pública. Por lo tanto, el reto ahora será un modelo estratégico para el sector de biocombustibles.

Afima el representante del MME, asimismo, que en el corto plazo van a empezar esa nueva política estratégica, posiblemente denominada Renova Bio, que definirá más claramente como el gobierno nacional ve el papel de los biocombustibles (biodiesel y etanol) en la matriz energética brasileña. Principalmente persiguen objetivar una meta clara respecto a qué parte de la matriz energética brasileña tendrá que venir de los biocombustibles hasta el año de 2030, además de integrar esta meta con la política mundial de sostenibilidad ambiental, reforzada con el acuerdo del Tratado de Paris (COP 21).

En este contexto, el gobierno enfrenta una serie de nuevos retos, como definir espacio para nuevos productos como los biocombustibles de segunda generación[2] (algo ya vigente en Europa), así como aclarar a los emprendedores la relación de sostenibilidad socioambiental y económico-financiera. En el caso del aspecto económico-financiero,

[2] La producción de biocombustibles se basa en las llamadas tecnologías de primera generación, lo que significa producción de etanol a partir de azúcares o almidón (caña, maíz, trigo, mandioca) y biodiesel de aceites vegetales o grasa animal (soja, ricino, palma). Están en desarrollo varias tecnologías que utilizan los materiales lignocelulósicos como matérias primas (residuos agroforestales, madera de bosques plantados, culturas energéticas de ciclo corto, basura orgánica urbana), que son más baratas, abundantes y pueden ser producidas en varias condiciones de clima y de suelo (Leite y Leal, 2007).

pretende aclarar para el mercado cuánto exactamente del producto será comprado, cuanto será tributado (impuestos) y cuales las tasas de inversión y retorno.

Resumiendo, el programa pretende expandir la producción de biocombustibles en el país, con sostenibilidad ambiental, económica y social, compatible con el crecimiento del mercado. Para el biodiesel, específicamente, se pretende: (i) evaluar e implementar mejorías en el mecanismo de subastas en el corto plazo; (ii) en el mediano o largo plazo, sustituir las subastas por instrumentos que induzcan la negociación directa entre productor y distribuidor; (iii) evaluar la anticipación de los porcentuales de biodiesel B9 y B10 en el corto plazo, así como asegurar la previsión para el alcance de la mezcla B15 (MME, 2017).

3. Objetivos y Estructura del Documento

La presente tesis tiene dos objetivos generales, que son planteados de forma más concreta en los tres artículos que la componen.

En primer lugar, se persigue analizar y caracterizar la evolución del sector de la transformación de biodiesel en Brasil en el contexto del marco regulador que ha ido impulsando y condicionando su desarrollo. En concreto, se aborda cómo ha ido cambiando la estructura empresarial del sector y qué configuración presenta en la actualidad, justo cuando parece avecinarse un cambio sustancial de dicho marco.

En segundo lugar, la tesis aborda de manera específica el funcionamiento del Sello de Combustible Social (SCS) como mecanismo de incorporación de los pequeños productores agrarios a la cadena de valor del biodiesel. Tal como se planteaba en el apartado anterior, el SCS ha sido uno de los aspectos más relevantes de la política de biodiesel del país, por lo que es necesario profundizar sobre la manera cómo ha incidido en las relaciones entre estos pequeños productores y la industria de transformación.

Los artículos que se incluyen a continuación abordan y desarrollan de forma más específica estos objetivos.

El primer artículo "Taking stock of the evolution of the Biofuel industry in Brazil: Business concentration and structural traits" se trata de una investigación que tiene dos objetivos principales. En primer lugar, evaluar la evolución de la concentración de los negocios en la industria brasileña de biodiesel a lo largo de todo el período de implementación del PNPB, de 2005 a 2016. En segundo lugar, busca examinar las principales características de la estructura del parque industrial de biodiesel. A lo largo del mismo se otorga especial atención a las materias primas utilizadas para la obtención de biodiesel y otros productos de las empresas que operan en el sector.

El segundo artículo, titulado "Effects of the Brazilian biodiesel certification in the relationship between the biodiesel industry and small-scale farmers", aborda precisamente, desde una óptica del conjunto del país, cómo funciona el sistema de certificación SCS y cómo ha ido configurando las relaciones entre distintos operadores de la cadena de valor (industria, cooperativas y pequeños productores) en el marco del mismo.

El tercer y último artículo vuelve sobre esta cuestión. Bajo el título "A closer look at the Brazilian Social Fuel Seal: uptake, operation and dysfunctions", constituye un análisis a profundidad sobre algunos aspectos relacionados con desajustes en su funcionamiento y sobre la base de un estudio más detallado realizado en el Estado de São Paulo.

Para finalizar este documento, se incluye un Capítulo de discusión y conclusiones que trata de sintetizar algunas cuestiones transversales de esta investigación y que refuerza los enlaces entre los tres artículos.

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CAPÍTULO II.

TAKING STOCK OF THE EVOLUTION OF THE BIODIESEL INDUSTRY IN BRAZIL: BUSINESS CONCENTRATION AND STRUCTURAL TRAITS

CAPÍTULO II: TAKING STOCK OF THE EVOLUTION OF THE BIODIESEL INDUSTRY IN BRAZIL: BUSINESS CONCENTRATION AND STRUCTURAL TRAITS

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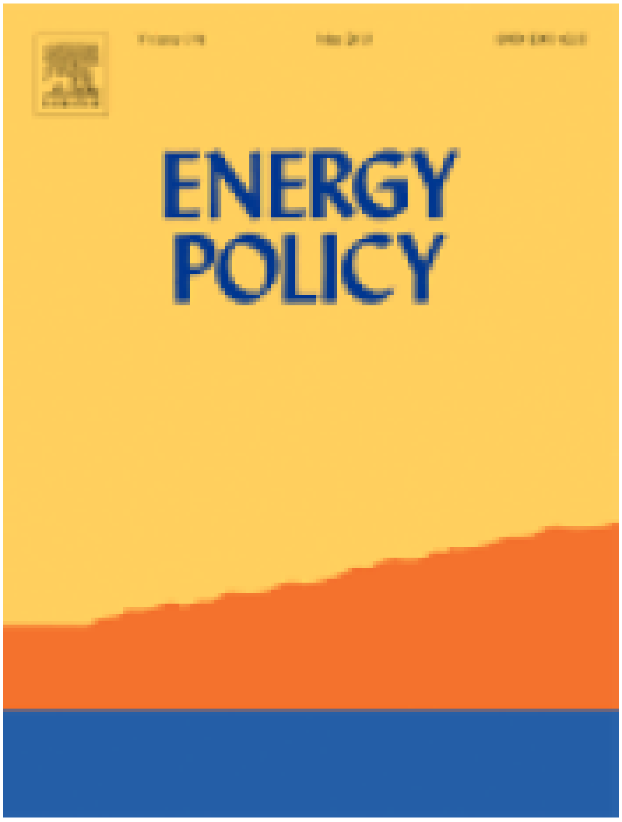

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Ms. Ref. No.: JEPO-D-17-00946R1
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TAKING STOCK OF THE EVOLUTION OF THE BIODIESEL INDUSTRY IN BRAZIL: BUSINESS CONCENTRATION AND STRUCTURAL TRAITS

Abstract

The Brazilian biodiesel industry has rapidly developed under the National Biodiesel Production and Use Programme (PNPB) launched in 2004, which is to be replaced by a new regulatory framework that is now under discussion. This paper aims to take stock of the evolution of the structure of the biodiesel industry in this country under the implementation of the PNPB —between 2005 and 2016— and to understand its current traits. The research combines a dynamic analysis of the industrial concentration indexes (closing the time gap with previous studies on this matter) and a multivariate analysis of the productive characteristics of the biodiesel plants operating in 2016. Results show that, following a period of de-concentration between 2005 and 2011, the industry entered in a stage of certain stability in the concentration indexes. This picture disguises the exit of biodiesel plants and firms from this market and a business horizontal growth in the last period. The static analysis has allowed for the identification of different 'business models' considering the scale of the plants and the input and output strategies of the firms producing biodiesel.

Keywords: Brazil; biodiesel; regulatory framework; industrial concentration; industrial structure.

Highlights

- The Brazilian biodiesel industry de-concentrated from 2005 to 2011.
- There has been certain stability of the concentration indexes from 2012.
- Biodiesel has been produced by fewer companies and plants in recent years.
- Different business models based on the plant size, input and output diversification.

1. INTRODUCTION

In December 2016, the Brazilian Administration launched a new regulatory framework for the biofuel sector, a programme named RenovaBio 2030, which integrates biodiesel and bioethanol production. The new strategic policy is aimed to discuss biofuel sustainability involving conventional and secondgeneration biofuels, establish the trading rules and encourage investments in this industry until 2030. The ambition is to expand the production of renewable fuels in the country, in accordance with the Brazilian commitments at COP21 (UN Climate Conference) of increasing the share of sustainable biofuels to around 18% of the overall national energy mix by 2030. At the time of writing (July 2017) the programme has been submitted for public consultation.

Regarding the biodiesel industry, in which this paper is focused, the new programme would entail a profound change in the legal framework that has driven this sector in Brazil for more than one decade. The National Biodiesel Production and Use Programme (PNPB), which was launched in 2004, has boosted a rise in biodiesel production until making Brazil the second world producer after USA today (REN21, 2016). The academic literature has paid great attention to both the development and the economic, social and environmental results of this programme, as a worldwide benchmark for national biofuel policies (see, among others, Cremonez *et al.*, 2015; Oliveira and Coelho, 2017; Rico and Sauer, 2015; Nogueira and Capaz, 2013; Padula *et al.*, 2012).

Some studies conducted at the beginning of this decade analysed the specific issue of the business concentration in the biodiesel industry throughout the initial stage of expansion of this market (Tanaca and de Souza, 2010; Leonardi *et al.*, 2011; Dos Santos and Padula, 2012; Cavalheiro, 2014), and all of them reported the low concentration of this industry at such stage. The negative effect of the market concentration over competition and its positive relationship with the firms' profitability has long been stated (Peltzman, 1977). Cavalheiro (2014) confirmed that this atomization led to a highly competitive market, preventing that some companies had gains by way of a significant price differentiation at the biodiesel auctions. However, these works have not been updated, despite the changes that this sector has undergone thereafter – e.g. some reforms undertaken in the PNPB in 2012, the increasing competition among biodiesel plants and the business movements that have taken place over the last few years.

In this context, we have carried out a research with two main objectives. First, to assess the evolution of the structure of the Brazilian biodiesel industry throughout the entire PNPB implementation period, from 2005 to 2016, paying special attention to the business concentration. Second, to examine the main traits of the structure of the biodiesel industry today — as the starting point of the upcoming regulatory framework, making emphasis on the different feedstocks utilised and the diversity of outputs that the firms operating in this sector produce.

The remainder of this paper is structured as follows. In Section 2 the methodology of this investigation is clarified. In Section 3 we comment the overall functioning of the PNPB and its main results based on the scientific literature, what will help to contextualize the analysis and provide explanatory elements to the following sections. The two specific objectives specified above are tackled in Sections 4 and Section 5, respectively, in which the insights from business economics and Industrial Organisation theories will support the discussion of the driving forces and repercussions of this sector's dynamics and current traits. Finally, conclusions and policy implications will be exposed in Section 6.

2. METHODOLOGY

Regarding the analytical approach of this investigation, the changes in the concentration of the firms participating in this industry have been assessed by means of two types of concentration indexes. First, the Concentration Ratios (CR) proposed by

Bain (1951) - who considered the business control in the hands of a limited number of firms as a key aspect to characterise an industry structure - are calculated from the expression

$$CR(k) = \sum_{i=1}^{k} S_i \qquad [1]$$

where CR(k) is the concentration ratio of the largest k industries and Si the market share (in parts per unit) of the i industries.

Second, the Herfindahl-Hirschman Index (HHI) (see Hirschman, 1964), defined as:

$$HHI = \sum_{i=1}^{N} {S_i}^2 \qquad [2]$$

Where *Si* is expressed as a percentage. HHI ranges from 0 (many small companies) to 1 (monopoly). A HHI below 0.15 indicates an unconcentrated industry, between 0.15 and 0.25 a moderately concentrated market and above 0.25 a concentrated one[4]. Whereas CR(k) informs on the degree of competition of the market focusing only on the largest firms, HHI provides a picture of the distribution of the firm size in an industry. This paper combines the indexes CR(2), CR(4), CR(8) and HHI to construct a more comprehensive yearly evolution.

Later, with the purpose of exploring and describing the structure of the Brazilian biodiesel industry today, a Multiple Correspondence Analysis[5] (MCA) has been performed with SPSS Statistics version 20. MCA is a multivariate data analysis technique that simplifies a dataset of observations (here biodiesel plants) described by more than two nominal variables into a small number of dimensions – similarly to what Principal Component Analysis performs with quantitative variables. The last step of the analysis was to combine the MCA with an agglomerative hierarchical clustering (Carvalho, 2008),

[4] Thresholds set by the US Department of Justice and the Federal Trade Commission https://www.justice.gov/atr/horizontal-merger-guidelines-08192010 (accessed in December 2016).

[5] See the classic text of Greenacre (1984) for a comprehensive explanation of this method.

in order to identify relatively homogeneous groups of biodiesel plants. Further details on this procedure are exposed in Section 5.

The consultation of a wide variety of sources have been necessary to conduct this analysis, as the limitations presented by official statistics has been a major challenge. The National Agency of Petroleum, Natural Gas and Biofuels (ANP) registers the volumes of biodiesel sold in all the auctions, as well as the industrial units participating in the bidding process. The same office issues a monthly report informing on the biodiesel production and the feedstocks utilised at regional level, the production capacity of each biodiesel mill and the firms authorized to build new plants or to expand/modify the existing units. This information is complemented with the bimonthly reports published by MME on the bioethanol and biodiesel market.

However, the governmental agencies do not consistently track or record the merger and acquisition movements that have taken place in this industry – a relevant information to know the way the business structure of this industry has evolved. Similarly, the information on the biodiesel plants that temporary or definitely retire from the biodiesel market is not always up-to-date, and there is no comprehensive information on the feedstocks utilized for biodiesel production.

In order to address these limitations, other sources such as press releases, websites of related institutions (i.e. the Brazilian Association on Vegetal Oil Industries – Abiove; the National Supply Company - CONAB) and the informative journal *BiodieselBr* were consulted. The website of firms producing biodiesel, when available, provided further details on the type of feedstocks utilised for and the outputs, other than biodiesel, manufactured by the company. Additionally, 10 telephone inquiries were made to the biodiesel mills for which this information was insufficient or not updated in the consulted sources.

3. THE FUNCTIONING AND EXPANSION OF THE BIODIESEL SECTOR IN BRAZIL

The effective introduction of biodiesel into the Brazilian energy matrix started with the PNPB, an inter-ministerial programme created by Federal Law nº. 11097/2005 and coordinated by the MME. It was aimed at fostering the biodiesel production and consumption in the country in a sustainable way, both technically and economically, focusing on social inclusion and regional development (MME, 2015). This regulatory framework was supported on a set of instruments aimed at driving the way the economic agents participating in the biodiesel supply chain operate and interact with each other, which are explained briefly below.

First, the programme introduced blending mandates to stimulate the consumption and production of biodiesel in Brazil. A voluntary blending percentage of 2% of biodiesel into petroleum diesel (denoted as B2) was authorised for the first time in 2005, but it turned mandatory in 2008 for all the diesel commercialized nationwide. The Government increased the blending rates gradually thereon to reach B7 in November 2014, and the forthcoming targets are B8 in March 2017, B9 in March 2018 and B10 in March 2019. Each biodiesel plant is authorized by the ANP to produce a maximum volume of biodiesel per year, although they produce well below their full nameplate capacity. By 2016, the total amount authorized was 3.68 Mm^3, but the utilization factor was of 50.3% (ANP, 2017). The overcapacity has been explained as a result of the strong incentives that the PNPB introduced to foster biodiesel production (Nogueira *et al.*, 2016) and the expectations of upcoming increases in the blending mandates.

Second, distributors buy biodiesel in auctions held on a bimonthly basis. The plants are the bidders, and offer biodiesel with a discount to a reference maximum price per region set by the ANP. Until the 25^{th} auction, biodiesel B100 (without blending) was sold by the mills to the State-led company Petrobras, and later re-auctioned between it and the authorised distributors. However, the Ordinance MME 276 of 2012 provisioned that from the 26^{th} auction, held in June 2012, distributors would choose the suppliers to whom they would buy the biodiesel. Regional restrictions were eliminated and the volume of biodiesel bought would no longer be defined previously by the ANP. These changes were aimed at reducing the public intervention and encouraging competition among biodiesel plants. Petrobras still intermediates the transaction and charges a fixed amount per cubic meter.

Third, a special tax system is aimed promote the diversification of the feedstocks used for biodiesel, particularly in the poorest areas of the country. Reductions are set for biodiesel producers in federal taxes, PIS/PASEP and COFINS[6], on the condition they utilise palm or castor oil as feedstocks in the North, Northeast and Semi-arid regions. These crops adapt well to the small scale production in the Amazonian conditions (Cremonez *et al.,* 2015; Bergmann *et al.* 2013; César *et al*. 2013), hence their promotion contributes to the goals of territorial inclusion.

Fourth – and connected with the former instruments - social inclusion was promoted by the Social Fuel Seal (SFS), a certification scheme awarded by the Ministry of Agricultural Development[7] (MDA) aimed at upgrading small farmers in the biodiesel value chain, also prioritising the less developed areas of the country. Credits and additional benefits in the federal taxes were established for biodiesel plants that acquired a minimum percentage of their feedstocks (between 15% and 40%, depending on the region) from family farmers and provided them with technical assistance. These plants had also priority to sell their biodiesel in the auctions. In 2015, animal fat was also included in SFS (Ordinance MDA 337 of 18 September).

The results of the PNPB have been ambivalent. The increasing mandatory blends have fostered the biodiesel production in the country, which went from 736 m^3 in 2005 to 3.67Mm^3 in 2016 (Figure 1). Production has continuously grown since the programme came into force, excepting in 2016, when it slightly declined due to the economic crisis (Barros, 2016).

[6] PIS/PASEP (Program of Social Integration/Program of Patrimony Formation of Public Servants), which are social contributions payable by legal entities, and COFINS (Contribution to the Social Security Funding), the federal tax levied on the gross revenues of enterprises.

[7] This Ministry was abolished in May 2016, and its competences transferred to the Ministry of Social and Agrarian Development.

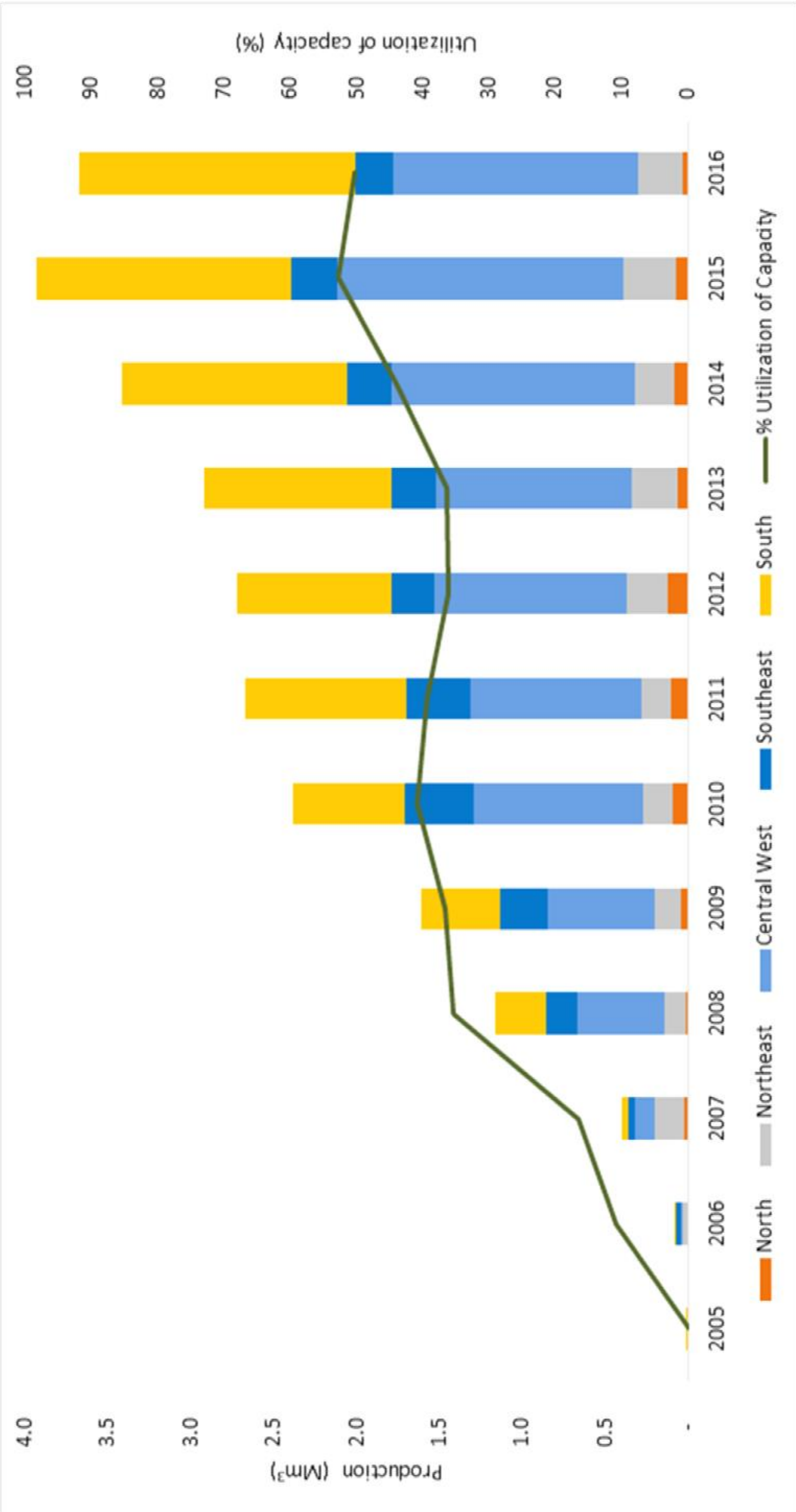


Figure 1. Biodiesel production and delivery by regions.
Source: Authors' elaboration based on the biodiesel auctions reports elaborated by the ANP from 2005-2016 (www.anp.gov.br)

However, the PNPB has failed in promoting the diversification of feedstocks. Soybeans are still, by far, the most important raw material– according to MME (2016), 77.6% of the Brazilian biodiesel was obtained from it (until October 2016). This prevalence is related with the increasing concentration of biodiesel production in the Central West and the South of the country (Fig. 1), where this crop is mainly produced.

Critically, feedstocks are responsible for 80% of the total costs of biodiesel production (Barros, 2016), and soybeans have been assessed to provide more profits for the biodiesel plants than other crops (Alves *et al.*, 2017). The main reason is their high yield, as they are produced in big, monoculture plantations that make use of modern technology. Zonin *et al.* (2014) went further and deployed, in a multicriteria matrix analysis, the management factors utilised by a Brazilian biodiesel company to assess the feedstocks. Many of them clearly point at the advantages of using soybeans: the availability of supply in sufficient volume and quality; the low costs of transportation, storage and crushing process (relative to other oilseeds[8]); the mastery in technological assistance and research; a high residual percentage of by-products with high liquidity in the market (remarkably bran) and the existence of large cooperation networks between companies and cooperatives.

Some of these factors are also determinant to explain the increasing importance of animal fat, a by-product of the strong Brazilian meat processing industry that was not originally taken into consideration by the PNPB, as the main alternative feedstock for biodiesel production. Its use has increased significantly in recent years and it represented 15.5% of the biodiesel production in 2016 (until October). The use of oilseeds other than soybean did not reach 4% of all the biodiesel produced in 2016 (MME, 2016). The role of palm and castor oil, incentivised by the PNPB, continues to be irrelevant due to the significant disadvantages it presents. Several studies have highlighted the low agricultural yields, the need for an intensive use of scarce labour in the North and Northeast, the logistical costs and a number of technical limitations of its

[8] These authors indicate that it is necessary to develop specific crushing machinery for castor, what considerably increases the production costs. In the case of canola and sunflower, the crushing process is more costly than for soybeans.

use to obtain biodiesel (Oliveira and Coelho, 2017; Nogueira *et al*. 2016; Padula *et al*., 2012, Zonin *et al*. 2014). Moreover, these feedstocks have more profitable uses - food in the case of palm; chemical, cosmetic or pharmaceutical in the case of castor (Stattman *et al*., 2013; Oliveira and Coelho, 2017).

The above facts relate to what may be considered a failure to meet the social inclusion objective. The number of small farmers participating in SFS reached a peak of 100,000 in 2011, and felt every year thereafter to be 72,500 in 2015 (MDA, 2016) – very far from the political target of 200,000 producers. Significantly, the farmers who have left SFS were mainly located in the Northeast, and those still involved are concentrated in the South, where they are well organised into cooperatives (Stattman and Mol, 2014). Important dysfunctions have been identified in the SFS operation. In overall terms, biodiesel plants find it difficult to reach the percentage of feedstock obtained from family farmers necessary to comply with the SFS requirements. In the North and Northeast, biodiesel plants have failed to involve family farmers from their own territories, as they buy feedstock from smallholders located in the other regions (Silva *et al*., 2014). Much of the castor and palm oil produced there is resold by power plants to buy soybean as feedstock for biodiesel (César and Batalha, 2013). Moreover, the diversion of soybean oil transacted within SFS to food processing is also a widespread practice in Brazil (Marcossi and Moreno, 2017).

4. THE EVOLUTION OF THE STRUCTURE OF THE BIODIESEL INDUSTRY IN BRAZIL

The expansion of biodiesel production run parallel to the increase in the number of plants operating in the country, particularly in the early years of implementation of the programme (Fig. 2).

Studies conducted so far (see Table 1) coincide in pointing out the high level of concentration shown by this industry when the auctions system started to operate, with very few companies supplying biodiesel. This situation rapidly changed as new firms entered into this market. Using different indexes, these works verified the de-concentration process along the first six years of implementation of the PNPB.

However, the authors quoted in the table only observed the structure of the biodiesel industrial park until 2010. The updating of this analysis is precisely one of the main contributions of this paper. With this purpose, we have combined the methodological approaches of these studies, in such a way that:

- Concentration indexes are calculated at the firm level, so that the delivered production of several plants belonging to a same company have been aggregated.
- Indexes are calculated annually, thus all the auctions in a given year have been aggregated.
- Market share has been estimated from the biodiesel production effectively delivered by each firm.

Table 2 shows the evolution of the structure of the biodiesel industry in the entire programme period, from 2005 to 2016. In line with preceding studies, our results reveal a clear trend towards a lower concentration during the first years of development of this market. Some of the new entrants were producers of soybean oil that coupled the crushing plant with the biodiesel production; some others rented the crushing plant or directly brought the vegetable oil to other firms (Dos Santos and Padula, 2012). From the early years of the present decade, concentration indexes start to show an apparent stability, what indicates that this industry reached a certain level of 'maturity' characterised by a low level of concentration (HHI < 0.15). However, this picture disguises some remarkable business movements that have taken place in the last period

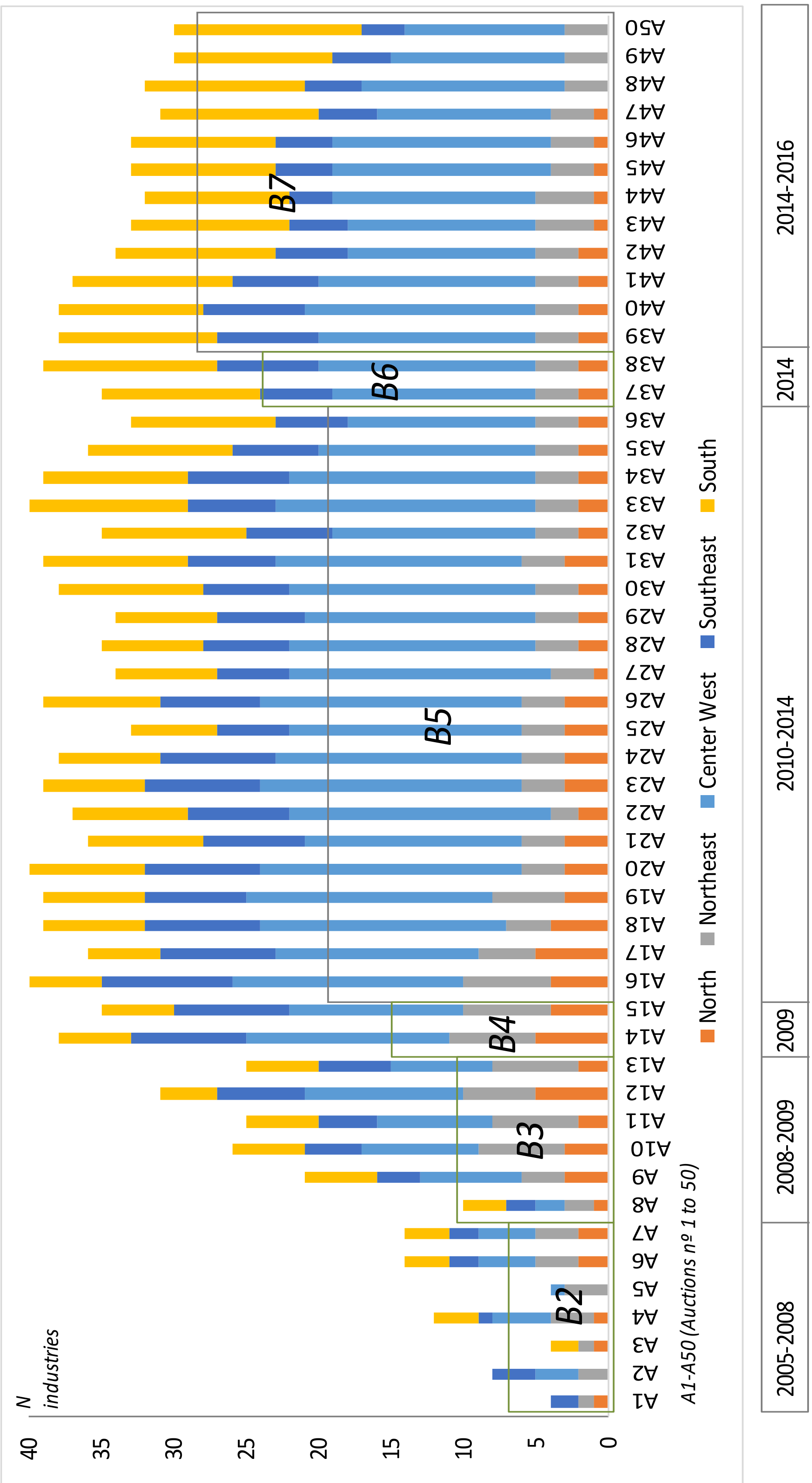


Figure 2. Evolution of number of biodiesel plants participating in the auctions (with indication of the blending percentage in force), by regions.

Source: Authors' elaboration based on data from ANP, 2005-2016 (www.anp.gov.br)

Table 1. Review of previous analyses on the structure of the Brazilian biodiesel industry.

	Period analysed	**Concentration indexes**	**Methodological approach**
Tanaca and de Souza, 2010.	From 1^{st} to 17^{th} auction (years: 2005 - 2010).	CR(4): 1 ⇨ 0.473 CR(8): 0.987 ⇨ 0.712 HHI: 0.384 ⇨ 0.078	Indexes are calculated individually for all bids considering the amount of delivered biodiesel. The unit of analysis is the firm, regardless of whether it has one or more plants in different locations.
Leonardi *et al.,* 2011.	From 1^{st} to 16^{th} auction (years: 2005 - 2010).	CR(4): 1 ⇨ 0.46 Gini Index: 0.2 ⇨ 0.6	Indexes are calculated individually for any bid (from 1^{st} to 17^{th}), considering the amount of delivered biodiesel. The unit of analysis is the individual plant, so that plants in different locations are considered separately even if they belong to the same company.
Dos Santos and Padula, 2012.	From 2005 to 2010.	CR(2): 0.905 ⇨ 0.239 CR(4): 1 ⇨ 0.411 CR(8): 0.999 ⇨ 0.669 HHI: 0.530 ⇨ 0.070	Indexes are calculated yearly (bids held in the same year are aggregated), considering the produced (not the delivered) biofuel. The unit of analysis is the firm, regardless of whether it produces in one or more plants in different locations.
Cavalheiro, 2014	From 2005 to 2012.	CR(4): 1 ⇨ 0.785 HHI: 0.530 ⇨ 0.185	The calculations are made only for the main producing regions (Goiás, Mato Grosso, Rio Grande do Sul, and São Paulo). Indexes are calculated yearly (bids held in the same year are aggregated), considering the produced (not the delivered) biofuel. The unit of analysis is the individual plant, so that plants in different locations are considered separately even if they belong to the same company.

Source: Authors' elaboration from the quoted studies

Table 2. Structure of biodiesel industry in Brazil, 2005-2016

Year	CR (2)	CR (4)	CR (8)	HHI	No. firms	Average delivery (m^3/firm)	No. plants	Average delivery (m^3/plant)	% Utilised capacity
2005	0.80	1	-	0.383	4	17,500	4	17,500	-
2006	0.65	0.99	-	0.273	6	28,333	8	21,250	12.3
2007	0.57	0.74	0.94	0.241	16	40,312	18	35,833	16.4
2008	0.33	0.53	0.82	0.101	24	30,864	31	23,895	32.4
2009	0.25	0.46	0.73	0.080	32	46,247	41	36,095	41.5
2010	0.25	0.42	0.69	0.074	38	61,023	49	47,324	45.4
2011	0.23	0.40	0.65	0.068	39	65,839	48	53,494	44.4
2012	0.23	0.42	0.68	0.069	36	72,740	45	58,192	39.7
2013	0.24	0.41	0.64	0.067	37	77,056	45	63,357	38.9
2014	0.22	0.38	0.64	0.066	35	93,493	42	77,911	45.6
2015	0.21	0.39	0.65	0.066	32	119,611	41	93,355	54.1
2016	0.21	0.39	0.66	0.067	26	143,534	34	109,761	50.3

Source: Authors' elaboration from the data on biodiesel auctions published by the ANP from 2005 to 2016 (www.anp.gov.br)
The utilised capacity is calculated from the MME monthly bulletins in the same period (www.mme.gov.br)

The number of firms bidding in the biodiesel auctions peaked in 2011 to start to descend thereafter, and so did the number of plants. The presence of fewer operators, compatible with the stability of the concentration indicators (there were only slight rebounds of concentration in 2012 and 2016), points to a certain homogenisation of the size of the firms.

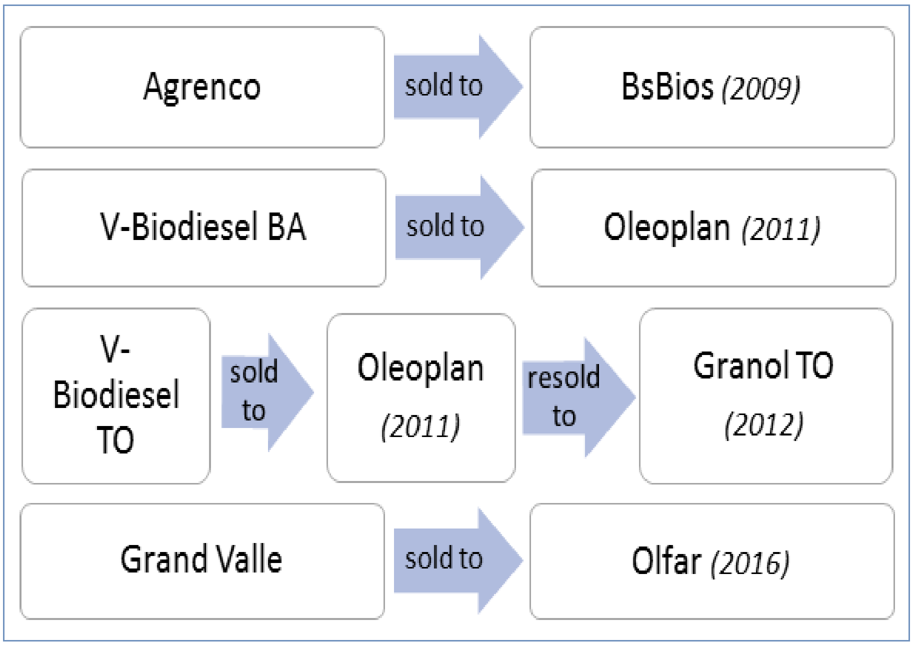
What some scholars have found is that, while small biodiesel plants (those with less than 80,000 t of installed capacity) were predominant at the beginning of the auction system, their average size increased in the last period (Nogueira *et al.*, 2016). These authors assessed that the operational expenditure was much greater than the capital expenditure for this industry, what explains that cost reductions can be obtained from a scale increase despite the idle capacity of the plants. Costs savings are achieved from upscaling by means of a better process control and lower production losses[9]. It is noteworthy that technology utilised by the biodiesel plants has not experienced important changes since 2005 (Nogueira *et al*., 2016), what have prevented any specific company to gain a competitive advantage from a technological breakthrough (Cavalheiro, 2014).

The change of the biodiesel auction format in 2012 played an important role in increasing competition, given that distributors were allowed, for the first time, to select the plants that best fit their needs in terms of logistics, price and quality. In contrast with the former stage, when the atomization of the biodiesel industry led to some homogeneity of the auction prices (Cavalheiro, 2014), the average prices started to show greater discounts with respect to the reference maximum price (Rico and Sauer, 2015). The prices approximated to the production costs, leading to a narrowing of the industries' profit margins (Nogueira *et al.* 2016). Some authors (Oliveira and Coelho, 2017) have linked the closure of several plants with the inability to keep up with such margins.

The drop in the number of firms also responds to acquisitions of some plants by other companies operating in the biodiesel industry. Examples of these movements have been schematized in Fig. 3, which illustrates the intense business dynamism that has characterized this sector in recent years.[10] The business economics literature considers the 'horizontal growth' - mergers and acquisitions – a strategy to, among other objectives, increase the bargaining power of the firms (Moatti *et al*., 2015).

[9] These authors also specify that the reduction in the operational expenditure of biodiesel plants registered from 2011 responds mainly to a drop in soybean prices.
[10] Today there are seven companies that own two or three biodiesel plants, either in the same or in different regions of the country: ADM, BsBios, Caramuru, Granol, Oleoplan, Olfar and PBio.

Figure 3. Business acquisitions in the Brazilian biodiesel industry



Source: BiodieselBr (2009, 2012, 2014a, 2014b, 2016)

The structural changes undergone from 2012 have been parallel to a progressive increase in the blend rates (Figure 2). This has been interpreted as a response of the Brazilian authorities to the biodiesel companies requests aimed at reducing the idleness of this industry, which compromised the financial health of the sector (Oliveira and Coelho, 2017).

Indeed, the Table 2 shows that the utilisation of the installed capacity have increased over the last years. Arguably, the utilization factor - that reached a low point in 2013 – would have played a role as a barrier of entry for new companies in the market and might have contributed to the exit of the productive units that could not cope with the competitive pressure.

In any case, the utilization factor will continue to rise, not only with the upcoming increases in the blend rates, but also with the expected recovery of the Brazilian economy (Barros, 2016).

5. The productive structure of the Brazilian biofuel industry in 2016

This section aims to respond to the second objective of the paper, *i.e.* bringing to light the structural characteristics of the biodiesel plants at present in operation. Although the basic unit of analysis is the plant rather than the firm, some traits of the firms will be taken insofar as they help to interpret the results. The 34 plants included in this analysis correspond to those that participated in the biodiesel auctions conducted in 2016.

Given that the information publicly available on the power plants is fairly limited, the analysis has been based on three variables on which we have captured data for all the productive units. To obtain this information it was necessary to consult different secondary sources, and in some cases to make direct enquiries to industries (see Section 2). First, we have observed the authorized nominal capacity; as a proxy of the scale of the infrastructures installed; second, the feedstock used to produce biodiesel; and third, the type of outputs manufactured by the firm, which provide an insight of its productive diversification. Glycerine has not been considered, as it is a coproduct of biodiesel production.

Table 3 shows the categorisation of these variables and the number of plants that fall into each category. The mills that exclusively use soybean as feedstock for biodiesel are distinguished from those using at least another oilseed (soybean is not excluded), and those using animal fats (alone or together with vegetable oils). Data show that nearly half of the plants still use soybean as the only raw material for biodiesel production, and one-third use animal fats (typically beef tallow) for this purpose. Regarding the outputs manufactured, the majority of the plants belong to firms that also produced foodstuff (including ingredients for animal feeding), and only a small part was specialised on biodiesel production.

Table 3. Distribution of Brazilian biodiesel plants in categories, 2016 (N=34)

Nominal capacity	Small (<120,000 m^3)	9
	Medium (120,000-200,000 m^3)	11
	Big (>200,000 m^3)	14
Feedstock for biodiesel	Soybean	14
	Various Oilseeds	9
	Vegetal & Animal Feedstock	11
Outputs	Biodiesel	8
	Biodiesel & Foodstuff*	20
	Biodiesel & Non-foodstuff	6

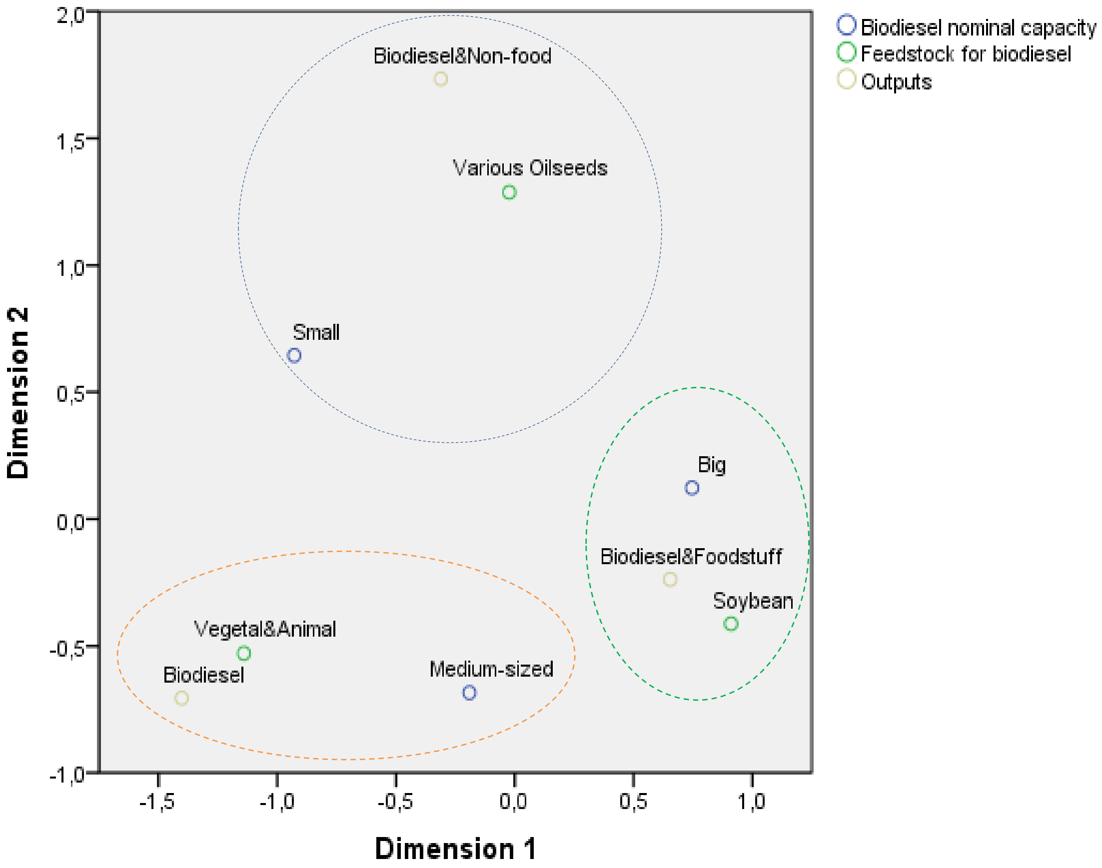
*Chemical products are not excluded from this category

Source: Authors' elaboration

In order to explore the patterns of relationships of these variables, we performed a MCA that displays the categories in a reduced factor space. The MCA enables a visual representation of the underlying structure of the dataset, in such a way that the closer the category points are, the more related. In our study, the dataset was summarized in two dimensions that explain a mean of 58.5% of the variance. The joint plot of category points is displayed in Fig. 4.

The chart reveals the close association existing between the category of 'big' biodiesel plants (over 200,000 m^3 of authorized capacity), soybean as the only biodiesel feedstock and multiple outputs processed by the firm (biodiesel, foodstuffs and sometimes also chemical products). On the contrary, plants specialized in biodiesel are close to the category of diversified (vegetal and animal) feedstocks. As we move to the left side of the space, the categories of 'medium-sized' and 'small' units are successively displayed. In the upper part of the chart, the plants that use diverse oilseeds to obtain biodiesel are close to the production of other (non-food) outputs in the same firm.

Figure 4. Joint plot of category points

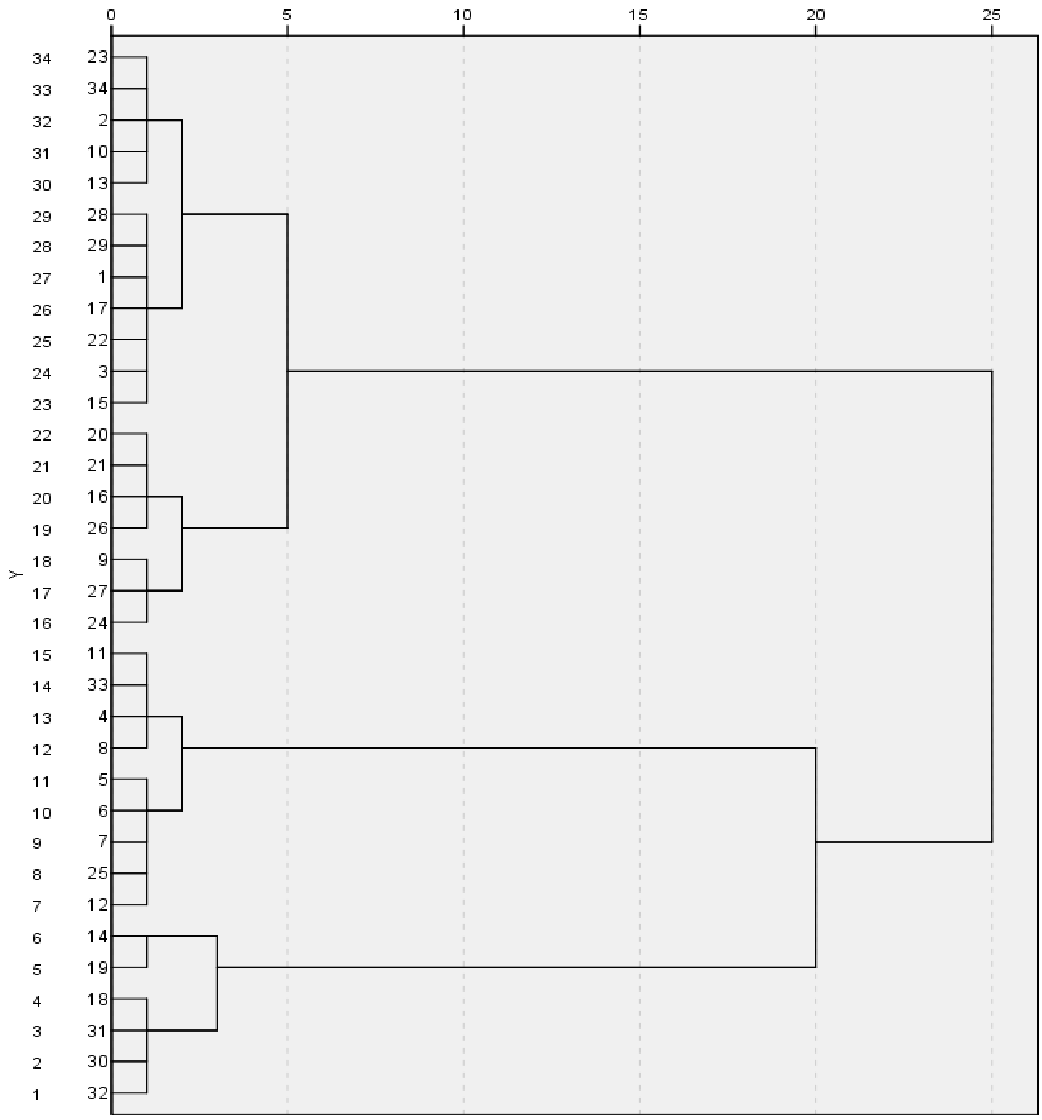


Source: Authors' elaboration

The MCA also calculates the coordinates of each object (biodiesel plant) in the same two-dimensional space. The second step of our analysis is to take these object scores as grouping variables for an agglomerative hierarchical clustering (Carvalho, 2008), in order to identify relatively homogeneous groups of biodiesel plants. This type of clustering suits for a small number of objects; more specifically, we have selected the Ward method, which minimises the variance of the distance of the objects to cluster centroids (Ward, 1963).

The number of clusters is determined with the help of the SPSS-derived dendrogram (Fig. 5), a tree graph that represents the different stages of the clustering process and the distance among the objects clustered in each stage. In the first stages of the procedure the objects combined are very homogeneous, and more dissimilar clusters are merged as we move to the right. The dendrogram obtained in our study makes it evident that the grouping process should stop in three clusters, as there is a clear jump in the distance (i.e. the heterogeneity) between this and the following clustering step.

Figure 5. Dendrogram using Ward linkage - rescaled distance cluster combine



Source: Authors' elaboration

The clusters are characterised in Table 4, which shows the number of biodiesel plants that fall in each category, and some complementary information about them such as the regions where they operate and the average volume of biodiesel delivered in the auctions. Further information obtained from the website of the industries or provided directly by them has been used to complete the description and, discuss the results and envisage three 'business models' with distinctive traits that emerge from this clustering.

Table 4. Clusters of biodiesel plants in Brazil

		Cluster 1 (n=19)	Cluster 2 (n=9)	Cluster 3 (n=6)
Nominal capacity	Small	1	4	4
	Medium	6	4	1
	Big	12	1	1
	Average (m^3)	236,697	132,640	113,673
Feedstock for biodiesel	Soybean	14	0	0
	Various Oilseeds	4	0	5
	Vegetal & Animal Feedstock	1	9	1
Outputs produced	Biodiesel	0	7	1
	Biodiesel & Foodstuff	18	2	0
	Biodiesel & Non-food	1	0	5
Biodiesel delivered* (m^3)		136,159	87,805	60,785
Region	North	1	0	0
	Northeast	1	0	2
	Central West	8	5	2
	Southeast	2	0	2
	South	7	4	0

Source: Authors' elaboration
*Given that the biodiesel delivered by the plants largely varies from year to year, we have used the average of biodiesel delivered in 2015 and 2016

The Cluster 1 is the most numerous group, and its average nominal capacity far exceeds that of the others. It includes all of the plants that only use soybean as feedstock for biodiesel production. They belong to firms that also produce foodstuff (such as oils, sugar, meat, cereals, flour and soy protein concentrate) and typically have an oil extraction plant annexed to the biodiesel plant, what contribute to reduce the operational costs (Nogueira *et al.*, 2016). Sometimes these firms also produce non-food products (cotton or agricultural inputs - seeds, pesticides and fertilizers) and, exceptionally, they are involved in broader businesses such as gas, coal and metal mining. In short, this cluster corresponds to an industrial model of *input specialisation and output diversification*. Some regional branches of large agri-food industries (ADM and GRANOL) are included here.

Cluster 2 is characterised by the utilisation of animal fat as a feedstock for biodiesel, although a mix of other oilseeds (mainly soybeans, but also cotton or canola) or waste oil are also utilised. Most of these plants belong to firms specialised in the production of biodiesel - it is thus a model of *input diversification and output specialisation*. According to the information provided to us by technicians of these industries, the plants mainly buy beef tallow as an alternative to soybeans to ensure a cheap and stable supply of feedstock throughout the year. In terms of scale, they are either small or medium sized plants, their average nominal capacity being intermediate between the two other clusters.

Cluster 3 is the least numerous group, it has only six plants and shows the smallest average size of the three clusters. These mills obtain biodiesel from a variety of oilseeds, but they are not coupled with food processing plants. These firms that are also involved in the production of ethanol from sugar cane, electric energy or a variety of products from tin, antimony and zinc. Importantly, there are three PBio plants that fall in this category.

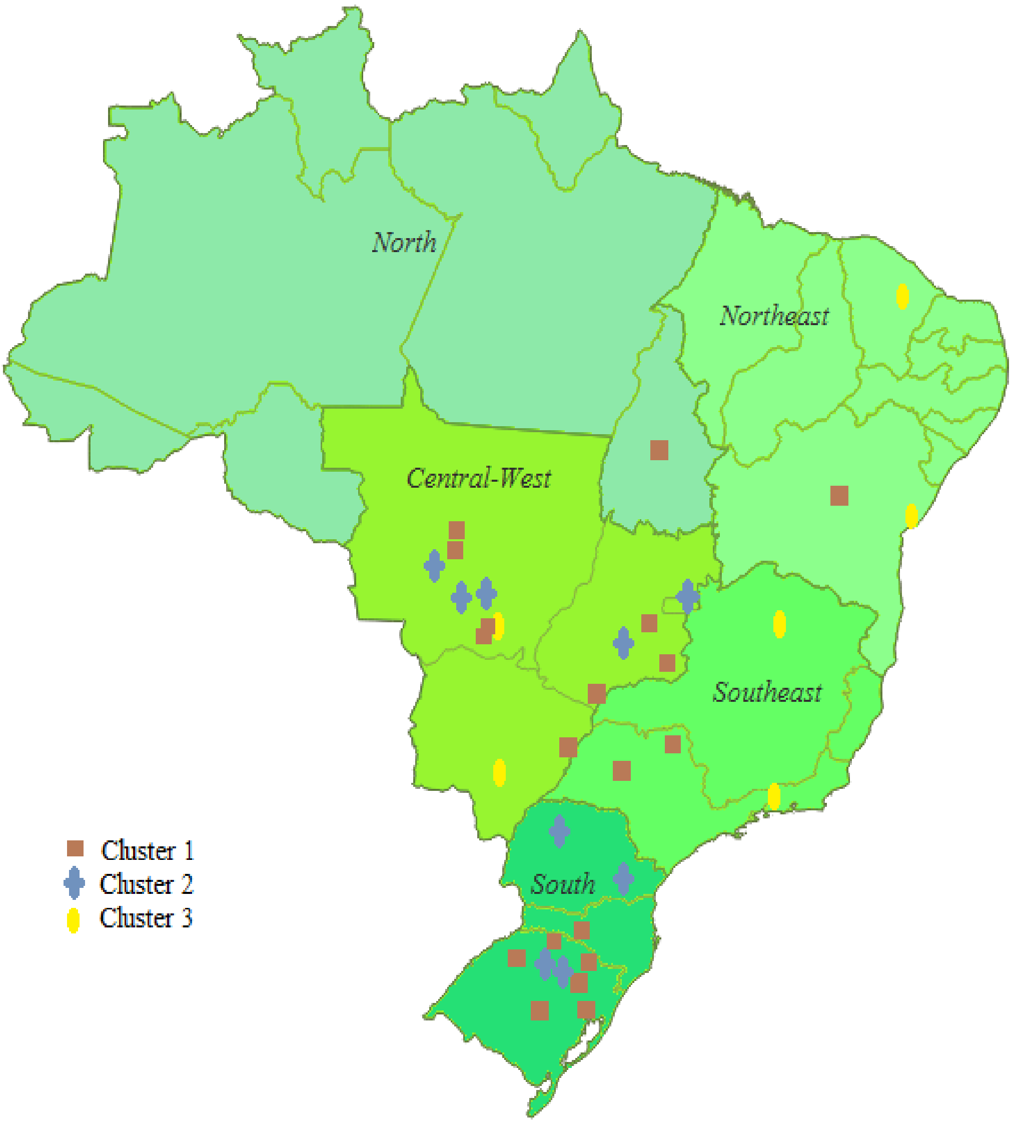
It is noteworthy that soybeans are present as a feedstock, to a greater or a lesser extent, in the three clusters identified. The choice of this raw material (see Section 3) is critical to explain the geographical distribution pattern of the biodiesel industrial park now. Fig.

6 shows that plants are markedly concentrated in the Central-West (15) and the South (11) of the country, where the large agri-food businesses producing biodiesel and foodstuff from soybeans (cluster 1) operate. It is also relevant from the logistical viewpoint that the production units located in those regions are also close to the most important consumption centres (Oliveira *et al.*, 2012). In fact, the territorialisation of biodiesel industries is intensifying; the MME informs that 86% of Brazilian biodiesel was produced in the South and Central-West in 2016, compared to 71% in 2010. The most outstanding progress was registered by the South (from 28% to 45% in the same period). Only the State of Rio Grande do Sul, where biodiesel has been assessed to be profitable for the plants even without public support, is responsible for 30% of the Brazilian production (Alves *et al.,* 2017).

Interestingly, the plants included in the cluster 2, those using animal fats, are also strongly concentrated in the same two regions. As mentioned above, beef tallow have become the preferred feedstock to complement supply in soybean-producing areas, and the interviewed technicians confirmed to us that this feedstock does not come from a food division of the same company, but is purchased from third firms[11]. Meanwhile, the few small plants of cluster 3 that produce biodiesel from diverse oleaginous crops are located in underrepresented regions for biodiesel production, such as Northeast and Southeast. Notably, despite the emphasis placed by the PNPB in fostering biodiesel production in the two northern regions, the Fig. 6 shows that only four mills continue to operate in the North and the Northeast in 2016, and their participation in the overall production, which was already poor in 2010 (11%) decreased to 8% according to the MME.

[11] According to Rico and Sauer (2015) there is surplus of beef tallow in Brazil, mainly in the Southeast region.

Figure 6. Map of biodiesel plants operating in Brazil in 2016, grouped by clusters



Source: Authors' elaboration

6. CONCLUSIONS AND POLICY IMPLICATIONS

The PNPB launched in 2004 has succeeded in promoting the expansion of biodiesel production in Brazil, making this country a world reference in this sector. In the dynamic analysis we have conducted, two different sub-periods have been identified; from 2005 to 2011 there was a rapid increase in the biodiesel produced and a gradual de-concentration of the market due to the entrance of new firms. However, the trends observed in the second period - beyond the time scope of previous studies - are very different, as the productive expansion was carried out by fewer plants. Some firms exited from the market in a context of greater competition – related with the deregulation introduced in 2012 - and underutilization of the productive capacity. The remaining plants homogenised their size to some point, and became larger.

These changes echo some of the debates held by the business economics and Industrial Organization literature. The 'organic growth' undergone by some biodiesel firms is found to generate improvements in their operational efficiency (Nogueira *et al.*, 2016). Meanwhile, the 'horizontal growth' by means of mergers and acquisitions would have increased the bargaining power of the firms resulting from these operations (Moatti *et al.*, 2015). Further research is needed to elucidate whether this strategy has led them to a better position as bidders at the biodiesel auctions, to an increased lobbying capacity or to management changes aimed at improving their performance.

Regarding the 'static' analysis of this sector in 2016, one important conclusion is that the criteria of cost reduction, stability of supply, technical viability and logistic optimization utilised to select the feedstocks have been determinant to configure the structure and organization of this industry. Hence the development of biodiesel production as a sort of subsidiary business articulated with two strong and well-organised agri-food industries in Brazil, soybeans and beef processing. Remarkably from the Industrial Organization viewpoint, power plants display varied and flexible operational arrangements as input provision, processing and output production are concerned. Industries may have the crushing plant annexed with the biodiesel plant or not; 20 out of 34 plants utilise more than one feedstock for biodiesel; some plants buy feedstocks to third parties; most of the firms also produce other products.

The multivariate analysis we have conducted reduces this diversity into three 'business models'. In this regard, big companies with diversified outputs, the most numerous group, seem to have prevailed over smaller or single-output firms. It could be argued that they have, at least, three competitive advantages: their bigger scale, that provides a greater operational efficiency; the coupling of oil extraction facilities with biodiesel plants, that reduces costs (Nogueira *et al.*, 2016); and the fact that biodiesel only represent one more activity in their business portfolio (Rathmann and Padula, 2011), what may qualify them to cope better with the idleness of biodiesel plants.

Another finding with relevant theoretical implications is that firms operating in the biodiesel industry are connected with multiple supply chains - those of the different feedstocks they use and the food and non-food outputs they produce – that are linked, but also have their own dynamics and market prospects (Zonin *et al.*, 2014; Areal *et al.*, 2016). Following Morales (2000), we argue that a filière analytical approach, albeit useful to illuminate partial aspects of an agribusiness of this kind, falls short to provide an overall picture. Even broader concepts such as the 'commodity chain', that comprises the network of production processes needed to produce a commodity (Hopkins and Wallerstein, 1994) are still limited to treat the oilseeds cake, with joint inputs and separate outputs (Raikes *et al.*, 2000).

The complex reality of the biodiesel industry demands to take a systemic approach and - importantly for both research and decision-making - to utilise analytical tools appropriate to deal with this complexity. There are some interesting contributions of this kind applied to Brazilian biodiesel industry, such as the multicriteria analysis conducted to choose feedstocks (Zonin *et al.*, 2014), the use of GIS and fuzzy logic to prioritise plant locations or the Policy Analysis Matrix to evaluate the impact of PNPB (Alves *et al.*, 2017). Further developments are needed in this vein.

It is necessary to remark that the technical-operational efficiency has prevailed in the configuration of this industry over the PNPB incentives aimed at promoting social and territorial inclusion. Our data show that some of these political goals have evolved to worse over the last years. The participation of family farmers through the SFS significantly dropped from 2011, plant units are more and more concentrated in soybean producing areas to the detriment of northern regions, the contribution of castor oil as a feedstock is virtually inexistent and other oleaginous seeds have an insignificant participation.

The upcoming regulatory framework will foster the biodiesel production in Brazil; however, in our opinion, it will have a limited capacity to improve the former objectives. The economic rationale that has led this industry to the structural setting we have delineated here is likely to prevail also in the future. Moreover, biodiesel production in northern areas needs public support, and a further involvement by Petrobras cannot be expected. Contrarily, the vast debts of this public company have led the new chief executive, designated in June 2016, to outline a five-year plan aimed at downsizing the structure of the company and concentrating the resources in the most profitable projects. The activity of one of the two PBIO plants that still operated in the Northeast ceased in November 2016, and a further disengagement of Petrobras from biodiesel industry is projected in the midterm[12.]

Although the insertion of family farmers in the biodiesel value chain has not been effective (Rathmann and Padula, 2011), the SFS has achieved some positive results that give us a clue as to some alternative political approaches to improve the social inclusion. The technical assistance provided by the biodiesel plants to family farmers has been underlined by literature as effective to increase farmers' performance (Marcossi and Moreno, 2017). Besides, in the northern regions, where cooperatives are almost inexistent due to longstanding political issues, the SFS has generated some positive experiences of horizontal cooperation among farmers (César and Batalha, 2013). These matters are central to attain smallholders' upgrading and improve their social-economic conditions, and further achievements could be pursued by means of public policies specifically aimed at them.

[12] http://www.petrobras.com.br/en/our-activities/performance-areas/biofuel-production/. Accessed 6 August 2017.

Finally, it is important not to lose sight of the fact that, under free market conditions, biodiesel would be more expensive than domestic diesel in Brazil, and vegetable oil would be better remunerated by the food market. Biodiesel production is only possible by way of pricing policy and incentive mechanisms that imply a substantial burden for the public budget (Rico and Sauer, 2015). This is to be taken into account when considering the replicability of this model in other developing countries. Economic efficiency and technical viability are required for the sustainability of the biodiesel industry, be it directed to the domestic or the international market. As Gasparatos *et al*. (2015) state, the massive failure of the large-scale projects of *jatropha* as feedstock for biodiesel in Southern Africa was precisely due to overoptimistic prospects of high yields under adverse growing conditions that never were reached on the field.

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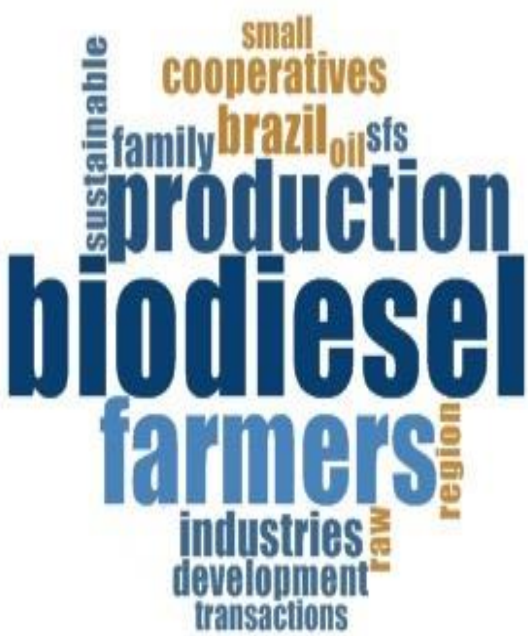

CAPÍTULO III.

EFFECTS OF THE BRAZILIAN BIODIESEL CERTIFICATION IN THE RELATIONSHIP BETWEEN THE BIODIESEL INDUSTRY AND SMALL-SCALE FARMERS

CAPÍTULO III: EFFECTS OF THE BRAZILIAN BIODIESEL CERTIFICATION IN THE RELATIONSHIP BETWEEN THE BIODIESEL INDUSTRY AND SMALL-SCALE FARMERS

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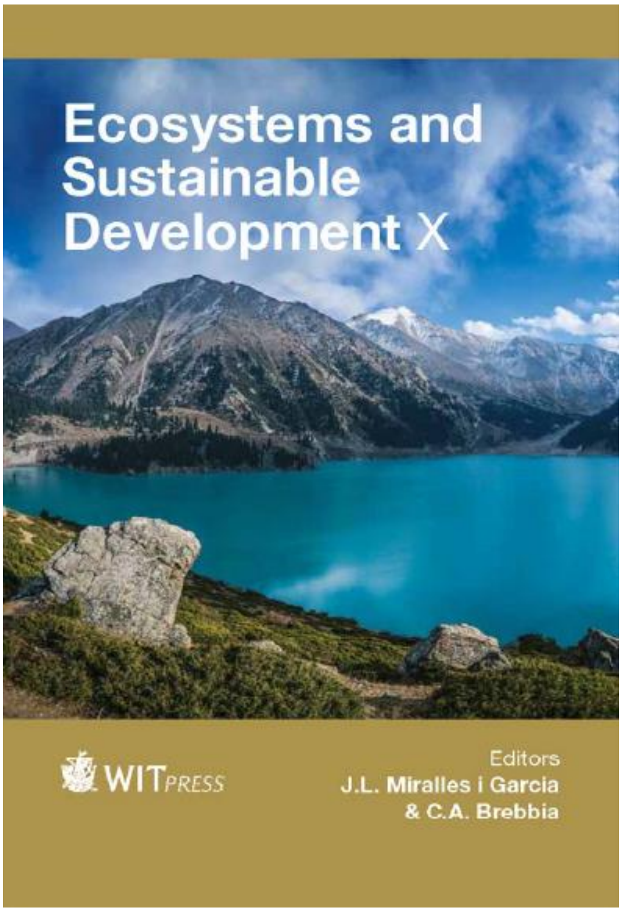

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Effects of the Brazilian biodiesel certification in the relationship between the biodiesel industry and small-scale farmers

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Abstract

The production of biodiesel in Brazil is encouraged by the government through the Fuel Stamp, a certification system linked to the National Plan for Production and Use of Biodiesel – PNPB – aimed at promoting economic and sustainable development. It focuses on social inclusion, also intending to reduce dependence on fossil fuels and emission of pollutants and diversify the energetic matrix through the use of different oil sources as raw material. Certification – and with it a number of tax benefits – are granted to industrial processors that are supplied with raw materials coming from small-scale farms. Thus, it facilitates the access of the family farms in this value chain. The objective of this work is to analyze the effects of this system of certification in the transactions between its main agents, farmers and processing industries. For this purpose, the work makes a revision of the studies that national public agencies have elaborated on regional cases and also scientific publications. Results show that this measure allowed the insertion of family farmers in the production chain and enabled the sustainable rural development. However, it presents gaps as the occurrence of failures in the fulfilment of contracts between family farmers and the industry. Moreover, in spite of being crop diversification, one of the objectives of the certification system, the preference of the industry for soy as raw material – because of technological reasons – is displacing traditional regional crops (for example palm and castor oil).
Keywords: biodiesel production, small-scale farms, Brazilian agriculture, Social Fuel Seal, rural development.

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Abstract

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Keywords: biodiesel production, small-scale farms, Brazilian agriculture, Social Fuel Seal, rural development.

1. INTRODUCTION

Biodiesel productive chain has a recent development in the world. In the case of Brazil, in spite of researches carried out over the last decades on this issue, it was only in 2004 that PNPB (National Program of Production and Use of Biodiesel) was officially launched by the government to consolidate the biodiesel market.

According to Milazzo *et al.* [1], in EU and the US sustainability and security of energy supply are the main concerns regarding biodiesel production, whereas in Brazil the socio-economic aspect is emphasized. The use of biodiesel as biocarburant energy indeed diminishes the dependence on fossil fuels and emissions of polluting gases. However, differently from the international tendency that puts focus on these environmental aims, biodiesel chain in Brazil divulges social inclusion as a fundamental pillar of its policy, in addition to the diversification of the energetic matrix using regional raw materials.

In order to encourage this social inclusion, a certification system was created – the Social Fuel Seal (SFS), which is granted by the Ministério do Desenvolvimento Agrário (MDA) [2] to the biodiesel producers who obtain raw material from family farmers.

By way of a contract, biodiesel processors are committed to providing technical assistance to farmers, and they receive as a benefit tax reduction (which varies according to the type of raw material and the region where it is obtained) and allowance to participate in biodiesel auctions organized by ANP (Agência Nacional de Petróleo), where biodiesel is bought. In most ANP auctions (80%), the selling company needs to have the SFS. The formation of cooperatives among farmers is also stimulated to catalyse the transactions between them and industries, state Stattman and Mol [3].

An important issue regarding this chain in Brazil relates to natural advantages of this country, such as the territorial extension and favourable agro-climatic conditions for biomass production, according to Beneditti *et al.* [4]. However, despite these advantages Dos Santos *et al.* [5] warn that, if the government does not make the necessary interventions to diversify raw materials, the prevalence of soy, with higher yields and productive infrastructures controlled by large capital, will hinder the development of regional crops that may serve as raw material for biodiesel.

Within this context, the objective of this work is to analyse the effects of the Brazilian certification system in the transactions among its main agents, agricultural producers (and their cooperatives) versus processing industries. It is important to remark that the environmental aspects of biodiesel production exceed the scope of our study and will not be specifically tackled in this paper.

The remainder of this paper structures is as follows: in the following section, an overall picture of biodiesel production in Brazil is outlined. Section 3 tackles the main methodological aspects of this investigation. In Section 4, relationships among the main agents of the biodiesel chain are analysed in four case studies referred to different regions of Brazil. Discussion is carried out in Section 5, where positive and negative results will be assessed for each component of the chain: agriculture, manufacturing and distribution. Finally, we will present the conclusions of this study.

2. BACKGROUND: CURRENT SCENARIO OF BIODIESEL IN BRAZIL

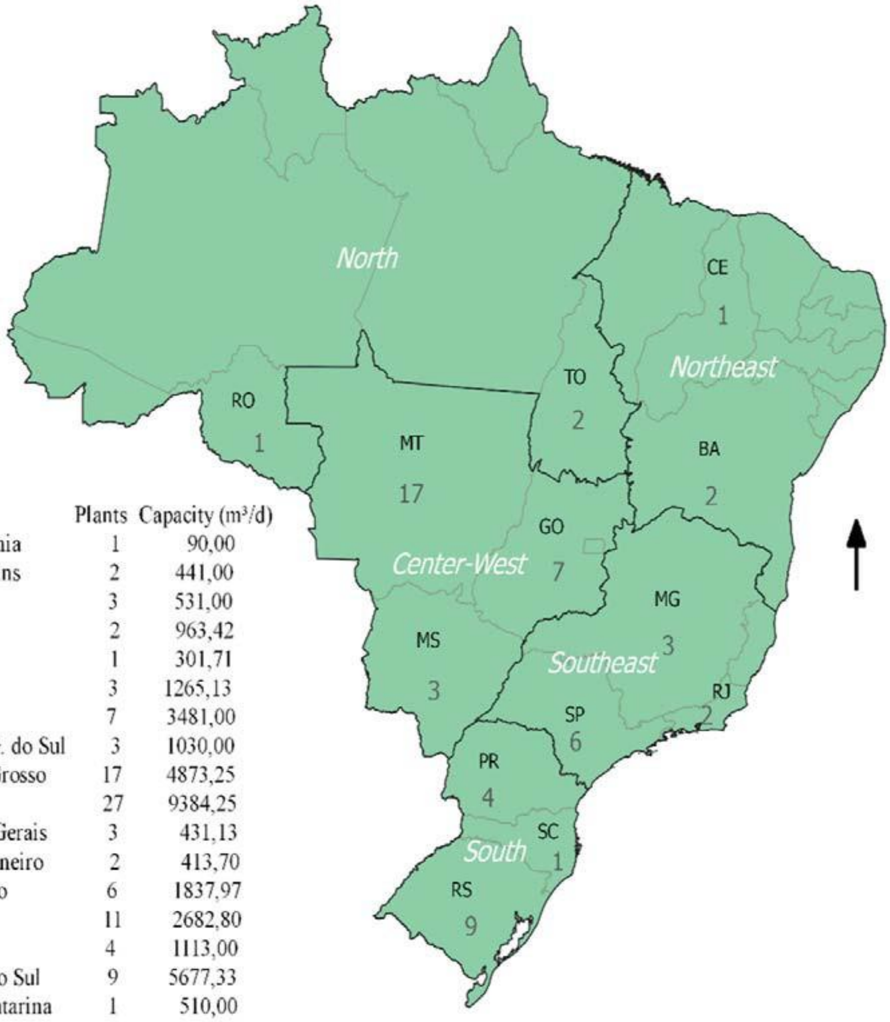
As Pereira *et al.* [6] state, there are numerous plants distributed throughout Brazil that process oil from different crops such as soy, palm, castor, babassu, sunflower and peanuts. All these oils are suitable for the production of renewable fuel – raw materials representing about 75% of biodiesel production costs in Brazil, according to Conab [7]. The choice of the raw material is influenced by the potential of the different oilseeds for each geographic region and climate, states Khalil [8]. Palm oil and babassu palm are more appropriate for north region and rapeseed, sunflower and cotton are more favourable in the south. However, the total production of soybean oil-based largely prevails in Brazil (81.36% of total production), followed by the bovine fat (13.36%) and cottonseed oil (4.11%). The production of alternative crops is small and locally-based, as pointed out by Leonardi *et al.* [9].

Indeed, in spite of the efforts made to diversify the raw materials for biodiesel production, soybean large-scale monoculture production, with little demand for manpower (thanks to mechanization) and strong connection with commodity markets, is massively used as raw material despite its low oil content per hectare. Meanwhile, crops such as *Jatropha curcas*, castor beans and palm, with a high oil content, do not experience any rapid expansion for biodiesel production. Soybean plantations already occupy 35% of the cultivated lands in Brazil, according to IBGE [10].

According to Conab [7], Brazil is the second largest soybean producer in the world, with a production of 81.3 million tons in the crop year 2012/2013. This production is led by the states of Mato Grosso, Paraná, Rio Grande do Sul and Goiás (29%, 20%, 15% and 11% of the national production respectively), and is expanding to the eastern states of Maranhão, Tocantins, Piauí and Bahia.

As for the socio-economic aspects of biofuel production, Dos Santos *et al.* [5] recall that the PNPB establishes a linkage between an energy policy and a social policy, by certifying the biodiesel producers that buy 10–30% of their feedstock from family farmers.

According to Stattman and Mol [3] the PNPB allowed the introduction of biodiesel in the Brazilian energy matrix which established biodiesel mandates, initially B2 (2% of biodiesel in diesel) to B5 (5% of biodiesel in diesel) to be reached in July 2010. Under legal provision, the required percentage of biodiesel mixed with diesel passed from 5% to 6% from Jul/2014, and 6% to 7% from Nov/2014. However, justified by the public interest, the National Energy Policy Council may at any time reduce it to 6%, states ANP [11].



Region	State Name	Plants	Capacity (m^3/d)
North	RO Rondônia	1	90,00
	TO Tocantins	2	441,00
		3	531,00
Northeast	BA Bahia	2	963,42
	CE Ceará	1	301,71
		3	1265,13
Center-West	GO Goiás	7	3481,00
	MS Mato G. do Sul	3	1030,00
	MT Mato Grosso	17	4873,25
		27	9384,25
Southeast	MG Minas Gerais	3	431,13
	RJ Rio de Janeiro	2	413,70
	SP São Paulo	6	1837,97
		11	2682,80
South	PR Paraná	4	1113,00
	RS Rio G. do Sul	9	5677,33
	SC Santa Catarina	1	510,00
		14	7300,33
Total		58	21163,51

Figure 1: Biodiesel plants authorized (m^3/d). Based on ANP (Dec/2014)

Federal tax exemptions and incentives differentiate according to the utilized raw material, the size of the agricultural producer providing the raw material and the region of production. Steps are taken to stimulate biodiesel production and social inclusion mainly for family farmers in disadvantaged areas such as the semi- arid Northeast and Amazon.

Thus, the percentage family farmer feedstock necessary for the industry to obtain the SFS is 15% in Center-West and North, 30% in North-East and Semi-Arid and 30% in South-East and South (year crop 2010/2011).

According to ANP [11] there are 58 plants of biodiesel authorized by ANP to operate, corresponding to an authorized total capacity of 21,163.5 m^3/day (see Figure 1).

Finally, as regards to the economic impact of biodiesel production, it is important to note that it also stimulates the development of alcohol industry, consumed in the transesterification process for biofuel by the ethyl route, with the subsequent generation of employment and income, as highlighted by Pereira et al. [6].

3. Methodology

The information necessary for this work was obtained by way of an intensive review of the literature. Authors consulted national public agencies' reports and scientific publications that have elaborated on regional case studies, in order to determine the present situation of the investigated energetic sector.

Apart from scientific publications, consultations were made with competent organisms responsible for the biodiesel sector in Brazil such as MME, Ministry of Mines and Energy; EMBRAPA, Brazilian Farming and Livestock Research Agency; ANP, National Petroleum Agency; MDA, Ministry of Agriculture Development and CONAB, National Supply Company. International Symposiums that took place in Brazil were also used as reference, as well as journals with national impact.

Case studies will be analysed paying particular attention to the implications that the SFS is having for parties (small-farmers, cooperatives and industries), as well as the capacity of this certification to reduce uncertainty of transactions.

4. Relationships among the main agents of the biodiesel chain in different regions of Brazil

PNPB and the Social Fuel Seal have been widely known in several regions of Brazil and have had different effects in each case. For a better understanding, the analysis have been tackled separately for each region.

4.1. The southern region, state of Rio Grande do Sul

In the southern region, Dos Santos and Padula [12] analysed the way transactions occur in the biodiesel supply chain in Rio Grande do Sul. These authors state that before SFS was launched there was more opportunism in the relationships among actors, and family producers sometimes did not comply with their commitments with industries or cooperatives, commercialising the grain with another agent who offered a better price. This situation created uncertainties in the transactions and frequent changes of raw material suppliers.

Figure 2: State of Rio Grande do Sul. Authors'

With the implementation of SFS, industries are obliged to sign contracts assuring the grain value and technical assistance to family farmers. This fact made the transactions attached to the plants become more favourable to family producers, minimizing their intention to act in an opportunistic way. As a result, the variation of suppliers tend to diminish. The greater the confidence in the exchange relations among family farmers, the greater the frequency of transactions, what makes the chain structure more stable. The authors point out, however, that limitation of purchase in auctions with volumes and prices established by the government restrain the strategies of the industries and their profit possibilities.

Another empirical study by Silva *et al.* [13, 14], also focused in the southern region, analysed the impact of the SFS on the sustainable development from the industries' point of view. They found that a great motivation for these industries to insert in such market is the fact that PNPB guarantees the demand of biodiesel. The reason why industries choose SFS is a better participation in ANP auctions and the proximity to family farmers, since the Seal makes it possible to access to a bigger market share. The main suppliers of the industries are cooperatives that mediate the relationship with the family farmers.

As for sustainable development, this addresses the socio-economic and, to a lesser extent, the environmental impact of this policy. The increase in the profits for the industry, as well as the creation of jobs and income for the region (450 jobs in Cachoeira do Sul, a municipality located in Rio Grande do Sul, and connection with over 1,000 farmers directly) are highlighted. It was also noted that the SFS allows the approximation and faithfulness of farmers previously set aside by the system. As one environmental issue, the authors mention the provision of technical assistance to orientate farmers towards the correct application of the chemical products, avoid waste and soil erosion – what also has a social lecture.

It is worth noting, as an important factor discussed in this study, that according to processors biodiesel production in Brazil does not greatly interfere in the production of food, even considering that frontiers of soya cultivation are expanding. Moreover, the by-product of biodiesel production, specifically bran at low price, is alleged to revert to more food since it can be used for animal feeding. Other positive factor underlined in this study is the stimulation of areas that generally would be unproductive during winter time.

A negative statement made by the industries is that the farmer who cultivates other crops hardly stops producing them to produce soya. In sum, the Seal brings the industries bureaucratic changes seen as a barrier but, in general, it is considered as an opportunity for their insertion in the market. The investigated industries reported that only because of the SFS they would have the intention to participate in the biodiesel production market. Before that time they did not visualize competitive advantage, what was only possible because of all the incentives of the policy (tax benefits and guaranteed participation in auctions).

4.2. The South-eastern region, state of Minas Gerais

The empirical analysis performed in the south-eastern region by Leite *et al.* [15] compares different types of farmers in two regions: the semi-arid areas and the more humid region of the Brazilian Southeast, both in the state of Minas Gerais. Each farming system shows a distinct decision-making process and requires specific solutions.

In the more humid region, medium-large scale farms, there is an annual rotation of soya followed by grass seed; this cultivation is made by means of intensive use of inputs (machinery, agrochemicals) and farms differed mainly in size (49.1 ha to 116.7 ha).

Figure 3: State of Minas Gerais. Authors'

In the case of semi-arid areas, small-medium size (2.4 ha to 46.4 ha), *diversity* is the most prominent characteristic of this production system. Farms are less intensive, combine cultivation with cattle production on grassland (larger farm area) or use a part of the land to produce maize and beans for self-consumption (smaller farms), and show low market orientation.

In both research areas, yields of sunflower and castor bean are relatively low. The provision of soil nutrients helps farmers to increase oil production and economic profits. The contracts included farmers' technical assistance with seeds – inputs provided by biodiesel producers.

In general, humid zone farms are more successful in obtaining information and credit and in delivering feedstock production, report Elbehri *et al.* [16]. In fact, farmers using soybean as raw material respond better to all terms of the policy of oil crop production and show higher gross margins than maize/beans farmers in semi-arid zones.

The potential of biodiesel crops for farmers in arid zones is lower than in humid zones, resulting in poor outcome in small-scale family farmers. These small-scale farmers were less affected by the biodiesel policy benefits, since the aggregate value associated with biodiesel oil crops was not sufficient to compete with traditional crops (i.e. beans). With fertilizer supply, sunflower crop could be a good alternative for these farmers.

Farmers and cooperatives indicate as an alternative to improve the viability of biodiesel production crushing the oil feedstock locally, through the deployment of small-scale oil extraction units, what could reduce current transportation distance by 75%.

4.3. The north-eastern region, state of Bahia

According to Stattman and Mol [3], the government noted complications with the implementation of the PNPB in this area due to the fact that biodiesel companies had little experience with technical assistance for family farmers.

Family farmers had small land areas, and they were only partly available for biodiesel feedstock production. Small producers also had little experience with biodiesel crops and seed provisions were not always appropriate or timely provided, resulting in low harvests, state Kilham *et al.* [17].

Contracts between family farmers and biodiesel industry were often ignored by farmers because they do not have business experience and preferred to produce other crops, what favoured local traders. In addition, a lack of commitment by industry as regards to payments and seed delivery is reported by Watanabe *et al.* [18]. Problems such as high logistical and transaction costs were recurrent.

Figure 4: State of Bahia. Authors'

From 2009, industries were allowed to buy biodiesel feedstock from agricultural cooperatives, and still receive the desired SFS if the cooperative has the legal permission emitted by the MDA. The number of cooperatives and farmers involved in biodiesel production have increased ever since because of the new market opportunities and the provision of technical assistance and seeds for farmers.

Financial support for technical assistance and biodiesel contracts allowed the professionalization of cooperatives and more participation in the PNPB. As for the benefits for individual farmers, these authors mention the assistance for irrigation and for crops adapted to the agro-ecological conditions of the region. A local seed bank was also developed to improve productivity.

Cooperatives agree that medium-sized family farmers are better benefitted from the technical assistance and better adapt farming practices, because they have greater capacity to use new knowledge and change old production practices. The smallest farmers in remote areas produce what is essential to their subsistence and have less ability for structural changes, thus they benefit less from this policy, add Watanabe *et al.* [18]. In addition, they do not always understand the cooperative system. Distance and poor infrastructure complicate agricultural assistance in remote areas. In general, these farmers choose not to join the PNPB or are not interested in becoming members of cooperatives. Some cooperatives report that farmers are not fully aware of the potential benefits of the policy for them.

There is uncertainty for cooperatives due to a significant dependence on the SFS for their establishment in the biodiesel market. Many cooperatives identify, as negative cases, industries that only use soy for biodiesel production and sell the other vegetable oils (castor and palm) to other industries, because they get higher market value for uses different to biodiesel production, as reported by César and Batalha [19]. In addition, some farmers do not want to stop negotiating with other potential buyers of their raw materials, breaking the contract assumed by SFS.

In sum, the PNPB states to have succeeded in stimulating agricultural modernization and innovation and thus the social inclusion of family farmers, but not all of them are equally benefitted from this policy. Cooperatives operate as instruments for the government to reach small farmers thus channeling technical advice, seeds, infrastructure and credit facilities to members. They created horizontal links between farmers and a vertical link between farmers and state/business organizations network, conclude Stattman and Mol [3].

4.4. The northern region, Amazon

In Brazil, palm crop is normally cultivated in the Amazon region, due to its good climate conditions for high oil palm productivity. Palm has a higher productivity than other oilseeds (3–6 tons of oil/ha by year), as well as more energetically efficient than other biodiesels and fossil fuels. According to César *et al.* [20] palm oil is not yet an important part of the biodiesel chain; in 2012, palm represented only 0.32% of this business. However, support policies such as easy credit and tax incentives reduce the cost of production and enable the competitiveness of this cultivation and regionalization of biodiesel production.

Figure 5: State of Amazonas. Authors'

The intensive use of manpower, year-round production and good business opportunities are positive aspects of oil palm cultivation by family farmers. Moreover, this oilseed can be cultivated together with subsistence farming and intercropping with short cycle crops such as beans and corn. However, the production by family farmers is still experimental. Industries are only beginning to identify the family farmers in the northern region to participate in the production of palm. The strategy is to set processing plants in new nearby areas.

The SFS were signed with a small number of farmers to detect and correct failures before implementing it on a larger scale. Technical assistance is constant, which allows a better connection between industries and the small producers. According to these researchers, although there are groups of rural workers in the North of the country, cooperatives are still beginning to operate in this region.

As negative factors, the authors point out that the transportation infrastructure in palm cultivation regions is precarious. Industries often have to build and maintain roads.

Difficulties related to register the family farmers interested in participating in PNPB are also reported, due to difficulties in accessing the regions where their properties are located.

The price of oil palm is currently high, what is considered another barrier in spite of its higher quality. These authors conclude that it is possible to expand its production to large scales if there is private and public participation to supply the food industry and the biodiesel chain.

For the time being, biodiesel production is less profitable than food industry considering oil palm, but biodiesel chain can also promote fuel supply in many isolated places of the northern region.

According to these researchers, the use of oil palm appears to be a viable medium-term possibility, contributing to biodiesel chain and social inclusion of family farmers. The SFS quota for the North of the country is encouraging to engage processing industries.

5. DISCUSSION

Besides the implications that SFS is having for participant farmers, the analysed studies also show that the system is side-lining other small farmers. In some cases, they are farmers located in remote areas with poor infrastructures, so that transportation costs are very high. In other cases, some small-farmers are reluctant to introduce some productive and managerial changes, particularly when they produce for self-consumption. Moreover, there are also farmers who prefer not to join cooperatives – which are channelling raw material from farmers to industries, so they keep out of this value chain.

From the point of view of regional crop diversification, authors point out that biodiesel production would not interfere with regional food production, which would prevent food insecurity implications. Nevertheless, the federal government's aim to promote energy crops diversity is not being realized due to infrastructure constraints and incipient technological development.

Table 1 summarises the main implications that, according to the analysed studies, the SFS has for participants (small-scale farmers, cooperatives and industries).

Table 1: Implications of SFS and biodiesel expansion.

Actor	
Small-scale farmers	- SFS is making possible the access to this chain for many small- farmers. - It is promoting farm diversification. - Farmers receive training and in some cases inputs (e.g. seeds) provided by industries. - Technical assistance orientates the producer towards the correct application of the chemical products avoiding waste and soil erosion.

	- Some participants face difficulties to stock their production in their small holdings. - Little experience with energy crops and difficulties to access appropriate seeds, resulting in low yields. - Subsistence farmers can hardly adopt the necessary changes to produce energy crops.
Cooperatives	- Strengthening and professionalization of cooperatives. - Cooperatives are investing in new facilities and equipment because of their relationships with industries. - However, investments make cooperatives very dependent on the maintenance of the SFS.
Industries	- Easier access to public credit and tax incentives. - Better conditions to participate in ANP auctions. However, they are restricted to public auctions and cannot resort to other potential buyers. - Contracts do not reduce industries' uncertainty, since sometimes farmers adopt opportunistic behaviour (in spite of the contracts, they sell to other buyers if they are offered a better price). This leads industries to look for new suppliers continually. The participation and mediation of cooperatives is reducing uncertainty. - There are several logistic and accessibility problems to access to farmers' production. In some cases industries have to construct roads and access to get raw material from some areas.

Source: Authors' elaboration

6. CONCLUSIONS

The consolidation of the biodiesel sector is still in process and depends on macro factors like government policies and micro questions like the input availability and production costs for each region and raw material. In spite of the PNPB and the SFS, important regional disparities persist regarding its performance (consolidation of cooperative structures, technological developments, diversity of raw material). Moreover, although SFS has allowed many small-farmers and cooperatives to participate and profit from this value chain, some uncertainties remain, particularly regarding the opportunistic behaviour of some farmers or the dependence of cooperatives on stable industries' demand.

On the other hand, according to WEF [21], government may impose additional costs and slow down the development of biodiesel sector due to excessive bureaucracy, overregulation and inability to provide appropriated services for the sector.

Issues related to sustainable development, with regard to the environment, should be analyzed more deeply, in order to achieve more tangible results.

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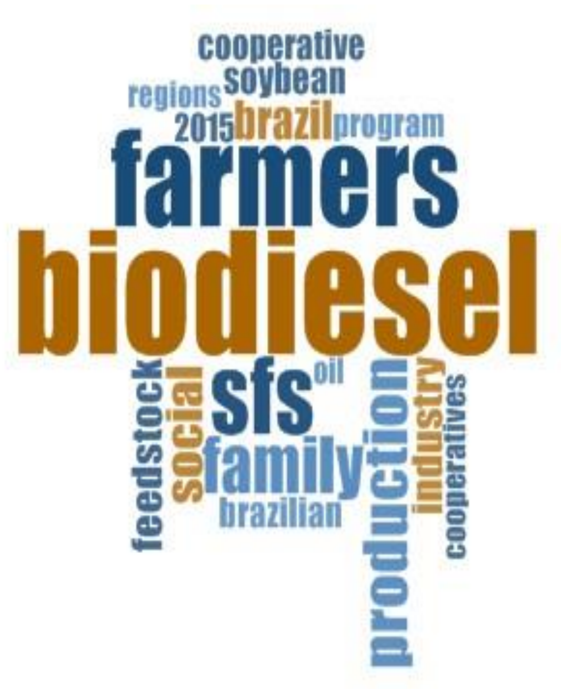

CAPÍTULO IV.

A CLOSER LOOK AT THE BRAZILIAN SOCIAL FUEL SEAL: UPTAKE, OPERATION AND DYSFUNCTIONS

CAPÍTULO IV: A CLOSER LOOK AT THE BRAZILIAN SOCIAL FUEL SEAL: UPTAKE, OPERATION AND DYSFUNCTIONS

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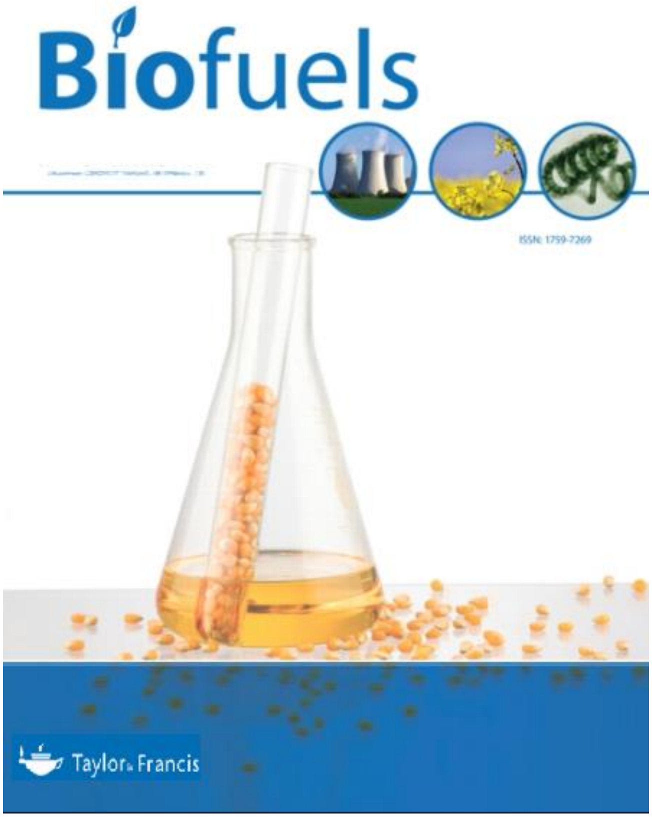

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A closer look at the Brazilian Social Fuel Seal: uptake, operation and dysfunctions

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ABSTRACT
Due to the increasing concerns about the social effects of biodiesel production in developing countries, the Brazilian government created the Social Fuel Seal (SFS) within the framework of the National Program of Production and Use of Biodiesel (PNPB) launched in 2004. The SFS is a certification scheme awarded by the MDA/MDSA (Ministry of Agricultural Development/ Ministry of Social and Agrarian Development), aimed at upgrading small farmers in the biodiesel value chain. In this article we discuss the institutional settings and explore the uptake, achievements and shortcomings of this political instrument in the light of the official data and the academic literature. Specific aspects of the practical implementation of SFS are examined upon the base of interviews conducted with different stakeholders in the state of São Paulo. Important dysfunctions in the overall operation of the SFS put into question the accomplishment of the social inclusion objective and awaken concerns about the sustainability of the role of family farmers in it.

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KEYWORDS
Brazil; Social Fuel Seal; family farmers; biodiesel value chain

Introduction

There has been an increasing concern over the last decade, in both the scientific and political spheres, about the effects of biofuel production in developing countries [1,2]. Emphasis has been placed on the social implications of large-scale production of commodity feedstock crops such as soy, palm oil, jatropha and sugarcane. Changes in land tenure patterns – particularly the processes of land ownership concentration and 'landless' displacement, competition with land for food production, smallholders' exclusion and poor labour conditions – have centred many of these studies [2–5].

Within this context, new governance mechanisms have been implemented in many countries to integrate social justice considerations into global biofuel markets. Voluntary standards represent an outstanding example of these initiatives. Certification systems may be devised by governments, inter-governmental organisations or private standardisation bodies – although hybrid models of public–private partnerships are increasingly common [6,7]. Contrary to the mandatory regulations, actors are free to choose whether they adhere to these programmes or not. Governments act as 'facilitators' to foster institutional arrangements that effectively encourage the upgrading of small farmers in the value chain or the improvement of labour conditions.

The Brazilian case has occupied a prominent position in these debates on biofuel production governance, as the second largest producer in the world. Brazil had a pioneering role in the promotion of biofuel production and use, and represents the most successful attempt of oil substitution in transport [8]. Bioethanol is a core part of Brazilian energy strategy since 1975 – when the National Alcohol Program (PROALCOOL) was launched as a response to the petroleum crisis and the falling sugar prices [9]. The incentives originally included in the programme have experienced changes over time, but high fuel taxes on gasoline, tax credits for ethanol and mandates to blend anhydrous ethanol in gasoline still exist [10].

In the case of biodiesel, the regulatory framework of this industry was not envisaged until the Brazilian Biofuel Program (PROBIODIESEL) was launched in 2002. Two years later, the National Program of Production and Use of Biodiesel (PNPB) introduced biodiesel in the Brazilian energy matrix, to be mainly used in truck and buses [4,11]. Mandatory blends were promulgated by Law no. 11.097/2005 and would gradually increase thereafter, from a 2% addition of biodiesel to the oil diesel (denoted by B2) in 2008 to 7% (B7) in November 2014.

A system of incentives and subsidies was devised to promote biodiesel production from vegetable oils, as these products have higher prices in the food market [12]. Following the PNPB implementation, the production of biodiesel grew from 0.07 to 3.8 Mm^3 between 2005 and 2015 according to the Ministry of Mines and Energy (MME) [101]. Nowadays Brazil is the world's

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A CLOSER LOOK AT THE BRAZILIAN SOCIAL FUEL SEAL: UPTAKE, OPERATION AND DYSFUNCTIONS

Abstract

Due to the increasing concerns about the social effects of biodiesel production in developing countries, the Brazilian government created the Social Fuel Seal (SFS) within the framework of the National Program of Production and Use of Biodiesel (PNPB) launched in 2004. The SFS is a certification scheme awarded by the MDA/MDSA (Ministry of Agricultural Development/ Ministry of Social and Agrarian Development), aimed at upgrading small farmers in the biodiesel value chain. In this article, we discuss the institutional settings and explore the uptake, achievements and shortcomings of this political instrument in the light of the official data and the academic literature. Specific aspects of the practical implementation of SFS are examined upon the base of interviews conducted with different stakeholders in the state of São Paulo. Important dysfunctions in the overall operation of the SFS put into question the accomplishment of the social inclusion objective and awaken concerns about the sustainability of the role of family farmers in it.

Keywords: Brazil; Social Fuel Seal; Family Farmers; Biodiesel Value Chain

1. INTRODUCTION

There has been an increasing concern over the last decade, in both the scientific and political spheres, about the effects of biofuel production in developing countries [1,2]. Emphasis has been placed on the social implications of large-scale production of commodity feedstock crops such as soy, palm oil, jatropha and sugarcane.

Changes in land tenure patterns – particularly the processes of land ownership concentration and 'landless' displacement, competition with land for food production, smallholders' exclusion and poor labour conditions – have centred many of these studies [2–5].

Within this context, new governance mechanisms have been implemented in many countries to integrate social justice considerations into global biofuel markets.

Voluntary standards represent an outstanding example of these initiatives. Certification systems may be devised by governments, inter-governmental organisations or private standardisation bodies – although hybrid models of public–private partnerships are increasingly common [6,7]. Contrary to the mandatory regulations, actors are free to choose whether they adhere to these programmes or not. Governments act as 'facilitators' to foster institutional arrangements that effectively encourage the upgrading of small farmers in the value chain or the improvement of labour conditions.

The Brazilian case has occupied a prominent position in these debates on biofuel production governance, as the second largest producer in the world. Brazil had a pioneering role in the promotion of biofuel production and use, and represents the most successful attempt of oil substitution in transport [8]. Bioethanol is a core part of Brazilian energy strategy since 1975 – when the National Alcohol Program (PROALCOOL) was launched as a response to the petroleum crisis and the falling sugar prices [9]. The incentives originally included in the programme have experienced changes over time, but high fuel taxes on gasoline, tax credits for ethanol and mandates to blend anhydrous ethanol in gasoline still exist [10].

In the case of biodiesel, the regulatory framework of this industry was not envisaged until the Brazilian Biofuel Program (PROBIODIESEL) was launched in 2002. Two years later, the National Program of Production and Use of Biodiesel (PNPB) introduced biodiesel in the Brazilian energy matrix, to be mainly used in truck and buses [4,11]. Mandatory blends were promulgated by Law no. 11.097/2005 and would gradually increase thereafter, from a 2% addition of biodiesel to the oil diesel (denoted by B2) in 2008 to 7% (B7) in November 2014.

A system of incentives and subsidies was devised to promote biodiesel production from vegetable oils, as these products have higher prices in the food market [12]. Following the PNPB implementation, the production of biodiesel grew from 0.07 to 3.8 Mm^3 between 2005 and 2015 according to the Ministry of Mines and Energy (MME) [101]. Nowadays Brazil is the world's third biggest producer of biodiesel, behind the United States and Germany. All biodiesel plants in Brazil are assigned a maximum capacity, and currently they produce well below that level. In overall terms, the biodiesel production in Brazil is around half of the installed capacity of the industry (which was 7.3 Mm^3 in 2015). The domestic demand is expected to increase as the biodiesel mandate will rise up to B8 from March 2017 and to B10 in 2019[15] and the national economy is likely to recover from the crisis [102].

The process of biofuel expansion has by no means been without detractors. In the early years of 2000s, the Brazilian bioethanol industry received massive international criticism as labour conditions on sugarcane farms and ethanol companies were branded 'slave-like' [3]. Financial incentives were also reported to support better off sugarcane farmers and industries settled in rich regions; meanwhile, labour-intensive production of cassava or sweet potato, in which small farmers of the impoverished northeast would have been integrated, was abandoned [13,14]. In the case of biodiesel, the prevalence of a productive model based on large-scale soybean plantations (mainly located in the Central-West region, where this agroindustry was already established [12,15]), has also been strongly contested [5,16].

The Brazilian government has prompted several political initiatives over the last decades to confront these problems – thus becoming one of the first countries to include social concerns in biofuel policy [4]. The multi-stakeholder National Commitment to Labour Conditions in Sugarcane Activity, reached in 2009, is an outstanding result of such efforts. In the case of biodiesel, the PNPB acknowledged social inclusion as one of its main objectives from the start – together with biodiesel blending promotion. With this aim, the programme created the Social Fuel Seal (SFS,

[15] As enacted by the recent Law no. 13.033/2016.

Selo Combustível Social) as an instrument to enable a better integration of small farmers into the biodiesel value chain, particularly in the poorest regions of the country. The original arrangements of the Seal underwent significant changes in subsequent years, as an effort to deal with the problems that arose in the beginning. However, there still are lights and shadows in the implementation of the programme.

This article is aimed at taking a closer look at the operational functioning of the SFS. More specifically, the objective is threefold: (i) to display the institutional settings of this instrument and the role that different stakeholders (processors, agricultural cooperatives and farmers) play in it; (ii) to explore the uptake, achievements and shortcomings of this programme in the light of the most recent official data and the academic literature; and (iii) to illustrate specific aspects of the practical implementation of SFS upon the base of interviews conducted with SFS stakeholders in the state of São Paulo (Southeast region).

2. METHODOLOGY

This research was initially based on secondary sources. First, a textual analysis of national legislation on this matter was conducted. The scientific literature review provided further information and elements for discussion. Data on the practical application of the SFS were compiled from a wide array of sources, notably reports and official databases by government agencies such as the Ministry of Mines and Energy (MME), the National Agency of Petroleum, Natural Gas and Biofuels (ANP) – responsible for the regulation and supervision of the Brazilian oil and biofuel market, and dependent on the former Ministry – and the extinct Ministry of Agricultural Development (MDA).[16] Specialised informative journals (eg. Biodieselbr [102]) provided useful updated material.

[16] The MDA was abolished in May 2016 by the interim President Michel Temer, and its work was transferred to the Ministry of Social and Agrarian Development (MDSA, in Portuguese). For this reason, hereinafter it will be referred to as MDA/MDSA.

Secondary sources were later verified and complemented with primary information. The empirical analysis was focused on the Southeast region, concretely in the state of São Paulo, the most industrialised state and the first biodiesel consumer in the country [11]. Telephone/email enquiries to power plants (made from May to July 2015) were necessary to check their current situation with respect to the SFS. Remarkably, the information provided by the official website of the MDA/MDSA regarding the agricultural cooperatives participating in the SFS was found to be outdated, and primary information thereon was also necessary [103].

Later, in-depth and semi-structured interviews were conducted (in August 2015) with several agents of the biodiesel chain involved in SFS functioning. Figure 1 displays the State of São Paulo and the different locations where fieldwork was conducted.

First, technical visits were made to one of the two biodiesel industries currently operating with the SFS in the state of São Paulo, headquartered in the city of Orlândia. Experts responsible for different stages of the productive process, together with the technician in charge of SFS in the industry, were interviewed. Another visit was made to an agricultural cooperative settled in the municipality of Motuca that worked with SFS for two years in recent times, as the only cooperative that have ever operated within this scheme in São Paulo.

Finally, we also interviewed two of the family farmers associated with this cooperative who used to provide soybean for biodiesel processing. Their farms were located in the settlement of Bela Vista do Chibarro, municipality of Araraquara. Finally, both primary and secondary information was analysed and discussed in the light of the academic literature.

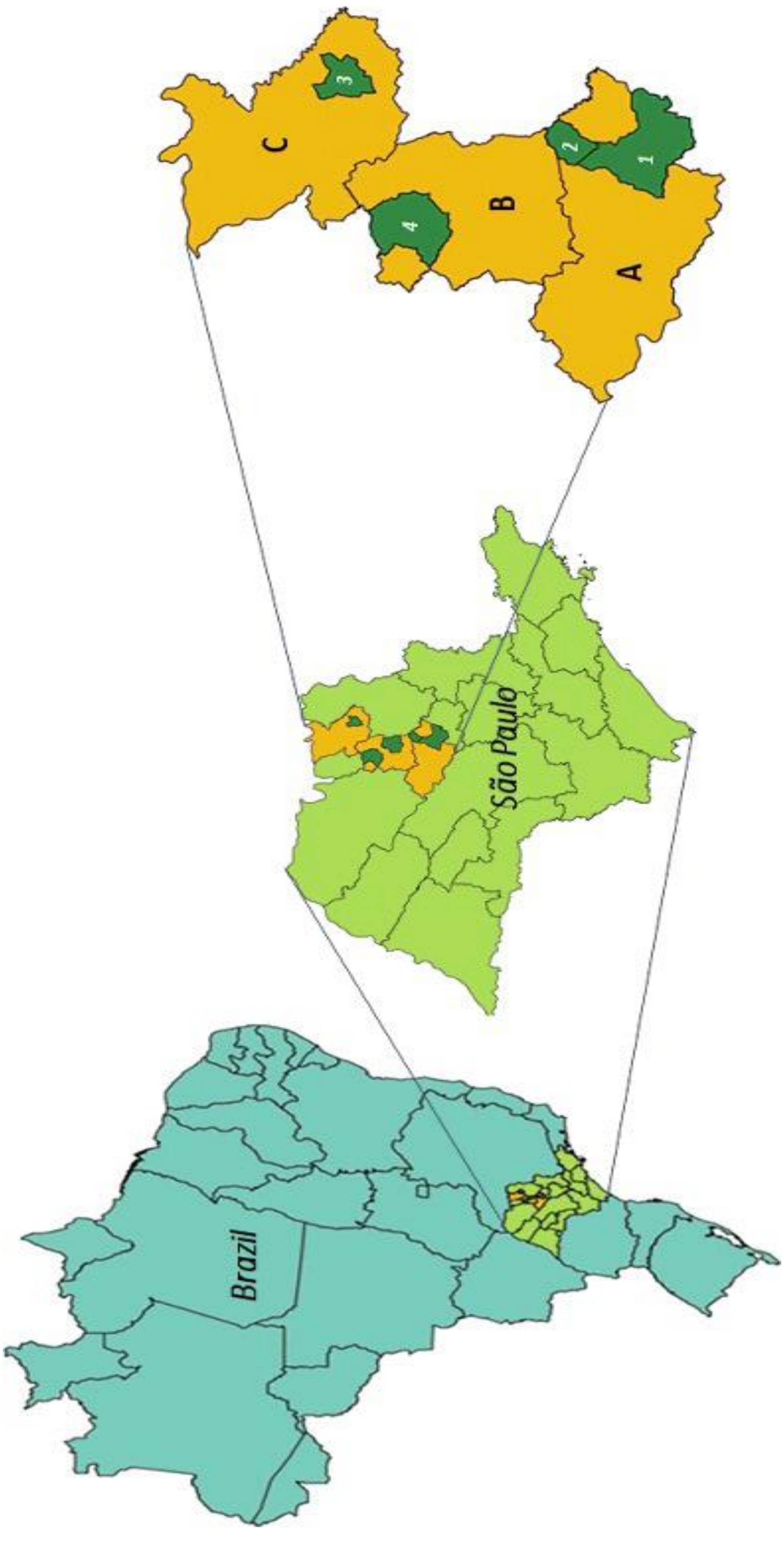

Figure 1. State of São Paulo, micro-regions and cities where fieldwork was conducted. Micro-regions: A – Araraquara; B – Jaboticabal; C – São Joaquim da Barra. Cities: 1 – Araraquara; 2 – Motuca; 3 – Orlândia; 4 – Bebedouro.

3. THE SOCIAL FUEL SEAL: STAKEHOLDERS AND INSTITUTIONAL ARRANGEMENTS

The SFS is awarded by MDA/MDSA to biodiesel processing plants that buy a minimum percentage of biodiesel feedstock from family farmers. The share of feedstock obtained from family farmers required to qualify for SFS ranges from 15 to 40%, depending on the region (15% in the North and Central West, 30% in Southeast, Northeast and Semi-arid regions and 40% in the South).

The MDA/MDSA determines which producers are eligible as family farmers, according to a number of criteria established within the framework of the National Program for Strengthening of Family Farming (PRONAF). A cooperative may also be awarded with SFS, as long as at least 60% of the members are qualified as family farmers. Therefore, an industry may obtain the SFS by purchasing the required percentage of raw materials either from individual family farmers or from accredited cooperatives [4].

The PNPB provides credit lines with favourable rates to power plants with the SFS and also to family farmers participating in the scheme [17]. The SFS is also connected with a special tax system that establishes federal exemptions and incentives for biodiesel producers that differ per supply region and type of raw material (Table 1).

Diversification of biodiesel raw materials is a central objective for the SFS, provided that soybean-based oil still largely prevails in the country (it generated 76% of the total biodiesel production in 2015, according to ANP [104]. In spite of the low oil content of the soybean (18%) compared to other oilseeds cultivated in Brazil,[17] the by-products obtained in the industrial process generate important revenues for these plants, notably glycerine (consumed by domestic chemical industries) and bran (used and exported as animal feedstock together with the beans) [1,18].

[17] Babassu has 66% oil content; palm 30–45%, sunflower 35–52%, peanut 44–56%, and jatropha 38% [18].

Table 1. Tax exemptions and incentives for biodiesel (R$/m^3)

Type of farmer	Family farmer (PRONAF)***		All other producers	All others
Region	North, Northeast & Semi-Arid regions	All other regions	North, Northeast & Semi-Arid regions	
Biodiesel feedstock	Any	Any	Palm oil or Castor oil	
Reduction coefficient	1	0.896	0.775	0.6763
PIS/PASEP*	0.00	10.39	22.48	26.41
COFINS**	0.00	47.85	103.51	121.59

Source: Authors' elaboration from Decree nº7.768, 27 June 2012

***PRONAF (National Program for Strengthening of Family Farming).

*PIS/PASEP (Program of Social Integration/Program of Patrimony Formation of Public Servants) are social contributions payable by legal entities.

**COFINS (Contribution to the Social Security Funding) is the federal tax levied on gross revenues of businesses.

In addition, soy production is based on large, specialised and highly mechanised farms. The cost reduction achieved through economies of scale is of particular importance considering that the raw material represents 80% of the total cost of biodiesel production [19].

The second-most used feedstock is beef tallow (from which 20% of biodiesel is produced), a residue of another massive agrifood industry – Brazil has the second largest beef herd in the world [12]. This low-cost fat used to be mainly destined to the soap industry by early 2000s, but power plants have increasingly used it as feedstock for biodiesel production. At present, this is largely the main destination of beef tallow in Brazil [20].

Other vegetable oleaginous feedstock different from soybean, such as cotton, canola, castor oil, babassu, sunflower, palm oil and peanuts, only generate around 5% of Brazilian biodiesel production altogether – and cotton accounts for an important part of this percentage. The PNPB aimed at enhancing the integration of alternative crops into the biodiesel chain, considering that some of them are better adapted to the production conditions of small farmers and/or disadvantaged areas. Thus, castor oil is a labour-intensive production suitable to be obtained in the Northeast on a low-input basis, and plays a role as a cash crop for small farmers [16,17,21], and palm oil also requires little capital investment, uses intensive manpower and adapts well to the Amazonian conditions [22].[18]

In addition to the tax exemptions, industries awarded with the SFS are allowed to participate on very favourable terms in the bimonthly biodiesel auctions organised by ANP [104]. These auctions have been the only way to trade biodiesel in Brazil; by means of them, the biodiesel necessary to comply with the blending mandates is bought by

[18] Babassu fruits are obtained from indigenous forests, and peasant families retain an important share of the income they generate [18], but this crop does not receive any tax reduction. In the case of peanuts, the production is concentrated in the industrialized state of São Paulo.

Petrobras to the power plants. The latter are the bidders; they offer a mix of price and quantity and those with the lowest prices win. The amount of biodiesel to be traded at these auctions is set by ANP; as the blending mandates, have increased from 2008, so has this amount. PNPB establishes that the first auction day is restricted to bids from processors certified with the SFS, and 80% of the biodiesel purchase is reserved for them. The remaining 20% is bought in the second-day auction, open to any industry.

The SFS requires the awarded industries to sign legally binding contracts with either farmers or cooperatives. Contracts have necessarily to include a technical collaboration agreement embracing the provision of technical assistance, training and other backing to farmers (e.g. in logistics, transport or access to credit). The ultimate objective of this help is to improve agricultural practices and increase farm productivity, not only for biodiesel raw materials but also for food crops.[19] Extension services may be assumed either by the company itself or by an outsourced enterprise or institution. A reference to pricesformation criteria and the amount of feedstock to be obtained by family farmers is also made in the contract – the industry guaranteeing the purchase of such an amount. The contracts have no legal value if they are not consented to and signed by collective actors such as agricultural labour unions, organisations of farmers' cooperatives, and associations of the biodiesel industry – a representative of one smallholder association is required. The contract compliance by the power plants is yearly evaluated by external agencies led by MDA/MDSA.

The technical settings of the SFS are adapted to the objectives of the programme. Thus, each time a certified industry buys raw material alternative to soy from family farmers, the value of this feedstock is multiplied by 4 in the accounting presented to MDA/MDSA to comply with the minimum percentage that should be obtained from family farms. A multiplying factor of 3 is applied to feedstock obtained in the most

[19] The biodiesel producer will ensure technical and training assistance permanently throughout the year for all other crops and activities produced in family farms contracted to deliver [biodiesel] feedstock'. Art. 15 of the Ordinance 337/2015 of the MDA, that regulates the criteria and procedures for the granting, maintenance and use of the SFS.

disadvantaged areas (i.e. Northeast and semi-arid regions), a factor of 1.2 to transactions with family farmers' cooperatives (the factor raises up to 1.7 if more than 80% of the associates are family farmers). Finally, as a novelty in 2014, a multiplying factor of 1.5 was applied to industries operating in Southeast and Central-West that buy raw materials from their own regions [23, 24].

The institutional arrangements we have just exposed are those that are currently in place, after an important amendment of PNPB was introduced in January 2009. This reform was aimed at reinforcing the participation of the regions that were lagging behind and improving the overall performance of the programme. First, the participation of cooperatives was institutionalised and encouraged by announcing new privileges and incentives for them. Cooperatives were thus given a more active role in biodiesel transactions and, importantly, in farmers' capacity building.

Second, Petrobras created PBio, a subsidiary company specifically aimed at promoting biodiesel feedstock cultivation by family farmers in the North and Northeast regions of Brazil. PBio became the sole buyer of all of the feedstock – above the market price – and also organised the provision of technical assistance and inputs to farmers [4]. Third, other technical thresholds of the programme were fine-tuned. For instance, the minimum share of feedstock obtained from small farmers was notably reduced for the Northeast and semiarid regions, considering the difficulties that industries had had in fulfilling the original requirement of 50%. As specified above, the minimum is now set at 30%.

4. THE SFS IMPLEMENTATION: STAKEHOLDERS' UPTAKE AT THE REGIONAL LEVEL

A discussion of the results of the SFS should necessarily start with an analysis of the programme uptake by the main stakeholders: family farmers, agricultural cooperatives and biodiesel processing industries. The number of family farmers involved in the scheme has been continuously far below the Brazilian government target of 200,000 producers (Figure 2). In the early years of implementation of the SFS, the poor results of the programme were attributed to the inexperience of both power plants and family farmers with technical assistance projects, the limited role given to cooperatives by the programme and the scarce agricultural area available on family farms for biodiesel feedstock crops – partly due to farmers' preference for food production [4].

The programme reached half of its target in 2011, and the number of participants has dropped ever since. Moreover – in spite of the emphasis made by policymakers in the promotion of the most disadvantaged areas of Brazil – farmers abandoning the scheme belonged almost exclusively to the Northeast, where the number of participants has gone from 41,200 to 3,900 between 2010 and 2015 [103]. Only 5.4% of the participants in 2015 lived in this region, a strikingly low percentage considering that half of the family farmers of the country live there [25]. Meanwhile, the northern farmers are virtually absent from the programme: there were only 304 of them in 2015 [103]. There are several reasons for this situation, i.e. structural problems in the access to land, scarce labour availability due to rural exodus, exhausted soils and poor infrastructure [26].

Focusing on castor and palm oil production, some of the obstacles in these areas are the scarce investment made by biodiesel plants, the 'chaotic' land tenure system [12], the lack of qualified agronomists for technical assistance and the difficulties in knowledge assimilation by farmers [21]. In the specific case of castor oil, the high prices of this product due to the lack of competitiveness compared with other feedstock hinder castor-based biodiesel production [21].

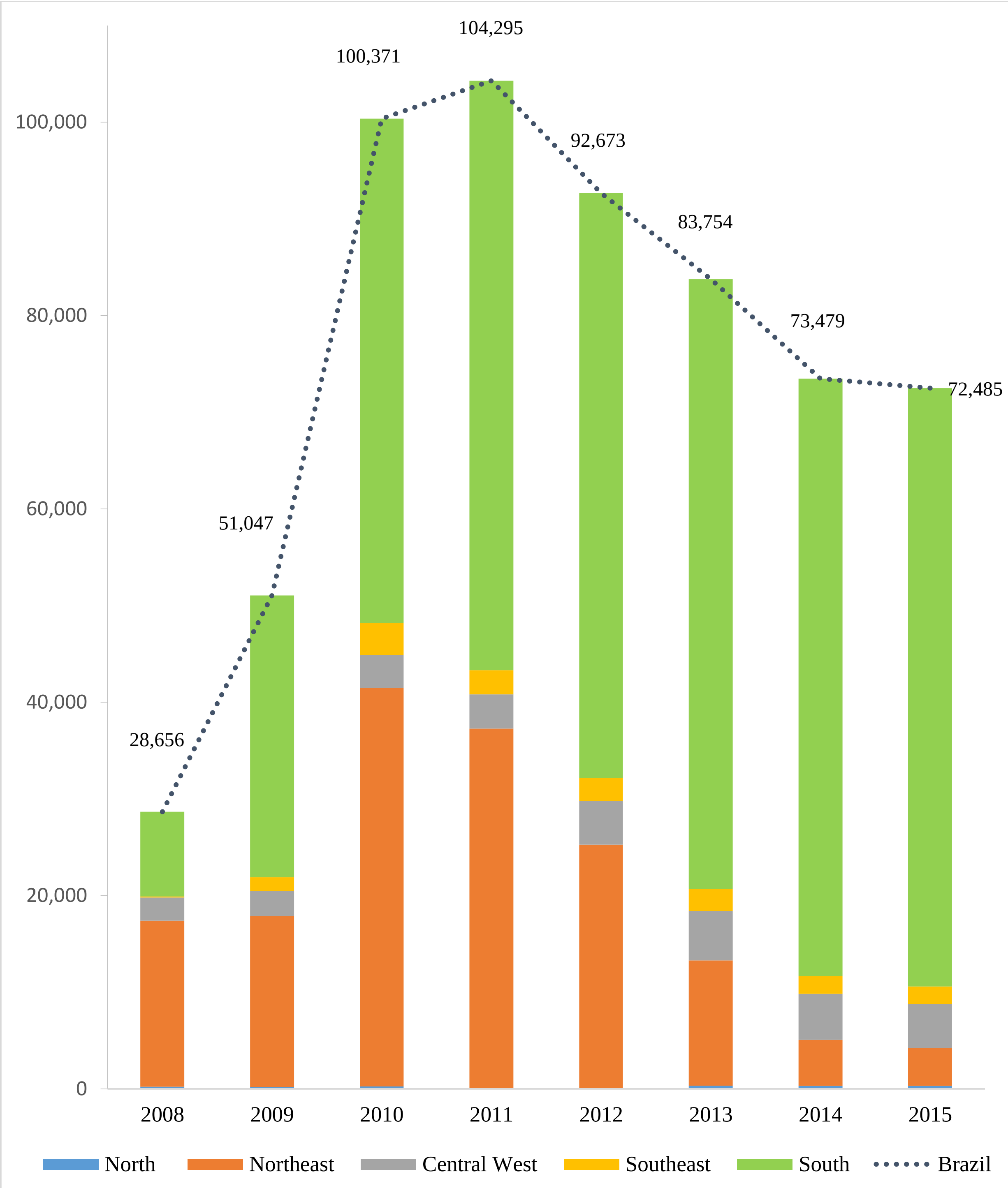

Figure 2. Number of farm families participating in Social Fuel Seal. Source: Authors' elaboration based on MDA/MDSA [103]

Whereas the number of farm families participating in the programme has been dropping since 2011, the volume of biodiesel feedstock traded with the SFS has increased sharply and continuously since 2008 (Figure 3).

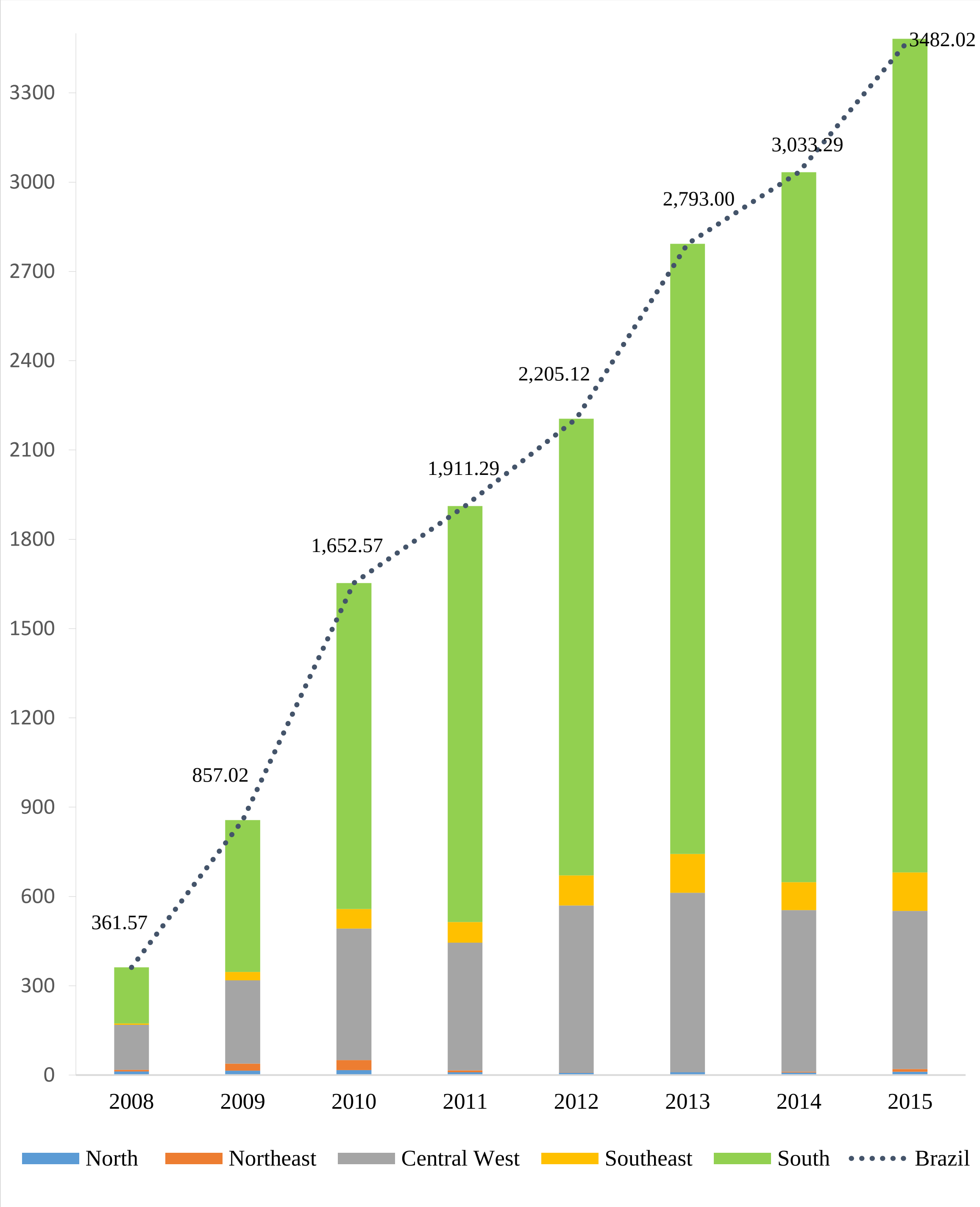

Figure 3. Volume of biodiesel feedstock obtained from family farmers within the Social Fuel Seal (1000 tons). Source: Authors' elaboration based on MDA/MDSA [103]

The programme has failed in diversifying the biodiesel feedstock, as big soybean farmers remain the main suppliers of biodiesel processing industries [3,5]. Along with the abovementioned advantages of soy production, the alternative uses of jatropha, castor oil and indigenous palm varieties for the cosmetics industry make them too expensive to be used for biodiesel [16]. The prevalence of soy explains the prominent role of the South and Central-West regions in the volume of biodiesel feedstock traded with SFS depicted in Figure 3 – as 85% of soy production in Brazil is concentrated there [27].

The consideration of the cooperatives' role in SFS sheds more light (and somehow provides a more positive view) upon the evolvement portrayed by the above figures. As a result of the amendment of the PNPB undertaken in 2009, the participation of cooperatives in the certification scheme underwent a four-fold increase between 2008 and 2014 – in fact it doubled the first year after the policy revision (Figure 4). It is worth noting that 85% of the biodiesel feedstock obtained from family farmers is sold to power plants through cooperatives at present [25].

The promotion of these entities has facilitated the uptake by small farmers especially in regions with a long collective action experience, remarkably the South – hence the concentration of the accredited cooperatives there [18,25]. The South region is clearly the principal contributor to the programme also in terms of volume of feedstock traded and number of farm households involved. Specifically, Rio Grande do Sul, the southernmost state of Brazil, is the state in which by far the most family farmers are involved in the SFS (45,200, representing over 60% of all the participants in the country) [103].

Contrarily, farmers from the North and Northeast have a scarce cooperative tradition [22]. This fact can be ascribed to, first, the 'protest' political profile of the collective initiatives in these areas (which have not been recognised by the Brazilian Cooperative Organization), linked to the disputes around unequal land access, and, second, distrust in formal cooperatives as they are seen as instruments of governmental control [4,21].

Thus, apart from harvest failures due to draughts over the last few years [105] and logistic difficulties due to the poor infrastructures existing in these regions, the scarce organisational capacity of cooperatives may have acted as a hindrance for their effective integration in the SFS.

Since PNPB was redesigned in 2009, the number of participating cooperatives has increased in the North and Northeast with a strong support from PBio, but these areas still lag behind other regions in terms of uptake and biodiesel outcome. Moreover, some of the cooperatives created in 2009 and 2010 failed shortly after (Figure 4).

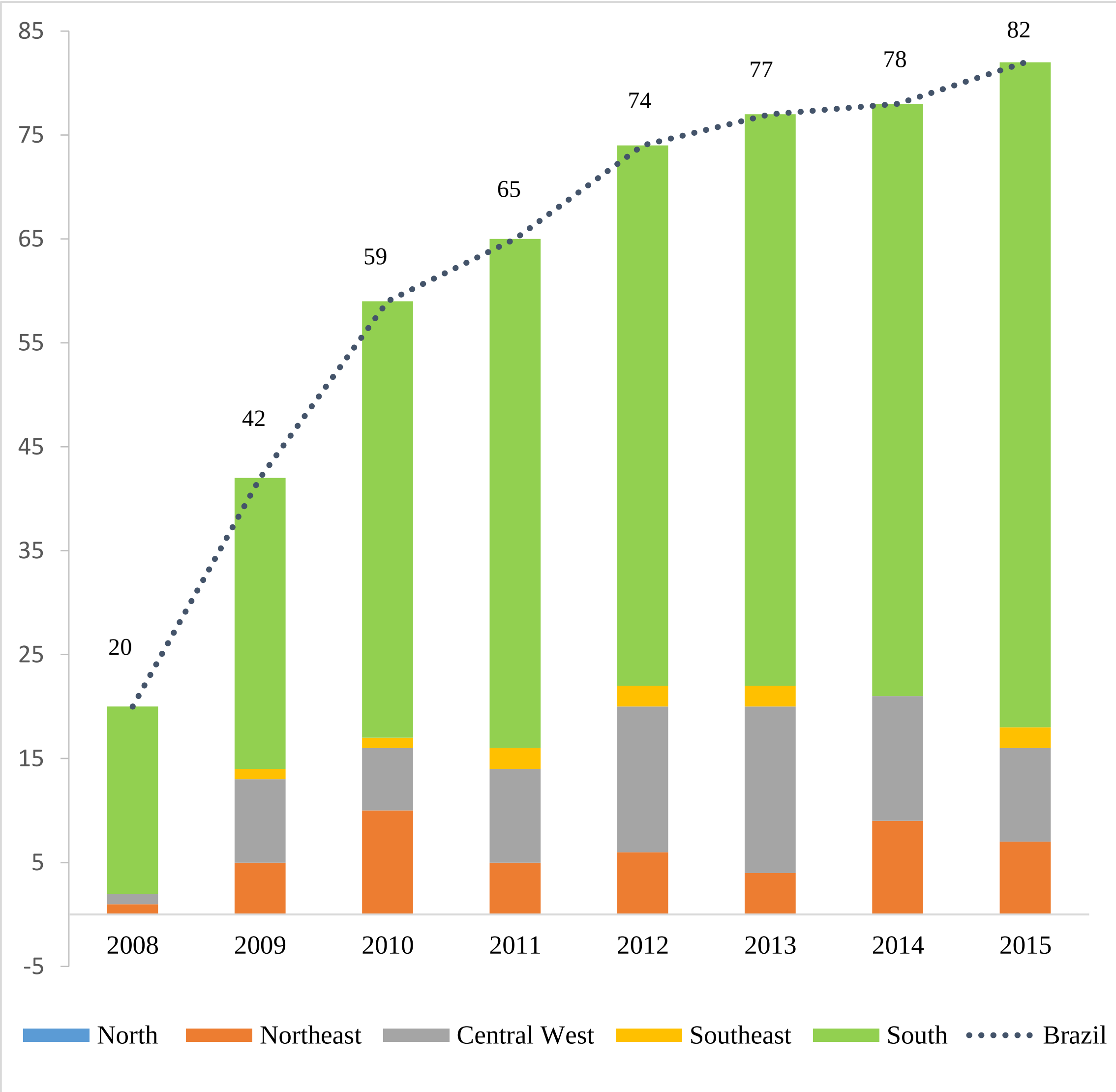

Figure 4. Number of cooperatives qualified in Social Fuel Seal. Source: Authors' elaboration based on MDA/MDSA [103]

Besides, the PNPB has succeeded in promoting the integration of medium-sized farmers, but has not properly reached the smallest ones [4]. Often these farmers are located in remote areas; they are ill educated and more reluctant to make changes or to engage in collective action initiatives. In other words, the least productive producers of the poorest regions of Brazil have remained largely marginalised from the programme.

To make things worse for the Northeast, PBio has recently closed two power plants in this region (i.e. Ceara and Rio Grande do Norte), within the framework of the profound changes that Petrobras is undergoing.[20] Due to the severe problems of indebtedness of the company and the need for downsizing its structure to adjust it to the reality of the market, Petrobras is dispensing with non-strategic activities such as biodiesel production in order to concentrate resources in the most profitable projects. At present only two plants in the Northeast region, located in Bahia, remain operative [106].

Opposite to the limited uptake by farm families, the appeal of the SFS for biodiesel processing plants becomes evident if one considers their engagement in the scheme (Figure 5). From the 51 industries authorised to participate in biodiesel auctions in 2015, 19 were located in the Central-West (the most productive region), 11 in the South and six in the Southeast. The 'target' North and Northeast regions only have three industries each awarded with the SFS.

There is some instability in the number of accredited industries, which varies from year to year due to the difficulty of reaching the required minimum percentage of feedstock collected from family farmers. In fact, the biodiesel obtained and delivered from family farmers' raw material is regularly below the contracted amount [12]. In the Northeast, the power plants reach the compulsory 30% of feedstock from family farming through contracts with cooperatives located in the other regions [25], thus failing to effectively involve smallholders from their own territories. This is why in 2014 a multiplying factor

[20] At the time of writing this article, the giant state-run oil company Petrobras is expected to undergo a process of privatisation.

was introduced by the PNPB for the raw material obtained in the same region where the industry operates (see section 3).

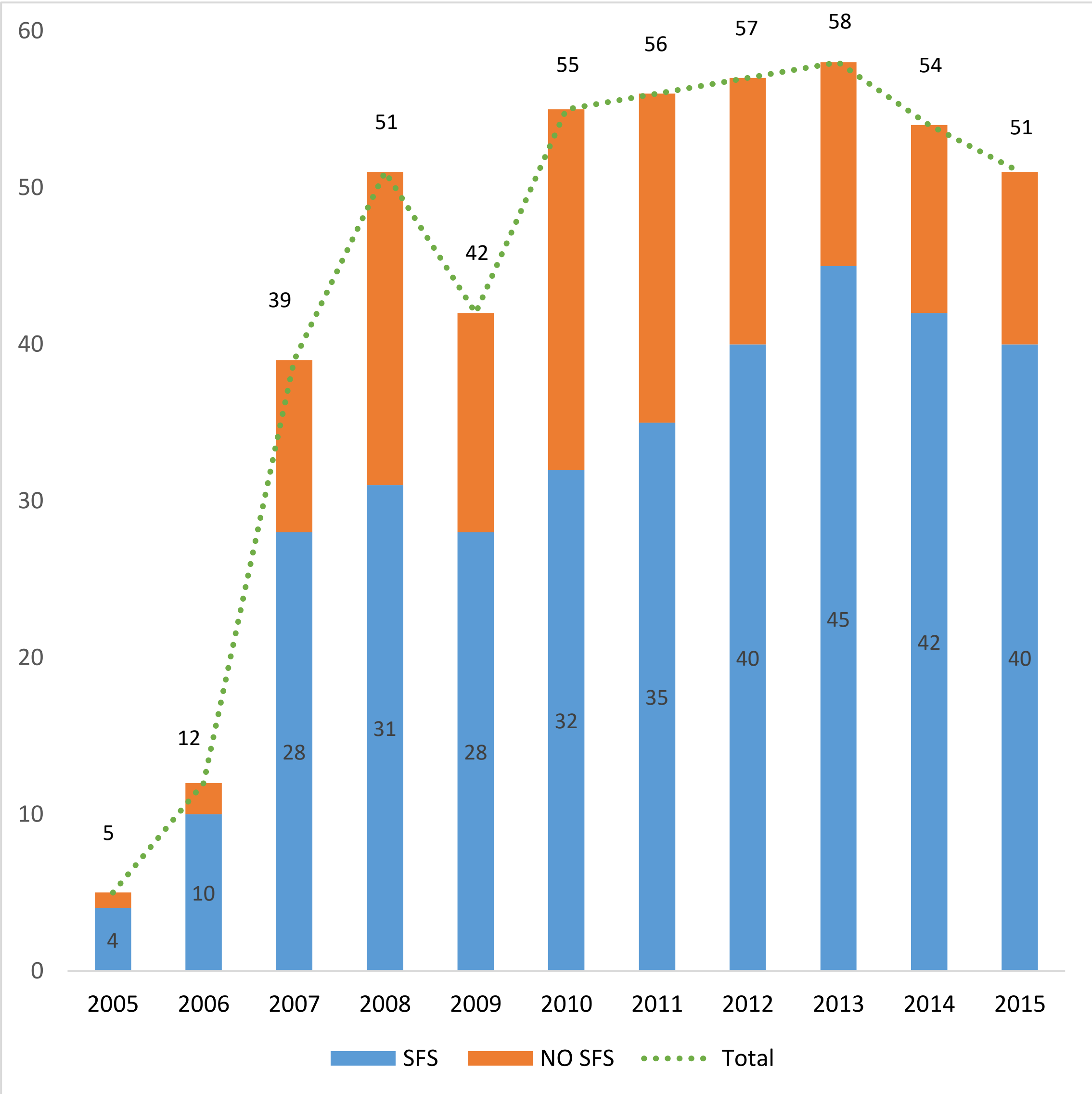

Figura 5. Participation of biodiesel processing industries in Brazilian SFS (Social Fuel Seal). Source: Authors' elaboration based on MME [101]

5. THE SFS IMPLEMENTATION: EXPERIENCES IN THE STATE OF SÃO PAULO

The industry where interviews were conducted operates in the city of Orlândia (São Paulo; see Figure 1), employs some 600 workers and has participated in the SFS since 2012. It is authorised for a nominal capacity of 11,000 m^3 of biodiesel per month by the ANP, but the monthly production greatly varies according to the demand at auctions. In 2014, the overall production was about 36,000 m^3 of biodiesel. The biodiesel is 100% obtained from soy, which is collected from three different states: São Paulo (20% of the raw material), Minas Gerais (10%) and Goiás (70%).

The strong competition with industries from other regions (namely Central-West and South), able to offer lower prices at biodiesel auctions, is remarked on by the interviewed technicians as a problem. The crop yields obtained in the states of Mato Grosso and Parana are indeed notably higher [18]. In this line, the most important incentive for the plant to operate with the SFS is the guarantee of participation in the first day of biodiesel auction, as tax reductions are not relevant in this case.

Importantly, the industry does not always use the soybean obtained from family farmers for biodiesel production. The company also produces other outputs such as soybean oil, bran and protein, vegetable fat, lecithin and soybean seeds. Because the soybean oil produced from improved seeds is of higher quality, it is re-routed for food production to obtain higher profits – meanwhile soybean oil is purchased from third parties as biodiesel raw material. This recalls another dysfunction in the SFS operation that other studies [4,25,101] found in the Northern regions: biodiesel industries sell to third processors the castor and palm oil produced by family farmers and, with the profits so obtained, they acquire the soybean for biodiesel production.

The studied power plant obtains feedstock mainly from individual, non-associated family farmers. Only one cooperative, which is located in the state of Goias (out of the geographical scope of this study; São Paulo), supplies raw material to them at present. Both farm inputs (remarkably improved soybean seeds) and technical assistance are directly provided by the power plant to those family farmers who are not associated in cooperatives, either by their own technicians or by outsourced enterprises. However, farmers who are associated receive this support by way of the cooperative. The technicians of the industry pointed out as a drawback that farmers sometimes ignored the contracts and sold the feedstock to local traders who offered a higher price for it; for this reason they only gave the improved soybean seeds to 'trustful members.'

There is only one cooperative in the state of São Paulo that has ever worked within the SFS scheme, which is settled in the municipality of Motuca. It supplied soybeans to the other power plant in this state, set in Bebedouro, but this commercial relationship broke off in 2013/2014. We interviewed a technician and farmers associated with this cooperative to better understand the functioning of the SFS scheme in that period.

The cooperative had 175 members, of which 151 were family farmers. They were mainly maize producers, but in the 2010/2011 crop year, 20 farmers started producing soybean for biodiesel processing as a strategy of farm diversification. The cooperative obtained SFS certification the following year, after completing the required administrative procedure, and the number of farmers producing soybean doubled in 2011/12.

The soybean production entailed some uncertainties for farmers, mainly related to the incidence of plagues in case of adverse weather. For instance, an excess of rain and heat made it necessary to increase the number of farm operations to avoid fungus plagues and diseases. Considering the costs of soybean production, farmers of this area were close to the financial limit of profitability. The soy producers associated with the cooperative were settled in two different locations: Monte Alegre (municipality of Motuca) and Fazenda Bela Vista do Chibarro, in Araraquara (see Figure 1). The former struggled to cover the production costs because their soils were sandy and impoverished, whereas those living in Bela Vista cultivated on clayey, more productive soils and were able to make profits on soybean production. By 2012/2013, only a few farmers of Monte Alegre continued to produce soybean, whereas the number in Bela Vista had increased to 44 (see Table 2).

All the SFS arrangements were detailed in the contract signed between the power plant and the cooperative. The contract specified the economic compensation that the cooperative should receive from the industry, which in 2012 amounted to 2 reais per 60-kg soybean bag (around 0.6 USD at the time of this research). This price, to be paid at the moment of delivery of the raw material, was in theory expected to cover the transport costs, the extension services and the inputs provided by the cooperative to farmers. The contract also included the minimum volume of feedstock to be delivered, which is calculated upon the base of the cultivated area and technical coefficients of crop productivity provided by official agencies.[21] In this particular area, the amount was 36 bags of 60 kg of soybean per hectare.

Table 2. Farmers producing soybean for biodiesel production in the studied cooperative

Soy producers	Fazenda Bela Vista do Chibarro (Araraquara)	Monte Alegre (Motuca)	SFS status
2010/11	3	17	In process of obtaining SFS
2011/12	26	26	With SFS
2012/13	44	7	With SFS
2013/14	15	5	No SFS

*SFS: Social Fuel Seal
Source: Authors' elaboration (information provided by the cooperative during fieldwork)

[21] Such as the National Food Supply Agency (CONAB) or the Brazilian Institute of Geography and Statistics (IBGE).

The interviewed technician reported that farmers' yields significantly improved thanks to the technical assistance (that covers all farm operations from preplanting to harvest, safety issues, etc.), focused not only on soy cultivation but also on other crops as SFS regulations indicate. However, the distance among farms and the bad communications (through unpaved roads) made the movements of the technician from one farm to another long and expensive. In addition, the cooperative was 140 km away from the biodiesel industry, much farther than the 60–70 km that the interviewee pointed out as the maximum distance that could be compensated by the plant.[22] Transport costs were hence recognised as a core problem for the functioning of the scheme.

In 2012/2013, a severe drought caused a crop loss and the cooperative was unable to supply the industry with the minimum volume of output required by the contract. The little amount paid by the plant for the delivered raw material left the cooperative in a difficult financial position, and farmers did not have enough financial resources to plant soy the following year. The cooperative has stopped commercialising soybean ever since and has specialised in maize again.[23] Only 20 of the associates still produce soybean at present, and they sell it to a large food industry in Bebedouro, 88 km away, outside the cooperative and the SFS.

In the interviews conducted with two of these farmers, they identify the loss of technical assistance for soybean production as the most important drawback from the breakup of the commercial relationship with the biodiesel industry within SFS. Given that the drought was a generalised problem for family farmers in Brazil that year, by September 2012 a revision was introduced to the SFS whereby, in case of a harvest loss, the minimum percentage of feedstock to be delivered by family farmers was to be

[22] According to the contract the transport costs are financed by the industry, but only up to a limit of 2% of the total value of the acquired feedstock.

[23] According to the strict contract terms, the power plant could have charged a penalty to the cooperative because the stipulated amount of raw material was not reached. Our informants reported that it was not charged, but the parties decided not to renew the contract, by mutual agreement.

calculated on the expected production (art. 6 of the Ordinance 60/2012 of MDA [28]; afterwards replaced by Ordinance no. 337, 18/09/2015 [23]).

As a final remark, the administrative burden is mentioned by technicians from both the cooperative and the biodiesel plant as a problem for SFS implementation. The procedure to certify the Seal is reported to be time-consuming for the industry, and the transaction costs of the programmes' functioning are also considered relatively high. For instance, the biodiesel company claims that it is penalised if MDA/MDSA inspections detect producers registered as family farmers that do not meet the necessary conditions to fall in this category – which forces the company to increase their surveillance effort by way of fieldwork visits. The interviewee from this industry estimates that around 10% of the farmers actually do not fulfil these legal criteria, because they have split the farm and registered as several separate (family) producers. When this kind of fraud is discovered, the DAP of the farmer (Declaração de Aptidão ao PRONAF, a document certifying the eligibility for such programme) is cancelled and subsequently the producer no longer has access to any kind of public support as a family farmer.

The industry also reports (exceptional) cases of farmers that lose the DAP due to a genuine improvement in their income. Extensive documentation (contracts, photographs and attendance lists of training days, follow-up reports on technical assistance, field measurements, etc.) needs to be collected and presented by the biodiesel industry in the yearly MDA/MDSA evaluation. Conclusions in this article we aimed to shed light on the institutional arrangements, the application and the main outcomes of the Social Fuel Seal in Brazil. Available data show that the programme uptake by small farmers has remained well below government expectations, although the cooperatives' involvement has rapidly increased and catalysed family farmers' participation after the revision of the policy in 2009.

6. CONCLUSIONS

In this article we aimed to shed light on the institutional arrangements, the application and the main outcomes of the Social Fuel Seal in Brazil. Available data show that the programme uptake by small farmers has remained well below government expectations, although the cooperatives' involvement has rapidly increased and catalysed family farmers' participation after the revision of the policy in 2009.

Interviews in the state of São Paulo have revealed that the technical assistance to family farmers, whether provided by the biodiesel processing plant or the cooperative, is regarded as an effective way to improve agricultural practices and yields. However, the logistic problems due to the high transport costs, the arrangements of the contract (that did not protect farmers in case of harvest loss at that moment), the administrative burden of the scheme, the lack of compliance of some farmers with the agreements and the withdrawal of the less-productive farmers have been identified as weaknesses of the SFS implementation.

Moreover, the soybean oil transacted within the SFS is diverted to food processing by the studied industry – a widespread practice in Brazil that adds to other dysfunctions in SFS practical operation. Biodiesel companies located in the North and Northeast only meet the minimum share of feedstock obtained from family farmers by means of contracts with cooperatives settled in other regions; in addition, much of the castor and palm oil produced by the few participating farmers in poor regions is resold by the power plants to buy soybean as biodiesel feedstock [29].

The overall operation of the programme raises concerns about the sustainability of the role of family farmers in it. The accomplishment of the social inclusion objective is also put into question. In the most critical line, the SFS has been considered more of an industry subsidy than a programme to benefit family farmers [14] – in short, a similar accusation to that voiced against the bioethanol policy. Hunsberger *et al.* [13] make a crucial point in this regard when they declare that 'Social Fuel Seal's incentives to encourage smallholder production in Brazil appear to be overpowered by counterincentives favouring economies of scale that are built into biofuel markets beyond the national level' (p. 255). In a similar vein, Stattman *et al.* [4] claimed that 'family farmers are [...] hardly relevant as raw material producers for biodiesel production but rather are only an entry ticket into the biodiesel auction' (p. 291), and indeed this preferential access to auctions was also found to be the most important motivation for the power plant in our case study.

However, the positive outcomes of the SFS for family farmers should not be underestimated. As occurs in our study area, the technical assistance was indeed recognised to have benefited farm productivity. Further, the institutionalisation of the role of the cooperatives in SFS has encouraged farmers' capacity building and collective action since 2009, which are undoubtedly positive side effects of PNPB. Fairly positive experiences in the Northern regions have been reported in this regard. As some authors remark [4], the role of cooperatives is particularly important considering that when small farmers become members, they indirectly gain access to an array of resources from other agricultural, social and rural programmes.

Finally, the fact that both industries and farmers divert biodiesel raw material to food purposes leads to two substantive issues for further debate: first, whether the improvements that smallholders may have achieved from PNPB are really due to their upgrading in the biodiesel value chain; and, second, whether biodiesel policy is a cost-effective way to promote family farmers compared to alternative policies specifically targeted at them.

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CAPÍTULO V. DISCUSIÓN Y CONCLUSIONES

En esta investigación se ha pretendido analizar y caracterizar la evolución del sector de transformación del biodiesel en Brasil desde del principio de su funcionamiento hasta la actualidad, investigando a los actores de la cadena del biodiesel (básicamente, agricultores familiares, cooperativas e industrias), con el propósito de entender cómo se desarrollan las relaciones entre estos actores y cómo funciona el Programa Nacional de Producción y Uso del Biodiesel en Brasil.

La primera de las publicaciones que se integran en este documento ha tratado de caracterizar las industrias participantes de la cadena del biodiesel. La investigación se hizo con el objetivo de analizar la evolución de la participación de estos actores desde el comienzo del funcionamiento del sector, a través, por ejemplo, de los índices de concentración, para posteriormente identificar e intensificar los análisis de las industrias vigentes en el sector, categorizándolas según sus variables productivas.

Este análisis permitió alcanzar conclusiones significativas sobre la evolución de esta industria. La combinación de herramientas institucionales del PNPB (subastas, incentivos fiscales) tuvo éxito en incorporar empresas en el sector y expandir la producción de biodiesel, llevando al Brasil a convertirse en uno de los grandes productores mundiales. Sin embargo, objetivos importantes del programa como el equilibrio territorial de la producción, la integración de los pequeños agricultores en la cadena de valor y la diversificación de materia prima no fueron alcanzados de forma satisfactoria. La soja sigue siendo la principal materia prima y las plantas están concentradas en regiones productoras de soja cercanas a los centros de consumo de biodiesel. Las industrias trabajan todavía en promedio en niveles cercanos al 50% de su capacidad instalada, aunque el factor de utilización mejora con los aumentos de mezcla de biodiesel en diésel.

En relación con la evolución de la estructura industrial, se identificaron dos periodos: el primero comprendido entre 2005-2011, caracterizado por un rápido aumento de volumen de biodiesel y por la entrada de nuevas empresas y por una gradual desconcentración del sector. El segundo periodo (de 2012 hasta la actualidad), por el contrario, muestra un crecimiento de la producción realizado por un menor número de empresas e industrias. Esta tendencia está relacionada con márgenes más estrechos de ganancia y una creciente competencia promovida por los cambios del modelo de subasta introducidos en 2012. Los índices de concentración alcanzan una estabilidad en este periodo, señalando una homogenización de las escalas de las plantas.

El análisis multivariante llevó a la formación de 3 grupos de plantas de transformación. El primero se caracteriza por la especialización de *input* (materia prima soja) y diversificación/ampliación de productos (producen biodiesel y géneros alimenticios). El segundo es un modelo de diversificación en los insumos y especialización en la producción, con empresas especializadas en biodiesel que necesitan diversificar materias primas para garantizar el abastecimiento a lo largo del año a bajo coste, comprando por ejemplo sebo bovino de otras empresas como alternativa barata a la soja. El último corresponde a un grupo reducido de empresas relativamente pequeñas que usan materias primas diversificadas para producir biodiesel y no corresponden a plantas que procesan alimentos, como las PBio, subsidiaria de la estatal Petrobras. Los resultados revelaron que la industria del biodiesel en Brasil evolucionó rápidamente y presenta negocios diferentes y flexibles.

A pesar del crecimiento productivo del biodiesel derivado también de los aumentos progresivos de las mezclas obligatorias de biodiesel, se observó así mismo una desigualdad regional y un desplazamiento productivo, siendo en Centro-Sur del país más productivo que el Norte-Nordeste. Esto coincide con la participación agraria y es contrario a los propósitos de la política social para la producción del biodiesel en Brasil. Igualmente demuestra que el factor logístico, en un país de extensiones territoriales como Brasil, es una variable de gran importancia.

Estas cuestiones son precisamente abordadas en la segunda publicación, que trató de visualizar el panorama del sector del biodiesel en las distintas regiones brasileñas, además de comprobar, en la medida de lo posible, la ocurrencia de discrepancias regionales y desplazamiento productivo. Para ello, se estudió el funcionamiento del sistema de certificación del biodiesel brasileño (SCS) y cómo se han ido configurando las relaciones entre los actores de la cadena de valor (industria, cooperativas y pequeños productores). Los resultados mostraron las discrepancias del funcionamiento del Programa y del Sello en las regiones del país y también los beneficios y desventajas para los actores de la cadena. Los resultados dieron cuenta de la existencia de un sector de biodiesel en Brasil aún en proceso de desarrollo y altamente dependiente de factores macro, como políticas gubernamentales y micro como la disponibilidad de materia prima y costes de producción para cada región. Las disparidades regionales encontradas fueron diversas, como dificultades en la consolidación de cooperativas como grupos operacionales, en el desarrollo de tecnologías (en el campo e industria) y en la diversificación de materia prima.

Desde el punto de vista de la capacidad del SCS para conseguir que los productores más pobres se incorporen en la cadena de valor, los resultados han mostrado que los actores de las regiones más pobres encontraron dificultades para actuar en este sector. Problemas de incumplimiento de los contratos por parte de los actores rurales y en algunos casos agricultores localizados en áreas remotas con infraestructura insuficiente, o pequeños productores reacios a introducir cambios productivos o formar parte de cooperativas, son factores que afectaban la participación de estos actores en la cadena.

Por otro lado, los problemas burocráticos y de sobre regulación de órganos estatales sobre las industrias participantes, además de los problemas citados, demandaron un análisis más a fondo sobre la participación de los actores (industrias, agricultores y cooperativas) y el funcionamiento del Sello Combustible Social y del programa gubernamental que rige la cadena del biodiesel en Brasil, el PNPB.

La tercera publicación contemplaba —sobre la base de un estudio empírico del estado de São Paulo— un análisis más a fondo del Sello Combustible Social, sus características, logros y deficiencias a lo largo de los años de existencia de la cadena de biodiesel en Brasil.

Según la teoría abordada en este marco conceptual, los gobiernos actúan como "facilitadores" para fomentar las condiciones al sector privado a fin de crear valor a través de la inclusión de los pequeños agricultores. Aunque cada país tenga un enfoque diferente a la promoción de este entorno, modelos híbridos de asociaciones público-privadas para la prestación de este tipo de servicios son cada vez más comunes. En el caso brasileño, se encontró que la participación "híbrida" de cooperativas aumentó, aunque en el estado de São Paulo, esta no fue la realidad encontrada. Problemas logísticos, contractuales (falta de cumplimiento del contrato por parte de los actores y falta de cobertura a los agricultores, ante la pérdida de la cosecha por problemas climáticos) han sido constatados, además de problemas administrativos y burocráticos del sistema, lo que ralentiza dicha participación.

Tal y como se planteó previamente, el objetivo de promover la diversificación de la materia prima no fue alcanzado (ya que la soja aún predomina como materia prima para fabricar el biodiesel, seguida de la grasa animal). Las materias primas minoritarias pretendidas por el sistema alcanzan hoy un mero 5% del mercado de las oleaginosas en la cadena. Otro problema es que muchas veces el aceite vegetal que se obtiene de los agricultores familiares es redireccionado a la industria de alimentos y la industria adquiere otro aceite (de productores que no son agricultores familiares contratados) más barato. De esta manera obtiene las ventajas de participar en el SCS, garantizando así su participación en las subastas de venta de biodiesel.

El reto de la inclusión social que planteaban Bolwig *et al.*, (2010), plasmado en el aumento del número de agricultores familiares, principalmente en las regiones más pobres del país, tampoco fue alcanzado. Esto sugiere que cambios en las políticas siguen siendo necesarios para alcanzar tal objetivo. Sin embargo, hubo constataciones positivas, como: el aumento de la productividad en el campo gracias a la asistencia técnica dada a los agricultores, prevista en el contrato del Sello; la institucionalización de cooperativas, lo que aumentó la participación de agricultores familiares y su acceso a recursos de otros programas sociales y rurales. No obstante, de acuerdo con los distintos planteamientos teóricos abordados a lo largo de la Tesis, para buscar una mejora en la participación de los pequeños productores en una cadena de valor (*upgrading*), hay que considerar aspectos horizontales y verticales, con el objetivo de aumentar recompensas y disminuir riesgos. Los estándares y certificaciones, por su diseño y particularidades, podrían coadyuvar a la consecución de estos objetivos.

Los contratos con agricultores, conforme se vio en la Introducción, pueden evitar la exclusión de pequeños productores de las cadenas de valores (Warning y Key, 2002). Este es un aspecto primordial que debe ser acompañado de manera más cercana por parte del gobierno, si se pretenden alcanzar los retos sociales del PNPB. Para esto, se necesitaria un trabajo de concienciación de los productores familiares, en relación con los beneficios de participar en el programa y de hacer parte de cooperativas, lo que facilitaría el proceso de inclusión social. Como enfatizado en la introducción, para mejorar la participación de los pequeños productores en la cadena son requeridas acciones de elevados niveles de toma de decisiones, dentro o fuera de la cadena. La acción de nivel local no basta para promover cambios significativos. Intervenir en un punto de acción frecuentemente requiere influencia política, financiera y recursos humanos además de la capacidad de los pequeños productores (Bolwig *et al.*, 2010).

En relación con el sistema de subastas, se puede decir que se mejoró a lo largo de los años (informatización del sistema, disminución de la intervención estatal, fin de la re-subasta, mayor transparencia en la negociación entre industrias y distribuidoras, consideración del factor logístico, mejor oferta y participación para las empresas detentoras del SCS). A pesar de estos avances, todavía se exige a las empresas participantes excesivos trámites burocráticos, por lo que las industrias participantes, que tienen que actualizar comprobantes fiscales cada dos meses para habilitarse como participantes en las subastas, no teniendo muchas veces tiempo hábil para ello, perjudicando su participación. Parte de los objetivos generales del Renova Bio es evaluar e implementar mejoras en el mecanismo de subastas en el corto plazo, no detalladas hasta el momento. En el medio o largo plazo, pretenden sustituir las subastas por instrumentos que induzcan la negociación directa entre productor y distribuidor, lo que puede generar más libertad para el negocio, aunque por otro lado podrían comprometer la transparencia del proceso.

Como consideraciones finales de este estudio, se puede afirmar que la cadena del biodiesel en Brasil a través del programa gubernamental PNPB y del Sello (SCS) intentó contribuir a la interrelación entre sus actores agrarios, industriales y distributivos. En cierto modo, aunque no sustancialmente, lograron aumentar la interdependencia entre estos sectores primarios y secundarios de la economía, aunque se encuentren todavía muchos obstáculos de carácter macro y micro (políticos, económicos y de gestión) a superar. Aspectos como la crisis económica y política que en el año anterior (2016) asolaron al país, afectaron también negativamente al sector del biodiesel, lo que se nota a través de la disminución de producción y venta de este biocombustible, comportamiento contrario al crecimiento experimentado en los años anteriores. La salida de industrias también fue un factor constatado: varias no resistieron al mercado competitivo y se retiraron del sector.

La incertidumbre de un nuevo gobierno, pautado en metas más neoliberales (notablemente más preocupado con los objetivos económicos y ambientales, como evidenció su participación en la COP 21), puede contribuir más a los intereses productivos de las grandes empresas (industrias) que participan de este sector y que tenían su producción limitada a las mezclas de biodiesel que aumentaban gradualmente; y al agronegocio del Centro-Sur, que tiene gran capacidad de producir soja, que sigue siendo la principal materia prima del biodiesel. A pesar del crecimiento de las cooperativas desde 2009, se hace difícil concluir que los agricultores familiares tendrán más incentivo a partir de las políticas gubernamentales actuales. Además ya se observa que el número de participantes ha caído en los últimos años, a pesar de las ventajas fiscales ofrecidas a las industrias a través del Sello.

Es cierto que la producción de biocombustibles, el bioetanol y el biodiesel va a crecer exponencialmente en los próximos años, de conformidad con los planes ya presentados. Desde el punto de vista ambiental, una meta clara de cuanto de la matriz energética brasileña tendrá que venir de los biocombustibles hasta el año de 2030, además de integrar esta meta con la política mundial de sostenibilidad ambiental, reforzada con el acuerdo del Tratado de Paris (tratado internacional para control de las emisiones de gases de efecto invernadero - COP 21).

La diversificación de la materia prima, todavía dominada por la soja, por fin puede ser alcanzada en los próximos años, dadas las posibles inversiones en desarrollo de tecnología para otros cultivos con mayor rendimiento (mayor obtención porcentual de aceite); expansión del uso del sebo bovino y del aceite de cocina previamente utilizado (reciclaje); y finalmente, por la exigencia internacional cada vez mayor por materias primas de segunda generación (que no utilice géneros alimentício para producción de biocombustibles). Hay que considerar, sin embargo, que este cambio se dará de manera muy paulatina, teniendo en cuenta que el cultivo de la soja como materia prima para el biodiesel y de la caña de azucar, materia prima para el bioetanol, ya están firmemente establecidos en el país; ya son muy numerosos los agricultores, desde familiares a *agrobusiness* que se dedican a estos cultivos. Por otro lado, la cuestión alimentaria tan comentada cuando se habla de biocombustibles, no se ha visto afectada en Brasil, debido principalmente a las grandes extensiones territoriales del país, que todavía no explota todo su potencial agrícola.

Resumiendo, el Programa pretende expandir la producción de biocombustibles en el país, con sostenibilidad ambiental, económica y social, compatible con el crecimiento del mercado. Sin embargo, en el ámbito social no se observa la existencia de algún plan concreto por ahora para mejorar la inclusión social, que antes era uno de los principales objetivos del programa del biodiesel. Para el biodiesel, específicamente, se pretende evaluar e implementar mejoras en el mecanismo de subastas en el corto plazo y evaluar la anticipación de los porcentuales de biodiesel (mezclas de biodiesel en el diesel comercial) (MME, 2017).

Como puntos positivos de esta investigación, se puede destacar que fue posible analizar y caracterizar a través de diversos ángulos la cadena de valor del biodiesel brasileño, las relaciones entre sus actores principales (industria y agricultores) y el papel de cada uno, considerando aspectos específicos de sus actuaciones y contribuciones al sector como un todo, además de sus deficiencias y demandas. El marco regulatorio que rige el sector del biodiesel en Brasil también fue estudiado y analizado ampliamente, resaltando sus logros y fallos a lo largo de los años.

Como limitaciones de esta investigación se puede citar la dificultad para relacionar datos de agencias del gobierno, que discrepan o fallan en registrar/actualizar algunos datos necesarios a la investigación, obligando a la búsqueda de otros medios de publicaciones/revistas privadas para obternelos/compilarlos. La gran extensión territorial del país, sus grandes distancias y sus discrepancias regionales también dificultan la investigación, así como los estudios empíricos y la obtención de resultados homogéneos.

5.1 LÍNEAS FUTURAS DE INVESTIGACIÓN

Como posibles **líneas futuras** de investigación se pueden citar:

- Estudio sobre la evolución y participación de las cooperativas, incentivadas más tardíamente a participar de la cadena del biodiesel brasileño. Si bien aquellas ya ejercen un rol importante en la inclusión social, futuros estudios podrían focalizar en el cómo podrían alcanzarla, así como en cuál podría ser su papel en la diversificación de la materia prima empleada para la producción del biodiesel.

- Estudio sobre la compleja logística de distribución del biodiesel brasileño, debido a su extensión territorial y limitada infraestructura de transporte (déficit en ferrovías y sobrecarga de carreteras), así como el papel de las distribuidoras en esta cadena, actores muy poco analizados, pero también esenciales para el funcionamiento del sector.

- Estudio sobre el fomento del desarrollo sostenible (cuestiones ambientales y nuevas tecnologías) tanto en el campo (materia prima de segunda generación) como en las industrias (eficiencia del proceso de producción), que será el nuevo reto del programa de biodiesel brasileño y de qué manera esta política está siendo implementada.

- Estudio sobre los efectos que las dinámicas de esta cadena de valor traen para los trabajadores rurales de la región sur del país (dónde la política del SCS obtuvo mayor éxito) tanto en términos de resultados de bienestar como sobre el nivel de ingresos, seguridad laboral, salud personal y seguridad social. También se podrían estudiar los factores que garantizaron su éxito con la finalidad de formular medidas para la implementación en las regiones más necesitadas del país (Norte y Nordeste) para de esta manera mejorar el reto de la inclusión social.

- Investigar los principales cambios agrarios en las explotaciones agrarias productoras de cultivos energéticos. Así mismo, se podría efectuar algún estudio sobre cómo los cambios en la estructura de la cadena de valor afectan el uso de la tierra, considerando las técnicas agroecológicas (como uso de fitosanitarios o fertilizantes), además de las consecuencias ambientales y económicas.

- Investigar los costes-beneficios del uso de materia prima para biocombustibles de primera y segunda generación y los impactos sobre el sector agroalimentario en los países en desarrollo.

Estas serían algunas de las futuras líneas de investigación para este sector bioenergético que está todavía en crecimiento en el mundo. Es importante destacar que hay otros lugares que también se dedican a esta actividad, incluyendo países no solo desarrollados como Estados Unidos, Alemania u otros países europeos, sino también países en desarrollo como Malasia e Indonesia, siendo interesante y productivo investigar cómo funciona el sector en estos países orientales, además de otros países latinoamericanos como Argentina.

Referencias

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CAPÍTULO VI. ANEXOS

1. Tabla con las categorías utilizadas en los cálculos ACM en SPSS:

Región	Industria	Capacidad	Materia Prima	Producto
3	ADM MT	4	1	2
5	ADM SC	3	1	2
5	Bianchini	4	1	2
3	Binatural	3	3	1
3	Bio Óleo	1	3	1
3	Biocamp	1	3	1
5	Biofuga	1	3	2
3	Biopar MT	3	3	1
5	Bocchi	1	1	2
4	Brejeiro	3	1	2
5	Bsbios/PR	3	3	1
5	Bsbios/RS	4	3	1
3	Bunge	3	1	2
3	Caibiense	1	2	1
3	Caramuru/SS	4	1	2
3	Caramuru/IP	4	2	2
3	Cargill	4	1	2
4	Cesbra	1	2	3
3	Delta	1	3	3
3	Fiagril	4	2	2
3	Granol GO	4	2	2
5	Granol RS	4	1	2
1	Granol TO	3	1	2
4	JBS/Lins	4	3	2
3	Minerva	1	3	2
3	Noble	4	1	3
2	Oleoplan BA	3	2	2
5	Oleoplan RS	4	1	2
5	Olfar	4	1	2
2	PBio BA	4	2	3
2	PBio CE	1	2	3
4	PBio MG	3	2	3
5	Potencial	3	3	1
5	Três Tentos	3	1	2

Elaboración propia

2. Resultados ACM y análisis cluster en el SPSS:

Iteration History

Iteration Number	Variance Accounted For		Loss
	Total	Increase	
1	,105559	,105559	2,894441
2	1,258880	1,153320	1,741120
3	1,618327	,359448	1,381673
4	1,730827	,112500	1,269173
5	1,750846	,020019	1,249154
6	1,754543	,003697	1,245457
7	1,755292	,000749	1,244708
8	1,755451	,000159	1,244549
9	1,755486	,000035	1,244514
10[a]	1,755493	,000008	1,244507

a. The iteration process stopped because the convergence test value was reached.

Model Summary

Dimension	Cronbach's Alpha	Variance Accounted For		
		Total (Eigenvalue)	Inertia	% of Variance
1	,736	1,963	,654	65,447
2	,531	1,548	,516	51,586
Total		3,511	1,170	
Mean	,646[a]	1,755	,585	58,516

a. Mean Cronbach's Alpha is based on the mean Eigenvalue.

- Quantifications:

Tables

Biodiesel nominal capacity

Points: Coordinates

Category	Frequency	Centroid Coordinates	
		Dimension	
		1	2
Small	9	-,928	,644
Medium-sized	11	-,191	-,684
Big	14	,747	,123

Variable Principal Normalization.

Feedstock for biodiesel

Points: Coordinates

Category	Frequency	Centroid Coordinates	
		Dimension	
		1	2
Soybean	14	,911	-,412
Various Oilseeds	9	-,023	1,287
Vegetal&Animal	11	-1,140	-,529

Variable Principal Normalization.

Outputs

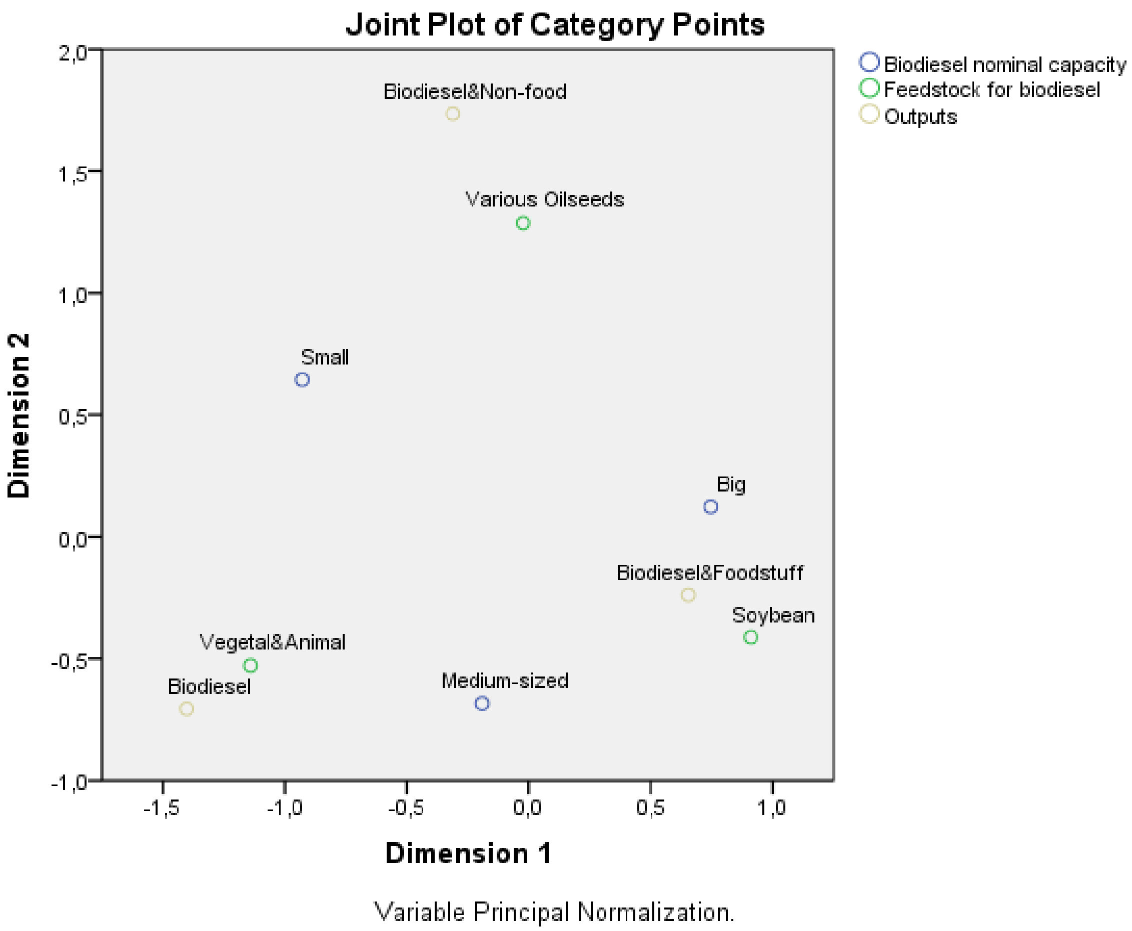
Points: Coordinates

Category	Frequency	Centroid Coordinates	
		Dimension	
		1	2
Biodiesel	8	-1,402	-,705
Biodiesel&Foodstuff	20	,654	-,238
Biodiesel&Non-food	6	-,311	1,735

Variable Principal Normalization.

- Plot:

Category Points



Correlations Transformed Variables

Dimension: 1

	Biodiesel nominal capacity	Feedstock for biodiesel	Outputs
Biodiesel nominal capacity	1,000	,403	,361
Feedstock for biodiesel	,403	1,000	,661
Outputs	,361	,661	1,000
Dimension	1	2	3
Eigenvalue	1,963	,699	,337

- Objects:

Object Scores

Case Number	Dimension	
	1	2
1	1,177	-,341
2	,701	-,862
3	1,177	-,341
4	-1,391	-1,239
5	-1,769	-,381
6	-1,769	-,381
7	-,722	-,079
8	-1,391	-1,239
9	,323	-,004
10	,701	-,862
11	-1,391	-1,239
12	-,916	-,717
13	,701	-,862
14	-1,199	,792
15	1,177	-,341
16	,702	,757
17	1,177	-,341
18	-,643	2,369
19	-1,213	1,196
20	,702	,757
21	,702	,757
22	1,177	-,341
23	,701	-,862
24	,131	-,416
25	-,722	-,079
26	,685	,934
27	,226	,235
28	1,177	-,341
29	1,177	-,341
30	,210	2,032
31	-,643	2,369
32	-,265	1,510
33	-1,391	-1,239
34	,701	-,862

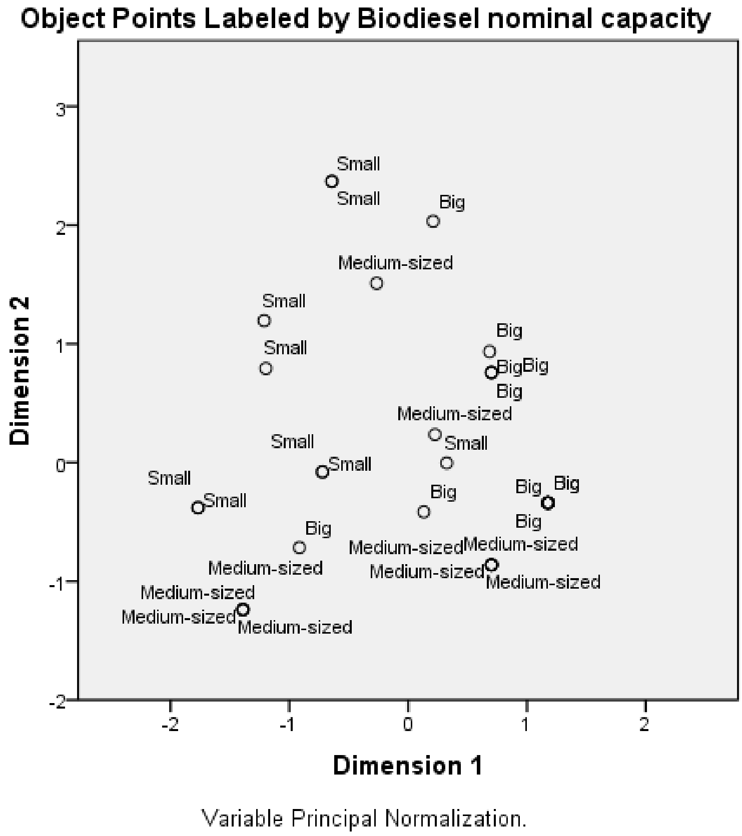
Variable Principal Normalization.

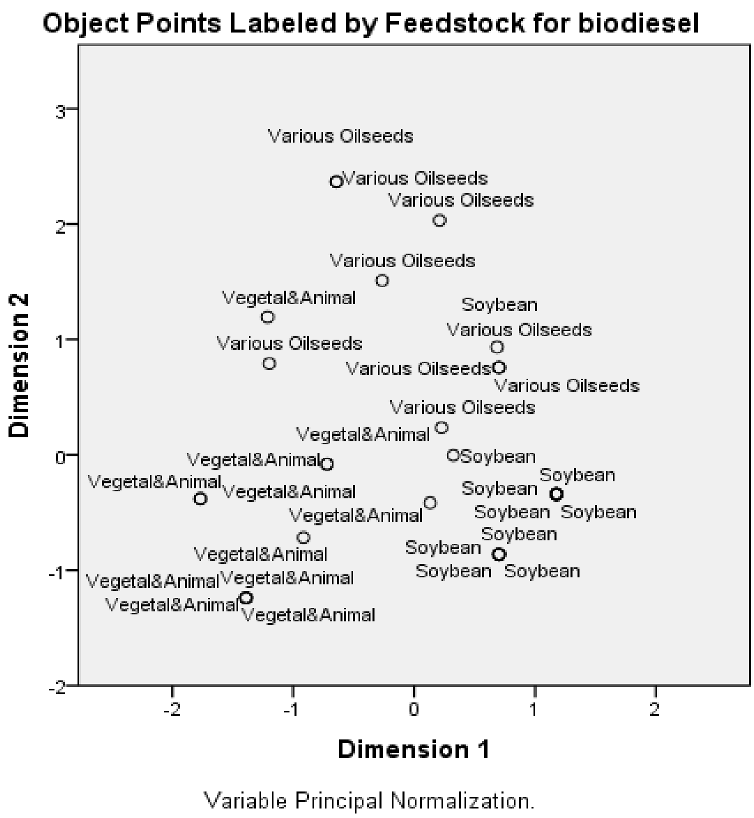
Object Contributions

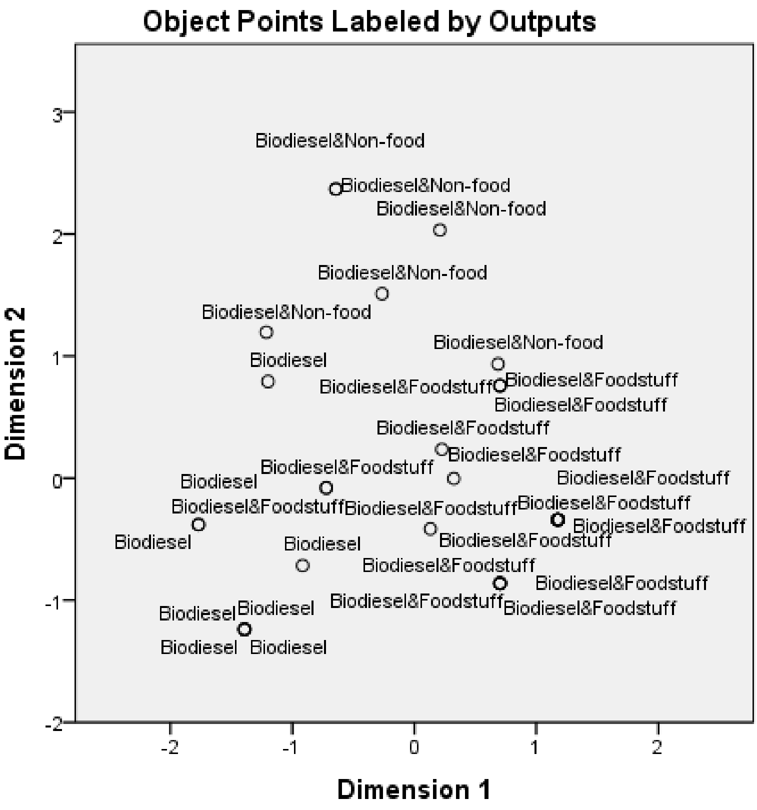
Case Number	Mass	Inertia	Contribution				
			Of Point to Inertia of Dimension		Of Dimension to Inertia of Point		
			1	2	1	2	Total
1	,029	,035	,041	,003	,764	,050	,815
2	,029	,041	,014	,022	,229	,273	,502
3	,029	,035	,041	,003	,764	,050	,815
4	,029	,073	,057	,045	,511	,320	,831
5	,029	,080	,092	,004	,757	,028	,785
6	,029	,080	,092	,004	,757	,028	,785
7	,029	,055	,015	,000	,184	,002	,185
8	,029	,073	,057	,045	,511	,320	,831
9	,029	,048	,003	,000	,042	,000	,042
10	,029	,041	,014	,022	,229	,273	,502
11	,029	,073	,057	,045	,511	,320	,831
12	,029	,066	,025	,015	,243	,118	,361
13	,029	,041	,014	,022	,229	,273	,502
14	,029	,086	,042	,018	,321	,110	,431
15	,029	,035	,041	,003	,764	,050	,815
16	,029	,048	,014	,017	,197	,181	,378
17	,029	,035	,041	,003	,764	,050	,815
18	,029	,100	,012	,165	,079	,849	,929
19	,029	,093	,043	,042	,303	,232	,535
20	,029	,048	,014	,017	,197	,181	,378
21	,029	,048	,014	,017	,197	,181	,378
22	,029	,035	,041	,003	,764	,050	,815
23	,029	,041	,014	,022	,229	,273	,502
24	,029	,041	,001	,005	,008	,063	,071
25	,029	,055	,015	,000	,184	,002	,185
26	,029	,074	,014	,026	,123	,180	,302
27	,029	,055	,002	,002	,018	,015	,033
28	,029	,035	,041	,003	,764	,050	,815
29	,029	,035	,041	,003	,764	,050	,815
30	,029	,087	,001	,121	,010	,720	,730
31	,029	,100	,012	,165	,079	,849	,929
32	,029	,093	,002	,067	,014	,370	,385
33	,029	,073	,057	,045	,511	,320	,831
34	,029	,041	,014	,022	,229	,273	,502
Active Total	1,000	2,000	1,000	1,000			

Variable Principal Normalization.

- Object Points Labeled by:

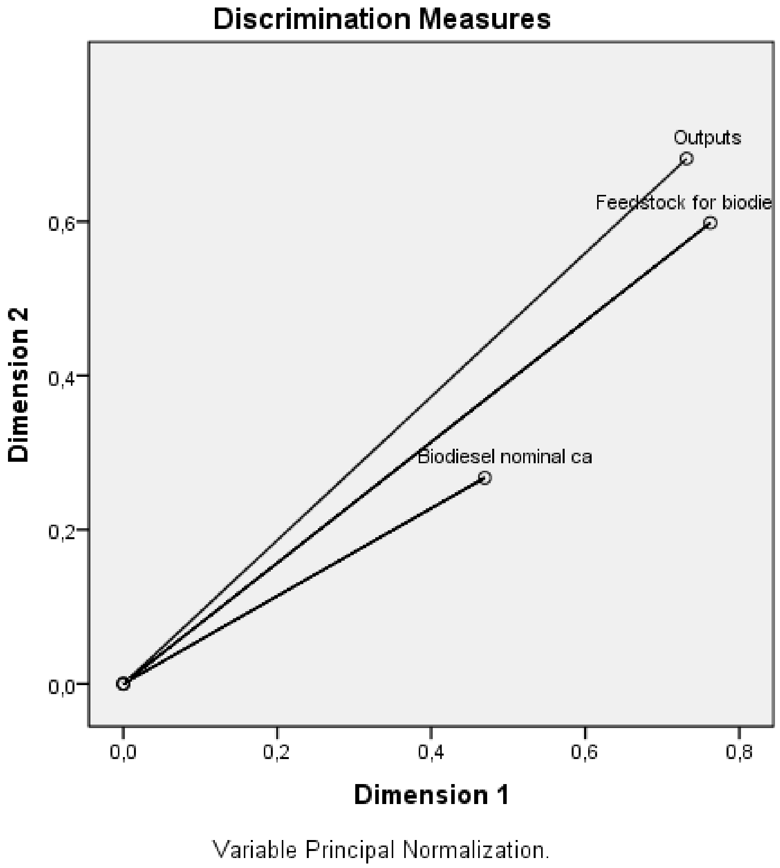






Variable Principal Normalization.

- Discrimination Measures:

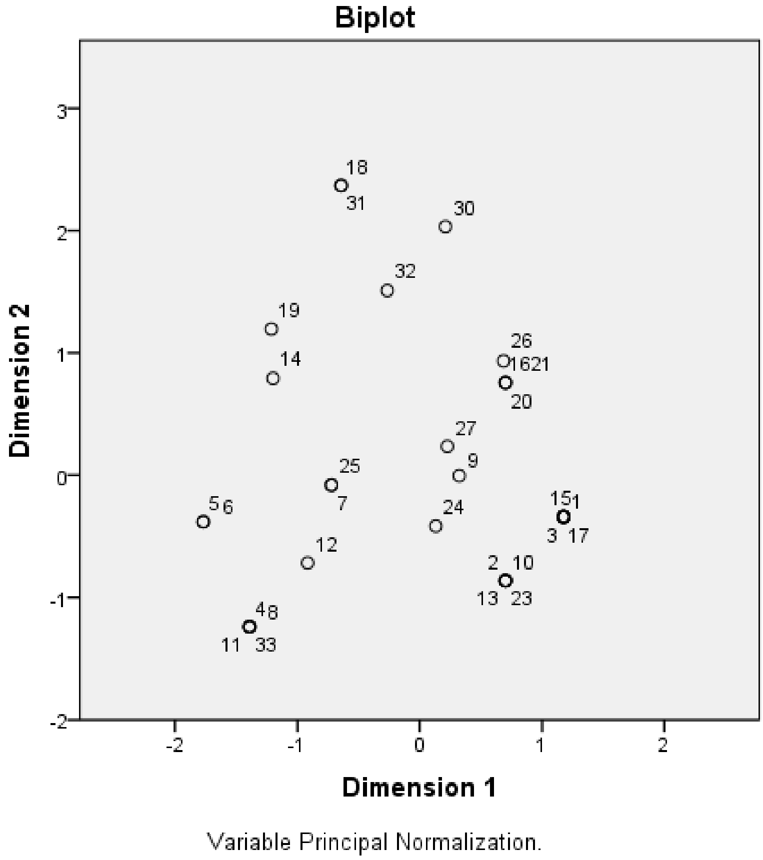


Discrimination Measures

	Dimension		Mean
	1	2	
Biodiesel nominal capacity	,469	,267	,368
Feedstock for biodiesel	,762	,598	,680
Outputs	,732	,682	,707
Active Total	1,963	1,548	1,755
% of Variance	65,447	51,586	58,516

- Biplot Centroids and Objects:

Objects Labeled by



Cluster

Case Processing Summary[a]

Cases					
Valid		Missing		Total	
N	Percent	N	Percent	N	Percent
34	100,0	0	,0	34	100,0

a. Ward Linkage

Proximity Matrix

Case	Squared Euclidean Distance																		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1	0.000	.498	0.000	7.401	8.679	8.679	3.672	7.401	.841	.498	7.401	4.520	.498	6.926	0.000	1.431	0.000	10.649	8.069
2	.498	0.000	.498	4.520	6.335	6.335	2.638	4.520	.879	0.000	4.520	2.637	0.000	6.349	.498	2.624	.498	12.246	7.899
3	0.000	.498	0.000	7.401	8.679	8.679	3.672	7.401	.841	.498	7.401	4.520	.498	6.926	0.000	1.431	0.000	10.649	8.069
4	7.401	4.520	7.401	0.000	.879	.879	1.793	0.000	4.465	4.520	0.000	.498	4.520	4.163	7.401	8.365	7.401	13.575	5.959
5	8.679	6.335	8.679	.879	0.000	0.000	1.188	.879	4.520	6.335	.879	.841	6.335	1.701	8.679	7.399	8.679	8.828	2.795
6	8.679	6.335	8.679	.879	0.000	0.000	1.188	.879	4.520	6.335	.879	.841	6.335	1.701	8.679	7.399	8.679	8.828	2.795
7	3.672	2.638	3.672	1.793	1.188	1.188	0.000	1.793	1.098	2.638	1.793	.444	2.638	.987	3.672	2.726	3.672	5.999	1.867
8	7.401	4.520	7.401	0.000	.879	.879	1.793	0.000	4.465	4.520	0.000	.498	4.520	4.163	7.401	8.365	7.401	13.575	5.959
9	.841	.879	.841	4.465	4.520	4.520	1.098	4.465	0.000	.879	4.465	2.044	.879	2.952	.841	.723	.841	6.564	3.800
10	.498	0.000	.498	4.520	6.335	6.335	2.638	4.520	.879	0.000	4.520	2.637	0.000	6.349	.498	2.624	.498	12.246	7.899
11	7.401	4.520	7.401	0.000	.879	.879	1.793	0.000	4.465	4.520	0.000	.498	4.520	4.163	7.401	8.365	7.401	13.575	5.959
12	4.520	2.637	4.520	.498	.841	.841	.444	.498	2.044	2.637	.498	0.000	2.637	2.358	4.520	4.790	4.520	9.597	3.747
13	.498	0.000	.498	4.520	6.335	6.335	2.638	4.520	.879	0.000	4.520	2.637	0.000	6.349	.498	2.624	.498	12.246	7.899
14	6.926	6.349	6.926	4.163	1.701	1.701	.987	4.163	2.952	6.349	4.163	2.358	6.349	0.000	6.926	3.613	6.926	2.795	.163
15	0.000	.498	0.000	7.401	8.679	8.679	3.672	7.401	.841	.498	7.401	4.520	.498	6.926	0.000	1.431	0.000	10.649	8.069
16	1.431	2.624	1.431	8.365	7.399	7.399	2.726	8.365	.723	2.624	8.365	4.790	2.624	3.613	1.431	0.000	1.431	4.403	3.857
17	0.000	.498	0.000	7.401	8.679	8.679	3.672	7.401	.841	.498	7.401	4.520	.498	6.926	0.000	1.431	0.000	10.649	8.069
18	10.649	12.246	10.649	13.575	8.828	8.828	5.999	13.575	6.564	12.246	13.575	9.597	12.246	2.795	10.649	4.403	10.649	0.000	1.701
19	8.069	7.899	8.069	5.959	2.795	2.795	1.867	5.959	3.800	7.899	5.959	3.747	7.899	.163	8.069	3.857	8.069	1.701	0.000
20	1.431	2.624	1.431	8.365	7.399	7.399	2.726	8.365	.723	2.624	8.365	4.790	2.624	3.613	1.431	0.000	1.431	4.403	3.857
21	1.431	2.624	1.431	8.365	7.399	7.399	2.726	8.365	.723	2.624	8.365	4.790	2.624	3.613	1.431	0.000	1.431	4.403	3.857
22	0.000	.498	0.000	7.401	8.679	8.679	3.672	7.401	.841	.498	7.401	4.520	.498	6.926	0.000	1.431	0.000	10.649	8.069
23	.498	0.000	.498	4.520	6.335	6.335	2.638	4.520	.879	0.000	4.520	2.637	0.000	6.349	.498	2.624	.498	12.246	7.899
24	1.098	.524	1.098	2.996	3.613	3.613	.841	2.996	.206	.524	2.996	1.188	.524	3.229	1.098	1.701	1.098	8.352	4.403
25	3.672	2.638	3.672	1.793	1.188	1.188	0.000	1.793	1.098	2.638	1.793	.444	2.638	.987	3.672	2.726	3.672	5.999	1.867
26	1.867	3.229	1.867	9.037	7.755	7.755	3.008	9.037	1.012	3.229	9.037	5.292	3.229	3.571	1.867	.032	1.867	3.821	3.672
27	1.235	1.431	1.235	4.790	4.361	4.361	.998	4.790	.067	1.431	4.790	2.212	1.431	2.341	1.235	.498	1.235	5.305	2.993
28	0.000	.498	0.000	7.401	8.679	8.679	3.672	7.401	.841	.498	7.401	4.520	.498	6.926	0.000	1.431	0.000	10.649	8.069
29	0.000	.498	0.000	7.401	8.679	8.679	3.672	7.401	.841	.498	7.401	4.520	.498	6.926	0.000	1.431	0.000	10.649	8.069
30	6.564	8.620	6.564	13.267	9.742	9.742	5.328	13.267	4.160	8.620	13.267	8.828	8.620	3.524	6.564	1.867	6.564	.841	2.726
31	10.649	12.246	10.649	13.575	8.828	8.828	5.999	13.575	6.564	12.246	13.575	9.597	12.246	2.795	10.649	4.403	10.649	0.000	1.701
32	5.504	6.564	5.504	8.828	5.840	5.840	2.736	8.828	2.640	6.564	8.828	5.386	6.564	1.389	5.504	1.501	5.504	.879	.998
33	7.401	4.520	7.401	0.000	.879	.879	1.793	0.000	4.465	4.520	0.000	.498	4.520	4.163	7.401	8.365	7.401	13.575	5.959
34	.498	0.000	.498	4.520	6.335	6.335	2.638	4.520	.879	0.000	4.520	2.637	0.000	6.349	.498	2.624	.498	12.246	7.899

Continuación:

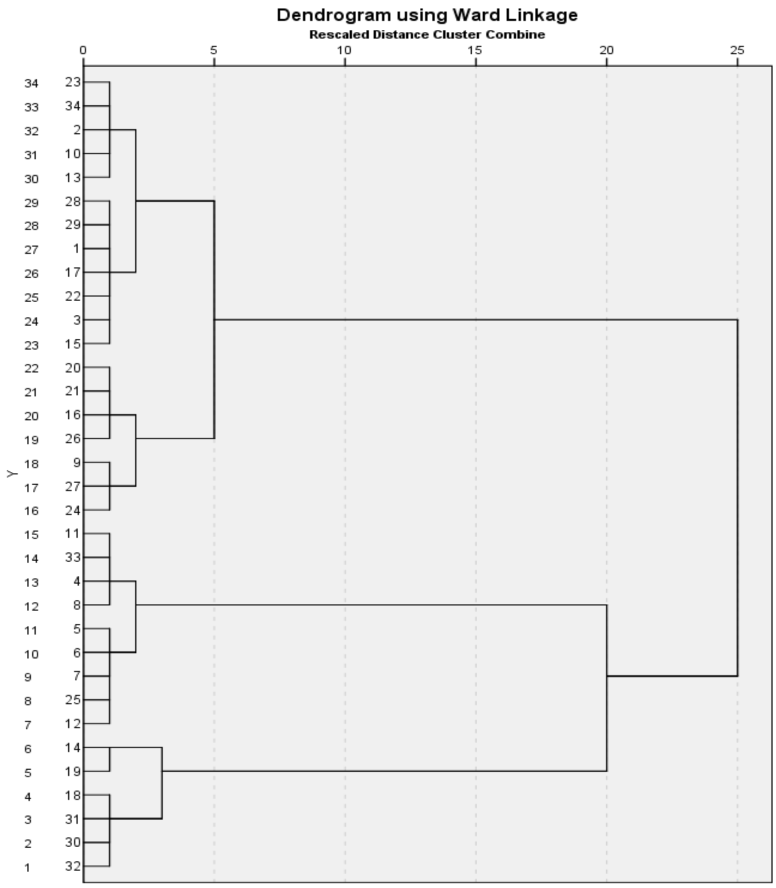
Proximity Matrix

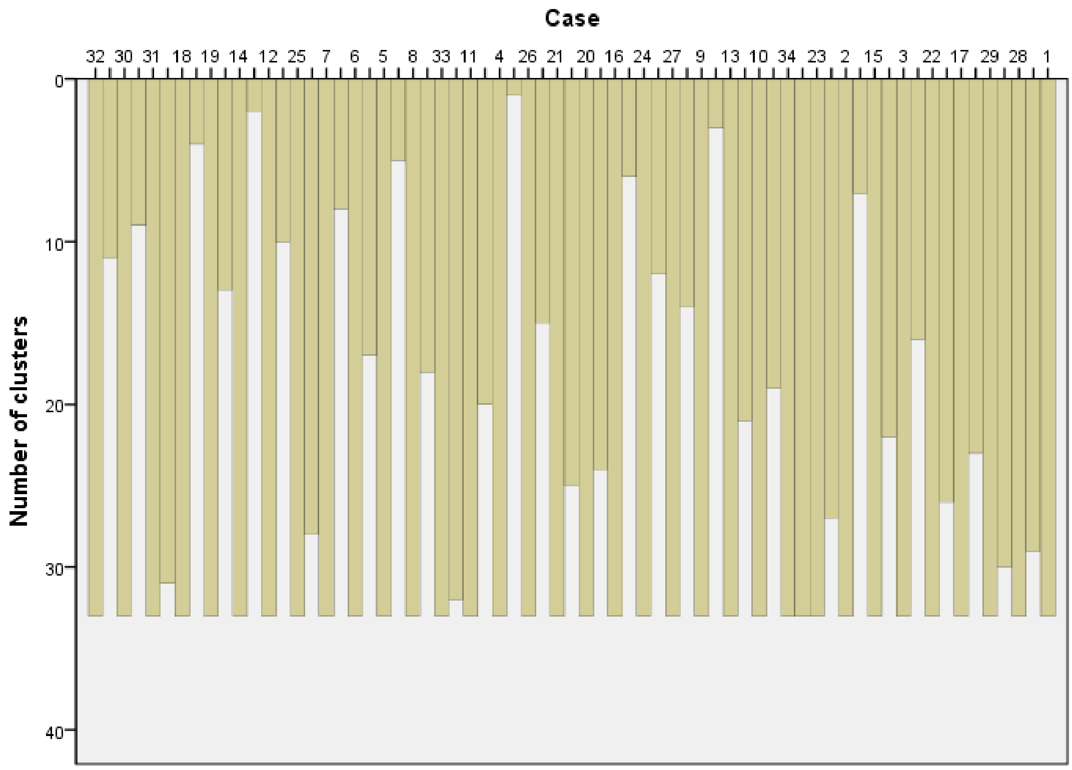
Case		Squared Euclidean Distance													
	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
1	1.431	1.431	0.000	.498	1.098	3.672	1.867	1.235	0.000	0.000	6.564	10.649	5.504	7.401	.498
2	2.624	2.624	.498	0.000	.524	2.638	3.229	1.431	.498	.498	8.620	12.246	6.564	4.520	0.000
3	1.431	1.431	0.000	.498	1.098	3.672	1.867	1.235	0.000	0.000	6.564	10.649	5.504	7.401	.498
4	8.365	8.365	7.401	4.520	2.996	1.793	9.037	4.790	7.401	7.401	13.267	13.575	8.828	0.000	4.520
5	7.399	7.399	8.679	6.335	3.613	1.188	7.755	4.361	8.679	8.679	9.742	8.828	5.840	.879	6.335
6	7.399	7.399	8.679	6.335	3.613	1.188	7.755	4.361	8.679	8.679	9.742	8.828	5.840	.879	6.335
7	2.726	2.726	3.672	2.638	.841	0.000	3.008	.998	3.672	3.672	5.328	5.999	2.736	1.793	2.638
8	8.365	8.365	7.401	4.520	2.996	1.793	9.037	4.790	7.401	7.401	13.267	13.575	8.828	0.000	4.520
9	.723	.723	.841	.879	.206	1.098	1.012	.067	.841	.841	4.160	6.564	2.640	4.465	.879
10	2.624	2.624	.498	0.000	.524	2.638	3.229	1.431	.498	.498	8.620	12.246	6.564	4.520	0.000
11	8.365	8.365	7.401	4.520	2.996	1.793	9.037	4.790	7.401	7.401	13.267	13.575	8.828	0.000	4.520
12	4.790	4.790	4.520	2.637	1.188	.444	5.292	2.212	4.520	4.520	8.828	9.597	5.386	.498	2.637
13	2.624	2.624	.498	0.000	.524	2.638	3.229	1.431	.498	.498	8.620	12.246	6.564	4.520	0.000
14	3.613	3.613	6.926	6.349	3.229	.987	3.571	2.341	6.926	6.926	3.524	2.795	1.389	4.163	6.349
15	1.431	1.431	0.000	.498	1.098	3.672	1.867	1.235	0.000	0.000	6.564	10.649	5.504	7.401	.498
16	0.000	0.000	1.431	2.624	1.701	2.726	.032	.498	1.431	1.431	1.867	4.403	1.501	8.365	2.624
17	1.431	1.431	0.000	.498	1.098	3.672	1.867	1.235	0.000	0.000	6.564	10.649	5.504	7.401	.498
18	4.403	4.403	10.649	12.246	8.352	5.999	3.821	5.305	10.649	10.649	.841	0.000	.879	13.575	12.246
19	3.857	3.857	8.069	7.899	4.403	1.867	3.672	2.993	8.069	8.069	2.726	1.701	.998	5.959	7.899
20	0.000	0.000	1.431	2.624	1.701	2.726	.032	.498	1.431	1.431	1.867	4.403	1.501	8.365	2.624
21	0.000	0.000	1.431	2.624	1.701	2.726	.032	.498	1.431	1.431	1.867	4.403	1.501	8.365	2.624
22	1.431	1.431	0.000	.498	1.098	3.672	1.867	1.235	0.000	0.000	6.564	10.649	5.504	7.401	.498
23	2.624	2.624	.498	0.000	.524	2.638	3.229	1.431	.498	.498	8.620	12.246	6.564	4.520	0.000
24	1.701	1.701	1.098	.524	0.000	.841	2.130	.433	1.098	1.098	5.999	8.352	3.867	2.996	.524
25	2.726	2.726	3.672	2.638	.841	0.000	3.008	.998	3.672	3.672	5.328	5.999	2.736	1.793	2.638
26	.032	.032	1.867	3.229	2.130	3.008	0.000	.700	1.867	1.867	1.431	3.821	1.235	9.037	3.229
27	.498	.498	1.235	1.431	.433	.998	.700	0.000	1.235	1.235	3.229	5.305	1.867	4.790	1.431
28	1.431	1.431	0.000	.498	1.098	3.672	1.867	1.235	0.000	0.000	6.564	10.649	5.504	7.401	.498
29	1.431	1.431	0.000	.498	1.098	3.672	1.867	1.235	0.000	0.000	6.564	10.649	5.504	7.401	.498
30	1.867	1.867	6.564	8.620	5.999	5.328	1.431	3.229	6.564	6.564	0.000	.841	.498	13.267	8.620
31	4.403	4.403	10.649	12.246	8.352	5.999	3.821	5.305	10.649	10.649	.841	0.000	.879	13.575	12.246
32	1.501	1.501	5.504	6.564	3.867	2.736	1.235	1.867	5.504	5.504	.498	.879	0.000	8.828	6.564
33	8.365	8.365	7.401	4.520	2.996	1.793	9.037	4.790	7.401	7.401	13.267	13.575	8.828	0.000	4.520
34	2.624	2.624	.498	0.000	.524	2.638	3.229	1.431	.498	.498	8.620	12.246	6.564	4.520	0.000

- Ward Linkage:

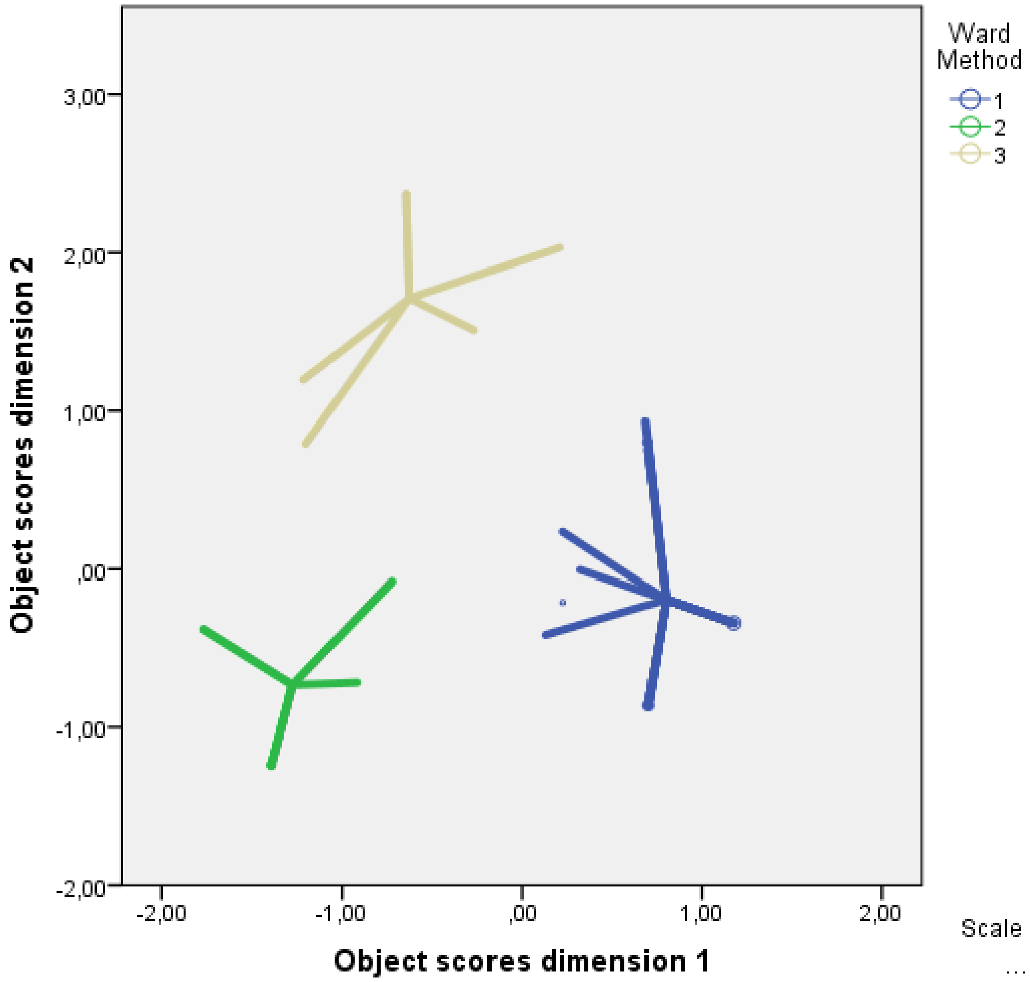
Agglomeration Schedule

Stage	Cluster Combined		Coefficients	Stage Cluster First Appears		Next Stage
	Cluster 1	Cluster 2		Cluster 1	Cluster 2	
1	23	34	,000	0	0	7
2	11	33	,000	0	0	14
3	18	31	,000	0	0	25
4	28	29	,000	0	0	5
5	1	28	,000	0	4	11
6	7	25	,000	0	0	24
7	2	23	,000	0	1	15
8	17	22	,000	0	0	11
9	20	21	,000	0	0	10
10	16	20	,000	0	9	19
11	1	17	,000	5	8	18
12	3	15	,000	0	0	18
13	10	13	,000	0	0	15
14	4	11	,000	0	2	16
15	2	10	,000	7	13	27
16	4	8	,000	14	0	29
17	5	6	,000	0	0	26
18	1	3	,000	11	12	27
19	16	26	,024	10	0	28
20	9	27	,057	0	0	22
21	14	19	,139	0	0	30
22	9	24	,341	20	0	28
23	30	32	,590	0	0	25
24	7	12	,886	6	0	26
25	18	30	1,622	3	23	30
26	5	7	2,790	17	24	29
27	1	2	4,243	18	15	31
28	9	16	5,899	22	19	31
29	4	5	7,845	16	26	32
30	14	18	10,401	21	25	32
31	1	9	15,761	27	28	33
32	4	14	38,776	29	30	33
33	1	4	68,000	31	32	0


Dendrogram using Ward Linkage
Rescaled Distance Cluster Combine
0 5 10 15 20 25
Y
23 34 2 10 13 28 29 1 17 22 3 15 20 21 16 26 9 27 24 11 33 4 8 5 6 7 25 12 14 19 18 31 30 32


Case
32 30 31 18 19 14 12 25 7 6 5 8 33 11 4 26 21 20 16 24 27 9 13 10 34 23 2 15 3 22 17 29 28 1
Number of clusters
0
10
20
30
40

- Graph:


Ward Method
1
2
3
3,00
2,00
1,00
,00
-1,00
-2,00
Object scores dimension 2
-2,00
-1,00
,00
1,00
2,00
Object scores dimension 1
Scale
...

- Custom Tables:

Table 1

		Ward Method		
		1	2	3
		Count	Count	Count
Biodiesel nominal capacity	Small	1	4	4
	Medium-sized	6	4	1
	Big	12	1	1
Feedstock for biodiesel	Soybean	14	0	0
	Various Oilseeds	4	0	5
	Vegetal&Animal	1	9	1
Outputs	Biodiesel	0	7	1
	Biodiesel&Foodstuff	18	2	0
	Biodiesel&Non-food	1	0	5
Region	N	1	0	0
	NE	1	0	2
	CO	8	5	2
	SE	2	0	2
	S	7	4	0

3. *Modelos de entrevistas para agricultores familiares, industria, especialista del sector de biodiesel y cooperativa. Utilizados en la publicación nº 3:*

AGRICULTURA FAMILIAR	Ano de adesão ao programa SCS	Número trabalhadores (familia ou assalariados?) Esse número mudou após o SCS? (quantidade e composição)	Produção por safra? (3 últimas)	Uso máquinas? Citar tipo (Trator, colhedeira). Qtde.
CARACTERISTICAS PROPRIEDADE RURAL				
Tamanho (área) propriedade (unidade) Aumentou o tamanho? Comprou ou arrendou terra? para produzir qual cultivo?	Tipo de solo (%) Argila Silte Areia Outro Uso prévio de corretivo no solo. Tipo **S N**	Há atividades de pecuária; de subsistencia ou para o mercado? hay ganadería, para autoconsumo o para mercado? Isto mudou depois do selo?	Limpeza prévia terreno **S N**	Uso de fertilizantes. Fonte ren./não-renov.
Uso de sementes melhoradas? **S N**	Tipo de cultivo (oleaginosa)	Houve mudanças para uma produçao mais sustentável? Ex.: manuseio da terra, uso de adubo orgánico etc.. **S N**	Outros cultivos/Proporção Anteriores: Atuais:	Estoque produção **S N**
Principais mudanças agrárias nas propiedades (se houver).				
EFEITOS DO SCS PARA PARTICIPANTES				
A industria cumpre contrato estabelecido pelo SCS? Como tem sido a relação com a industria?				
SCS melhorou a produção total e produtividade (eficiencia, produção x tempo)? Por que? Houve ampliaçao da superficie ou aumentaram-se os rendimentos?				
Houve redução de custos? Houve aumento nos proventos do agricultor?				
A mediação de cooperativas melhorou a relação com indústria? De que maneira?				

ASSISTÊNCIA TÉCNICA, TECNOLOGIA E CULTIVO
A assistência técnica gerada pelo programa é eficiente? Funciona regularmente? Quais os serviços prestados?
A assistência atende também a outros cultivos produzidos pela agricultura familiar? Quais?

INDUSTRIA	Ano de adesão ao programa SCS:	Número trabalhadores: Houve mudança desse número após o SCS?	Região de obtenção de matéria-prima:	Tipo de oleaginosa dos produtores fornecedores. (soja, girasol, etc...):
PRODUÇÃO E SUSTENTABILIDADE	Produção Qtde mensal/anual:	Produtividade (prod x tempo):	Houve redução de custos?	Qual a relação Custo x benefício (lucratividade)? **S N** Comentarios se houver.
	Principais etapas do proceso de produção:	Rota metílica ou etílica?	Qual o destino glicerina subproduto?	O custo do projeto social é sustentável?
EFEITOS DO SCS PARA PARTICIPANTES				
Os agricultores e cooperativas cumprem o contrato? Como tem sido essa relação?				
A entrada das cooperativas influenciou no processo, a mediação estreitou relação com agricultores?				
A implementação burocrática é morosa? Quais as etapas principais para a obtenção do selo? Quais as sugestões para melhoras nesta etapa?				
Oferece insumos às cooperativas/agricultores? Que tipos?				
Como é a participação nos leilões da ANP? Quais as restrições? Tem sido vantajoso? Quais as sugestões				

para melhoras nesta etapa?
Como funciona a redução de taxas? É rentável para a empresa tendo em conta o tipo de materia-prima do agricultor familiar e a região obtida?
Como é a logística de acessibilidade à áreas produtivas rurais e logística de distribuição?
O que produzia antes?
Quais as perspectivas futuras quanto ao SCS?
ESPECIALISTAS
1- Existe a possibilidade de diversificar cultivo de oleaginosa para produção de biodiesel na região sudeste? Qual(is) cultivo(s) seria(m) adequado(s)?
2-Quais os efeitos da certificação para participantes da cadeia del biodiesel (agricultores familiares e indústrias)?
3-Qual a avaliação de 10 anos de SCS?
4-Quais as perspectivas futuras quanto ao SCS?
5-Quais as sugestões de mudanças ou adaptações à política do SCS e PNPB?
6-Perspectivas quanto ao aumento da inclusão social do agricultor familiar nesta cadeia.
7-Perspectivas do mercado biodiesel nacional para os próximos anos.
8-Considerações sobre: a)Sistema de Leilões da ANP. b)Logística de Produção (questão das plantas esmagadoras) e Logística de Distribuição. c)Sistema de incentivos fiscais. d)Papel das cooperativas.

Houve melhora na logística de produção? (caminhões, tratores, estradas, etc)?		
Houve alguma melhora tecnológica? Qual(is)?		
Quais as principais dificuldades desse cultivo energético? Houve diminuiçao de outras culturas para dar lugar a oleaginosa?		
Houve eventos climáticos adversos? Quais?		
COOPERATIVA	Ano de adesão ao programa SCS	Quantos membros?
Quais as funções desempenhadas atualmente no SCS em relação aos agricultores?		
Houve investimento em equipamentos e facilidades? Houve investimento em profissionalização dos funcionarios? Houve outras melhoras trazidas com SCS? Quais?		
Existe a possibilidade de diversificar o cultivo oleaginosa para produção de biodiesel? Qual(is) outra(s) oleagionosa(s) poderia(m) ser cultivada(s) na região?		
Existe incerteza quanto à dependência do SCS? Quais as perspectivas futuras quanto ao SCS?		
Se dedica(va) a outras atividades agrícolas? Quais?		
Qual a localização das plantas esmagadoras grãos (usinas)?		
Quais são os principais problemas encontrados em relação aos agricultores?		
Quais são os principais problemas encontrados em relação às industrias?		

4. *Imágenes del trabajo de campo. Hacienda Bela Vista do Chibarro e Industria Brejeiro:*

- Imágenes trabajo de campo. Hacienda Bela Vista do Chibarro. Estado de São Paulo:






- Imágenes trabajo de campo. Hacienda Bela Vista do Chibarro:





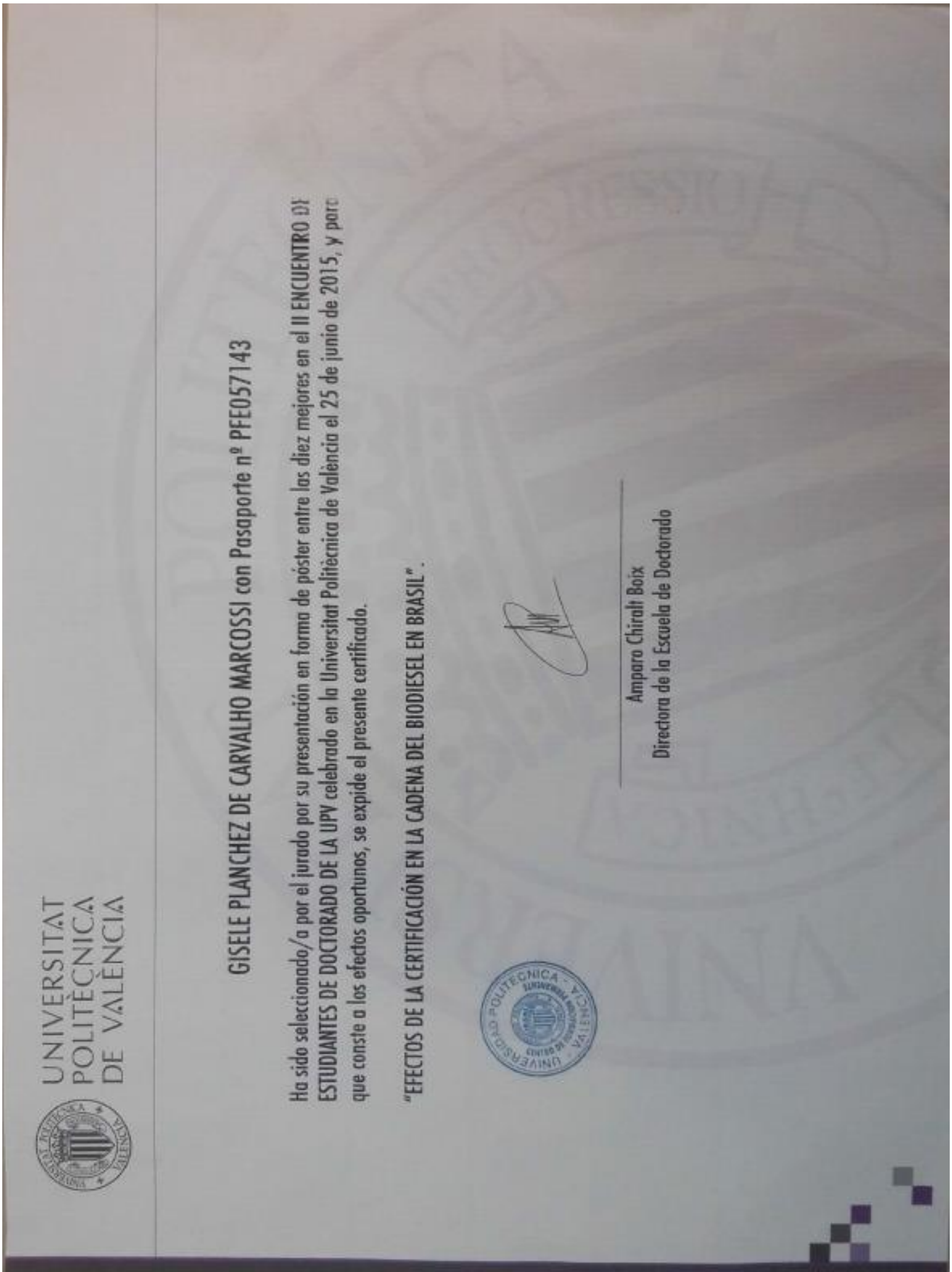


- Imágenes trabajo de campo. Hacienda Bela Vista do Chibarro:

- Imágenes trabajo de campo. Instalaciones Industria Brejeiro:

5. Participaciones en eventos (certificados y fotos):

- Póster seleccionado por el jurado entre los 10 mejores en el II Encuentro de Estudiantes de Doctorado de la UPV, 2015:



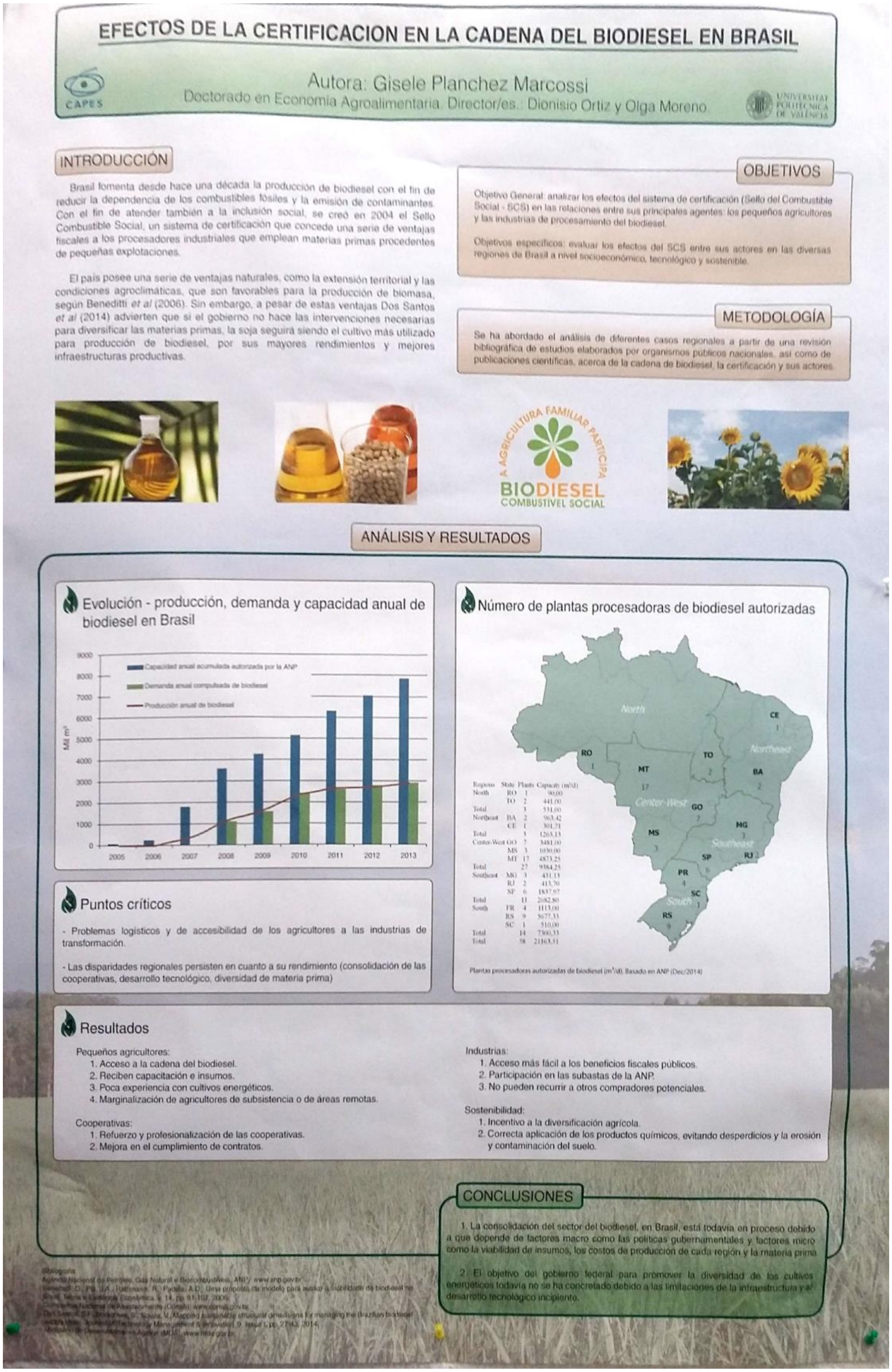
UNIVERSITAT POLITÈCNICA DE VALÈNCIA

GISELE PLANCHEZ DE CARVALHO MARCOSSI con Pasaporte nº PFE057143

Ha sido seleccionado/a por el jurado por su presentación en forma de póster entre las diez mejores en el II ENCUENTRO DE ESTUDIANTES DE DOCTORADO DE LA UPV celebrado en la Universitat Politècnica de València el 25 de junio de 2015, y para que conste a los efectos oportunos, se expide el presente certificado.

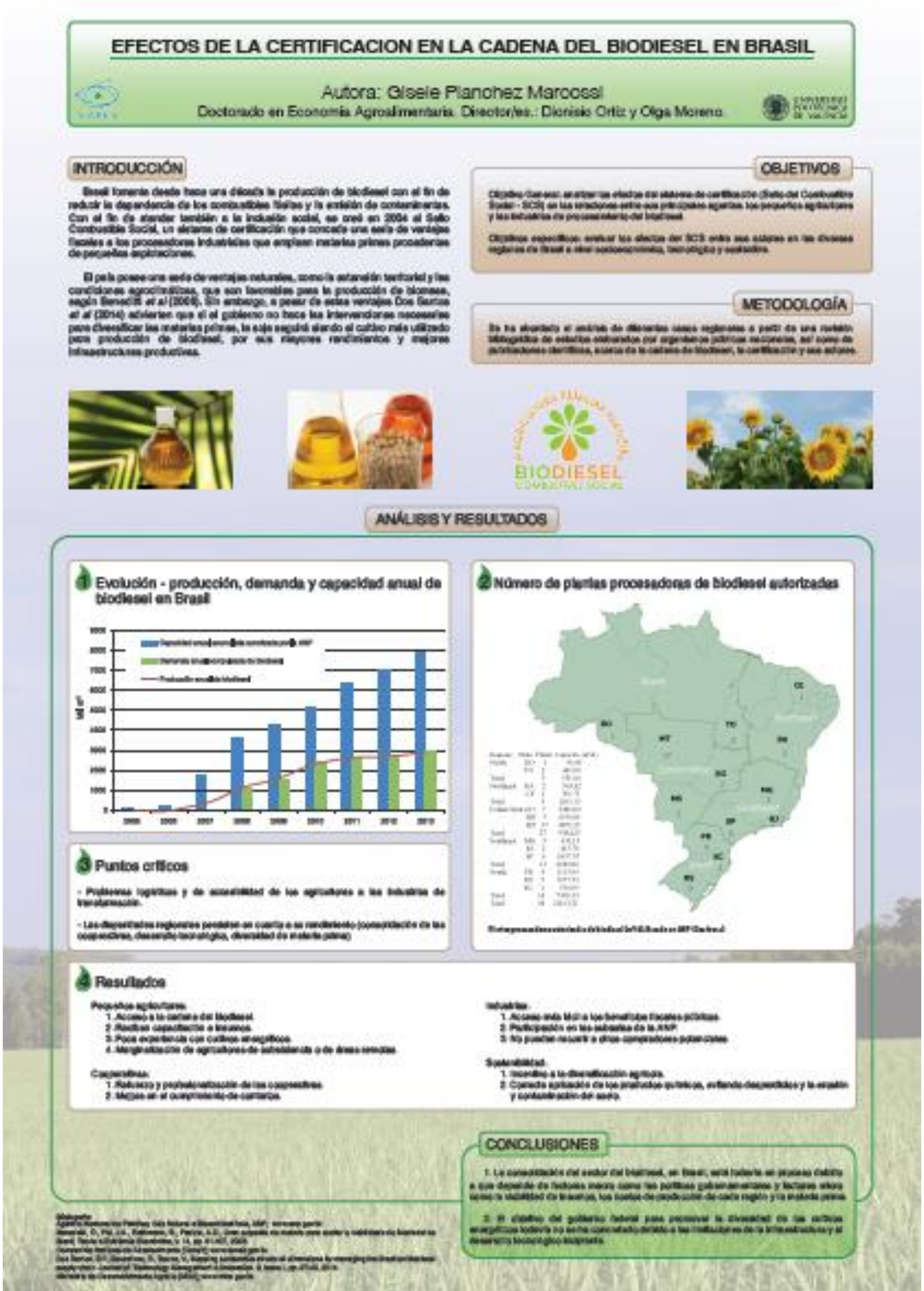
"EFECTOS DE LA CERTIFICACIÓN EN LA CADENA DEL BIODIESEL EN BRASIL".

Amparo Chiralt Boix
Directora de la Escuela de Doctorado



Poster presentado en el II Encuentro de Estudiantes de Doctorado, 2015.

- Versión pdf del póster:



- Certificado: Presentación oral seleccionada por la escuela de doctorado para presentación en el III Encuentro de Estudiantes de Doctorado de la UPV, 2016:

UNIVERSITAT POLITÈCNICA DE VALÈNCIA

CERTIFICAT D' ASSISTÈNCIA
CERTIFICADO DE ASISTENCIA

La Universitat Politècnica de València certifica que

GISELE PLANCHEZ DE CARVALHO MARCOSSI

amb passaport número FE057143, ha participat en l'esdeveniment **II Trobada d'Estudiants de Doctorat**, realitzat el dia 30/06/16, perquè conste i als efectes oportuns, expedeix aquest certificat.

El participant ha presentat comunicacions. Títols al dors.

La Universitat Politècnica de València certifica que

GISELE PLANCHEZ DE CARVALHO MARCOSSI

con pasaporte número FE057143, ha participado en el evento **III ENCUENTRO DE ESTUDIANTES DE DOCTORADO DE LA UPV**, realizado el día 30/06/16, y para que conste a los efectos oportunos, se expide el presente certificado.

El participante ha presentado comunicaciones. Títulos al dorso.

València, 6 de juliol de 2016 / Valencia, 6 de julio de 2016

Núm. de registre / Nº de registro: 16/35513

Document signat electrònicament, verificable en **https://sede.upv.es/eVerificador**. Codi Segur de Verificació FCPWNK9YIZZ
Documento firmado electrónicamente, verificable en **https://sede.upv.es/eVerificador**. Código Seguro de Verificación FCPWNK9YIZZ

Títol/s presentats per GISELE PLANCHEZ DE CARVALHO MARCOSSI	Título/s presentados por GISELE PLANCHEZ DE CARVALHO MARCOSSI

PRESENTACIÓN ORAL: ANÁLISIS DEL VÍNCULO ENTRE LA INDUSTRIA DEL BIODIÉSEL Y EL DESARROLLO AGRARIO A TRAVÉS DEL SISTEMA DE CERTIFICACIONES

- Fotos de las presentaciones, respectivamente:

- Fila 1: II Encuentro de Doctorandos 2015.
- Fila 2: Congresso Internacional Ecosud, 2015.
- Fila 3: III Encuentro de Doctorandos 2016.

6. Resultados previos - Excel.

- Tabla industrias del sector de biodiesel en Brasil por regiones:

INDUSTRIA	Município	UF	REGION	Nº participaciones subastas	Capacidad m³ dia	Capacidad Anual
ADM MT	Rondonópolis	MT	CO	37	1.352	486.720
Agrenco	Alto Araguaia	MT	CO	1	660	237.600
Agrosoja	Sorriso	MT	CO	11	80	28.800
Araguassu	Porto Alegre do Norte	MT	CO	12	100	36.000
Barrálcool	Barra do Bugres	MT	CO	21	190,46	68.565,6
Binatural	Formosa	GO	CO	36	450	162.000
Bio Óleo	Cuiabá	MT	CO	21	150	54.000
Bio Vida	Varzea Grande	MT	CO	2	18	6.480
Biobras (Renobras)	Dom Aquino	MT	CO	2	20	7.200
Biocamp	Campo Verde	MT	CO	35	300	108.000
Biocar	Dourados	MS	CO	28	30	10.800
Biopar	Nova Marilândia	MT	CO	33	338	121.680
Bunge	Nova Mutum	MT	CO	17	413,79	148.964,4
Caibiense	Rondonópolis	MT	CO	21	100	36.000
Caramuru/Ipameri	Ipameri	GO	CO	28	625	225.000
Caramuru/São YESmão	São YESmão	GO	CO	41	625	225.000
Cargill	Três Lagoas	MS	CO	19	700	252.000
CLV/JBS	Colider	MT	CO	8	100	36.000
Cooperbio	Cuiabá	MT	CO	21	10	165.600
Cooperfeliz	Feliz Natal	MT	CO	8	10	3.600
Delta	Rio Brilhante	MS	CO	25	300	108.000
Fiagril	Lucas do Rio Verde	MT	CO	41	563	202.680
Granol GO	Anápolis	GO	CO	43	1.033	371.880
Grupal	Sorriso	MT	CO	12		43.200
Minerva	Palmeiras de Goiás	GO	CO	22	45	16.200
Noble	Rondonópolis	MT	CO	12	600	216.000
SYESL	Rondonópolis	MT	CO	4	50	18.000
Agropalma	Bélem	PA	N	12		10.800
Amazonbio	Jí Paraná	RO	N	29	90	32.400
Biotins	Paraíso do Tocantins	TO	N	18	81	29.160
Brasil Ecodiesel TO	Porto Nacional	TO	N	17	360	129.600
Granol TO	Porto Nacional	TO	N	18	500	180.000

INDUSTRIA	Município	UF	REGION	Nº participaciones subastas	Capacidad m^3 dia	Capacidad Anual
Nubras/DVH	Tailândia	PA	N	4	35	12.600
Ouro Verde	Rolim de Moura	RO	N	2	17	6.120
Brasil Ecodiesel BA	Iraquara	BA	NE	18	360	129.600
Brasil Ecodiesel CE	Crateús	CE	NE	9	360	129.600
Brasil Ecodiesel MA	São Luís	MA	NE	12	360	129.600
Brasil Ecodiesel PI	Floriano	PI	NE	6	270	97.200
Comanche	YESmões Filho	BA	NE	15	335	120.600
Oleoplan Nordeste	Iraquara	BA	NE	21	360	129.600
PBio BA	Candeias	BA	NE	36	603,42	217.231,2
PBio CE	Quixadá	CE	NE	36	301,71	108.615,6
PBio RN	Guamaré	RN	NE	2	56	20.160
ADM SC	Joaçaba	SC	S	14	510	183.600
Bianchini	Canoas	RS	S	18	900	324.000
Biofuga	Camargo	RS	S	15	300	108.000
Biopar PR	Rolândia	PR	S	20	120	43.200
Bocchi	Muitos Capões	RS	S	11	300	108.000
Bsbios/Marialva	Marialva	PR	S	28	580	208.800
Bsbios/Passo Fundo	Passo Fundo	RS	S	38	600	159.800
Camera	Ijuí	RS	S	17	650	234.000
Granol RS	Cachoeira do Sul	RS	S	39	933,33	335.998,8
Oleoplan	Veranópolis	RS	S	41	1.050	378.000
Olfar	Erechim	RS	S	28	600	216.000
Potencial	Lapa	PR	S	16	553	199.080
Três Tentos	Ijuí	RS	S	8	500	180.000
Abdiesel	Araguari	MG	SE	1	6	2.160
B100 (Biominas)	Araxá	MG	SE	5	30	10.800
Bio Petro	Araraquara	SP	SE	2	194,44	69.998,4
Biocapital	Charqueada	SP	SE	29	400	144.000
Bioverde	Taubaté	SP	SE	21	267,44	181.200
Brejeiro	Orlândia	SP	SE	21	367	132.120
Cesbra	Volta Redonda	RJ	SE	27	166,7	60.012
Fertibom	Catanduva	SP	SE	29	333,3	119.988
Grand Valle	Porto Real	RJ	SE	2	-	88.900
Innovatti	Mairinque	SP	SE	3	30	10.800

INDUSTRIA	Município	UF	REGION	Nº participaciones subastas	Capacidad m^3 dia	Capacidad Anual
JBS/Lins	Lins	SP	SE	36	560.23	201.682,8
PBio MG	Montes Claros	MG	SE	34	422.73	152.182,8
Soyminas	Cássia	MG	SE	1	40	14.400
SPBIO	Sumaré	SP	SE	21	200	72.000

- Tabla industrias – participación en subastas por región:

INDUSTRIA	UF	REGION	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
Agrenco	MT	CO	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Granol GO	GO	CO	-	X	X	-	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Caramuru/São Simão	GO	CO	-	-	-	X	-	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Fiagril	MT	CO	-	-	-	X	-	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Cargill	MS	CO	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Binatural	GO	CO	-	X	-	-	-	X	X	-	-	-	-	X	-	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Biocamp	MT	CO	-	-	-	-	-	X	X	-	-	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-	-	X	X	X	X	X	-	X	X
Bunge	MT	CO	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Cooperbio	MT	CO	-	-	-	-	-	-	-	-	-	-	-	-	-	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-	-	-	-	-	-	-	-	-	-	-
Delta	MS	CO	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	X	X	X	X	X	X	-	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Barrálcool	MT	CO	-	-	-	X	-	-	-	-	X	X	X	-	-	X	X	X	X	X	X	X	-	X	X	X	X	X	X	X	X	X	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Grupal	MT	CO	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	X	X	X	X	X	X	X	X	X	-	-	X	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-
Bionasa	GO	CO	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	X	X	-	X	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Biocar	MS	CO	-	-	-	-	-	-	-	-	-	-	-	-	-	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-	-	-	-
Minerva	GO	CO	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-	X	X	X	X	X	X	X
Agrosoja	MT	CO	-	-	-	X	-	-	-	-	X	X	X	X	-	X	X	X	X	X	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CLV /JBS	MT	CO	-	-	-	-	-	-	-	-	-	-	-	X	X	X	X	X	-	X	X	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Araguassu	MT	CO	-	-	-	-	-	-	-	-	-	-	-	X	X	-	-	X	X	X	X	X	X	X	X	X	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bio Óleo	MT	CO	-	-	-	-	-	-	-	-	-	X	X	X	-	X	X	X	-	-	-	-	-	-	-	-	-	X	X	X	-	-	X	X	X	X	X	-	X	X	X	X	-	-	X	X	X
Cooperfeliz	MT	CO	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	X	X	X	X	-	-	X	X	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Biobras (Renobras)	MT	CO	-	X	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Beira Rio	MT	CO	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BIO VIDA	MT	CO	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-
Caramuru / Ipameri	GO	CO	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Biopar	MT	CO	-	-	-	-	-	-	-	-	-	X	X	X	-	X	-	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-	X	X	X	X	X	X	X	X	X	X	X	X	X
SSIL	MT	CO	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	X	-	X	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ADM MT	MT	CO	-	-	-	-	-	-	-	-	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Noble	MT	CO	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	X	X	X	X	X	-	X	X	X	X	X	X
Caibiense	MT	CO	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	X	X	X	X	X	-	X	X	X	X	X	X	X	-	X	X	-	X	X	-	-	-	X	X	-	X	-	-	-	X
Amazonbio	RO	N	-	-	-	-	-	-	-	-	-	-	-	X	-	X	X	X	X	X	X	X	X	-	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-	-	-
Biotins	TO	N	-	-	-	-	-	-	-	-	X	X	X	X	-	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-
Agropalma	PA	N	X	-	-	-	-	X	X	X	X	X	X	-	X	X	X	X	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nubras/DVH	PA	N	-	-	-	-	-	-	-	-	-	-	-	X	-	X	-	-	X	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ouro Verde	RO	N	-	-	-	-	-	-	-	-	X	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
V/Biodiesel TO	TO	N	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Brasil Ecodiesel TO	TO	N	-	-	-	X	-	X	X	-	-	X	-	X	X	X	X	X	X	X	X	X	X	X	X	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Granol TO	TO	N	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

Continuación:

- Tabla industrias – participación en subastas por región:

PBio BA	BA	NE	-	-	-	-	-	-	-	-	-	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Brasil Ecodiesel CE	CE	NE	-	X	X	X	X	-	-	-	-	X	X	X	-	-	X	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Brasil Ecodiesel PI	PI	NE	X	-	-	-	-	-	-	-	-	-	-	X	X	X	X	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PBio RN	RN	NE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	X	-
Oleoplan Nordeste	BA	NE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Brasil Ecodiesel BA	BA	NE	-	X	X	X	X	X	X	-	X	X	X	-	X	X	X	X	X	-	X	-	X	-	X	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Comanche	BA	NE	-	-	X	-	X	X	X	X	X	X	X	X	X	X	-	-	X	X	X	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PBio CE	CE	NE	-	-	-	-	-	-	-	-	-	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Brasil Ecodiesel MA	MA	NE	-	-	-	X	-	X	X	X	X	X	X	-	X	X	X	X	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Granol RS	RS	S	-	-	-	-	-	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Olfar	RS	S	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
ADM SC	SC	S	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-	-
Bsbios 0 Marialva	PR	S	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Bsbios/Passo Fundo	RS	S	-	-	-	X	-	-	-	-	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Oleoplan	RS	S	-	-	-	X	-	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Biopar PR	PR	S	-	-	-	-	-	-	-	-	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-	X	X	X	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bianchini	RS	S	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Camera	RS	S	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-	-	X	X	X	-	-	-	-	-	-	-
Potencial	PR	S	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Camera/ Rosário do Sul	RS	S	-	-	-	X	-	X	X	X	X	X	X	-	X	X	X	X	X	X	X	X	X	X	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Biofuga	RS	S	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Três Tentos	RS	S	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	X	X	X	X	X	X	X
Bocchi	RS	S	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	X	X	-	X	X	X	-	X	X	X	X	X
PBio MG	MG	SE	-	-	-	-	-	-	-	-	-	-	-	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
JBS / Lins	SP	SE	-	-	-	-	-	-	-	-	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Biocapital	SP	SE	-	X	-	-	-	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-	-	-	-	-	-	-	-	X	X	X	X	X	X	X	X	-	-	-	-
Bioverde	SP	SE	-	-	-	-	-	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Fertibom	SP	SE	-	-	-	-	-	-	-	-	-	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-	-	X	X	X	-	-	-	-	-
Brejeiro	SP	SE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	X	X	-	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Cesbra	RJ	SE	-	-	-	-	-	-	-	-	-	-	-	-	-	X	X	X	X	X	X	X	-	-	-	X	-	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-	X
SP BIO	SP	SE	-	-	-	-	-	-	-	-	-	-	-	-	-	X	X	X	X	X	X	-	-	X	X	X	-	X	X	X	X	X	X	X	X	X	-	-	-	-	-	X	X	X	-	-	-
Ponte Di Ferro / RJ	RJ	SE	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ponte Di Ferro/ SP	SP	SE	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Granol	SP	SE	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Soyminas	MG	SE	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
B0100 (Biominas)	MG	SE	-	-	-	-	-	-	-	-	-	-	-	X	-	X	X	X	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Biosep	MG	SE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	X	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Biominas	MG	SE	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bio Petro	SP	SE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Innovatti	SP	SE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	X	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Grand Valle	RJ	SE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	X	-	-	-	-	-	-	-
Abdiesel	MG	SE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Número industrias			4	8	4	#	4	15	#	11	22	27	26	31	25	38	35	40	36	39	39	40	36	37	39	38	33	39	34	35	34	38	39	35	40	39	36	33	35	39	38	38	37	34	33	32	33

- Tabla producción anual por industrias:

Industrias de Biodiesel	UF	REG	SFS	2015	2014	2013	2012	2011	2010	2009	2008	2007	2006	2005	Total (vol m^3)
Oleoplan Sul	RS	S	X	262.592	261.003	229.188	231.621	219.908	176.143	156.845	57.263	10	-	-	1.604.563
Granol GO	GO	CO	X	275.667	283.853	237.872	209.655	158.353	177.229	107.551	79.02	28	36	-	1.593.200
ADM MT	MT	CO	X	280.276	156.239	88.586	152.13	146.765	231.45	154.102	70.53	-	-	-	1.280.078
Caramuru	GO	CO	X	157.86	141.45	128.071	142.721	135.491	153.867	108.324	72.954	30	-	-	1.070.738
Bsbios	RS	S	X	168.585	110.961	85.245	129.548	109.579	126.57	100.612	42.272	70	-	-	943.372
Granol RS	RS	S	X	107.349	103.306	77.346	99.378	206.317	159.962	106.931	61.392	-	-	-	921.981
Fiagril	MT	CO	X	151.072	126.519	86.53	118.177	118.934	100.451	73.44	51.492	27.5	-	-	854.115
PBio BA	BA	NE	X	114.002	107.907	153.984	155.076	99.844	69.44	38.447	4.598	-	-	-	743.298
Bsbios	PR	S	X	196.417	174.622	138.386	102.898	80.165	42.899	-	-	-	-	-	735.387
JBS - Lins	SP	SE	X	113.178	103.589	102.026	84.514	97.215	115.495	64.927	29.082	-	-	-	710.026
Olfar	RS	S	X	130.895	120.345	106.397	122.981	119.399	50.494	-	-	-	-	-	650.511
Caramuru	GO	CO	X	131.977	121.898	118.853	116.586	91.76	42.252	-	-	-	-	-	623.326
PBio MG	MG	SE	X	98.038	78.213	86.505	81.313	72.278	69.903	34.625	-	-	-	-	520.875
Biocapital	SP	SE	**	1.918	9.257	-	19.526	104.301	121.637	84.13	63.611	-	60	-	464.38
PBio CE	CE	NE	X	85.057	72.931	82.34	59.001	44.56	68.604	42.031	4.449	-	-	-	458.973
Binatural	GO	CO	X	83.743	68.401	78.315	59.183	66.466	66.72	17.015	984	-	1.32	-	442.147
Biocamp	MT	CO	X	41.999	26.927	57.177	65.543	52.06	46.365	28.412	8.362	-	-	-	326.845
Cooperbio	MT	CO	X	-	3.061	65.1	62.372	74.815	75.958	26.184	-	-	-	-	307.49
Camera	RS	S	X	-	-	-	2.792	69.328	62.831	51.599	38.212	80	-	-	304.762
Brasil Ecodiesel TO	TO	N	X	-	-	-	18.403	87.519	68.57	25.727	12.62	90	-	-	302.839
Brasil Ecodiesel BA	BA	NE	X	-	-	-	17.524	19.379	17.959	29.852	25.34	86	20	-	216.054
Bioverde	SP	SE	**	-	-	-	12.765	70.791	45.694	41.526	24.575	-	-	-	195.351
Biopar	MT	CO	X	40.343	49.812	6.833	13.366	16.797	12.529	4.456	846	-	-	-	144.982
Fertibom	SP	SE	X	465	5.714	11.826	12.954	35.946	24.837	28.648	8.424	-	-	-	128.814
Brasil Ecodiesel MA	MA	NE	X	-	-	-	-	595	17.697	31.052	27.08	50	-	-	126.424
Barrálcool	MT	CO	X	-	-	5.694	23.28	17.196	25.084	16.165	14.648	16.629	-	-	118.696
Brasil Ecodiesel CE	CE	NE	NO	-	-	-	-	-	120	7.031	2.218	90.22	1.78	-	101.369
Biopar PR	PR	S	X	-	-	2.29	12.811	22.786	23.953	23.677	6.755	-	-	-	92.272
Cesbra	RJ	SE	X	17.86	15.74	9.021	16.719	1.635	11.022	7.936	-	-	-	-	79.933
SP BIO	SP	SE	X	8.894	2.469	22.674	16.308	2.278	16.752	2.823	-	-	-	-	72.198
Comanche	BA	NE	X	-	-	-	-	4.491	11.496	10.958	21.525	9	-	-	57.47
Grupal	MT	CO	NO	-	-	3.75	21.353	21.896	5.93	-	-	-	-	-	52.929

Industrias de Biodiesel	UF	REG	SFS	2015	2014	2013	2012	2011	2010	2009	2008	2007	2006	2005	Total (vol m³)
Amazonbio	RO	N	NO	3.733	11.06	13.559	9.11	2.302	6.055	4.665	-	-	-	-	50.484
Biotins	TO	N	X	-	-	1.346	13.153	14.637	11.78	4.621	2.618	-	-	-	48.155
Caibiense	MT	CO	X	2.205	4.086	3.475	14.05	11.943	9.823	974	-	-	-	-	46.556
Biocar	MS	CO	X	2.195	6.453	8.926	8.274	6.923	6.206	3.944	-	-	-	-	42.921
Brasil Ecodiesel PI	PI	NE	X	-	-	-	-	-	122	4.073	-	-	-	38	42.195
Agrosoja	MT	CO	X	-	-	-	-	5.005	14.036	10.394	5.214	5	-	-	39.649
CLV - JBS	MT	CO	NO	-	-	-	-	2.92	15.063	16.167	-	-	-	-	34.15
Araguassu	MT	CO	X	-	-	-	2.574	6.416	6.433	2.8	-	-	-	-	18.223
Bio Óleo	MT	CO	X	3.591	2.614	2.701	2.701	-	765	1.633	134	-	-	-	14.139
Agropalma	PA	N	NO	-	-	-	-	-	2.256	3.137	2.765	-	-	5	13.158
B-100 (Biominas)	MG	SE	NO	-	-	-	-	-	2.24	1.946	-	2.651	-	-	6.837
Cooperfeliz	MT	CO	X	-	-	278	1.462	1.473	219	-	-	-	-	-	3.432
Innovatti	SP	SE	NO	-	-	-	162	443	1.878	-	-	-	-	-	2.483
SSIL	MT	CO	NO	-	-	-	-	466	782	-	-	-	-	-	1.248
Beira Rio	MT	CO	NO	-	-	-	-	-	860	-	-	-	-	-	860
Nubras/DVH	PA	N	NO	-	-	-	-	-	414	386	-	-	-	-	800
Abdiesel	MG	SE	NO	-	-	-	-	-	20	-	-	-	-	-	20
	**	PERDIO SCS		3.827.535	3.272.267	2.851.051	2.618.624	2.567.706	2.318.865	1.479.884	740.748	595	170	70	

- Tabla participación anual por industrias:

Industrias de Biodiesel	**Región**	**2015**	**2014**	**2013**	**2012**	**2011**	**2010**	**2009**	**2008**	**2007**	**2006**	**2005**
ADM MT	CO	X	X	X	X	X	X	X	X	-	-	-
Agrenco	CO	-	-	-	-	-	-	-	X	-	-	-
Agrosoja	CO	-	-	-	-	X	X	X	X	X	-	-
Araguassu	CO	-	-	-	X	X	X	X	-	-	-	-
Barrálcool	CO	-	-	X	X	X	X	X	X	X	-	-
Beira Rio	CO	-	-	-	-	-	X	-	-	-	-	-
Binatural	CO	X	X	X	X	X	X	X	X	-	X	-
Bio Óleo	CO	X	X	X	X	-	X	X	X	-	-	-
BIO VIDA	CO	X	-	X	-	-	-	-	-	-	-	-
Biobras (Renobras)	CO	-	-	-	-	-	-	-	X	-	X	-
Biocamp	CO	X	X	X	X	X	X	X	X	-	-	-
Biocar	CO	X	X	X	X	X	X	X	-	-	-	-
Bionasa	CO	-	-	-	X	X	-	-	-	-	-	-
Biopar	CO	X	X	X	X	X	X	X	X	-	-	-

Industrias de Biodiesel	**Región**	**2015**	**2014**	**2013**	**2012**	**2011**	**2010**	**2009**	**2008**	**2007**	**2006**	**2005**
Bunge	CO	X	X	X	-	-	-	-	-	-	-	-
Caibiense	CO	X	X	X	X	X	X	X	-	-	-	-
Caramuru - Ipameri	CO	X	X	X	X	X	X	-	-	-	-	-
Caramuru - São Simão	CO	X	X	X	X	X	X	X	X	X	-	-
Cargill	CO	X	X	X	X	-	-	-	-	-	-	-
CLV - JBS	CO	-	-	-	-	X	X	X	-	-	-	-
Cooperbio	CO	-	X	X	X	X	X	X	-	-	-	-
Cooperfeliz	CO	-	-	X	X	X	X	-	-	-	-	-
Delta	CO	X	X	X	X	X	-	-	-	-	-	-
Fiagril	CO	X	X	X	X	X	X	X	X	X	-	-
Granol GO	CO	X	X	X	X	X	X	X	X	X	X	-
Grupal	CO	-	-	X	X	X	X	-	-	-	-	-
Minerva	CO	X	X	X	X	X	-	-	-	-	-	-
Noble	CO	X	X	X	-	-	-	-	-	-	-	-
SSIL	CO	-	-	-	-	X	X	-	-	-	-	-
Agropalma	N	-	-	-	-	-	X	X	X	-	-	X
Amazonbio	N	X	X	X	X	X	X	X	-	-	-	-
Biotins	N	-	-	X	X	X	X	X	X	-	-	-
Brasil Ecodiesel TO	N	-	-	-	X	X	X	X	X	X	-	-
Granol TO	N	X	X	X	-	-	-	-	-	-	-	-
Nubras/DVH	N	-	-	-	-	-	X	X	-	-	-	-
Ouro Verde	N	-	-	-	-	-	-	X	X	-	-	-
V-Biodiesel TO	N	-	-	-	X	-	-	-	-	-	-	-
Brasil Ecodiesel BA	NE	-	-	-	X	X	X	X	X	X	X	-
Brasil Ecodiesel CE	NE	-	-	-	-	-	X	X	X	X	X	-
Brasil Ecodiesel MA	NE	-	-	-	-	X	X	X	X	X	-	-
Brasil Ecodiesel PI	NE	-	-	-	-	-	X	X	-	-	-	X
Comanche	NE	-	-	-	-	X	X	X	X	X	-	-
Oleoplan Nordeste	NE	X	X	X	X	-	-	-	-	-	-	-
PBio BA	NE	X	X	X	X	X	X	X	X	-	-	-
PBio CE	NE	X	X	X	X	X	X	X	X	-	-	-
PBio RN	NE	X	-	-	-	-	-	-	-	-	-	-
ADM SC	S	X	X	X	-	-	-	-	-	-	-	-
Bianchini	S	X	X	X	-	-	-	-	-	-	-	-
Biofuga	S	X	X	X	-	-	-	-	-	-	-	-
Biopar PR	S	-	-	X	X	X	X	X	X	-	-	-
Bochi	S	X	X	X	-	-	-	-	-	-	-	-

Industrias de Biodiesel	Región	2015	2014	2013	2012	2011	2010	2009	2008	2007	2006	2005
Bsbios - Marialva	S	X	X	X	X	X	X	-	-	-	-	-
Bsbios - Passo Fundo	S	X	X	X	X	X	X	X	X	X	-	-
Camera	S	-	X	X	X	X	-	-	-	-	-	-
Camera - Rosário do Sul	S	-	-	-	X	X	X	X	X	X	-	-
Granol RS	S	X	X	X	X	X	X	X	X	-	-	-
Oleoplan	S	X	X	X	X	X	X	X	X	X	-	-
Olfar	S	X	X	X	X	X	X	-	-	-	-	-
Potencial	S	X	X	X	-	-	-	-	-	-	-	-
Três Tentos	S	X	X	-	-	-	-	-	-	-	-	-
Abdiesel	SE	-	-	-	-	-	X	-	-	-	-	-
B-100 (Biominas)	SE	-	-	-	-	-	X	X	-	X	-	-
Bio Petro	SE	-	-	-	-	X	-	-	-	-	-	-
Biocapital	SE	X	X	-	X	X	X	X	X	-	X	-
Biosep	SE	-	-	-	-	X	-	-	-	-	-	-
Bioverde	SE	-	-	-	X	X	X	X	X	-	-	-
Brejeiro	SE	X	X	X	X	X	-	-	-	-	-	-
Cesbra	SE	X	X	X	X	X	X	X	-	-	-	-
Fertibom	SE	X	X	X	X	X	X	X	X	-	-	-
Grand Valle	SE	-	X	-	-	-	-	-	-	-	-	-
Granol	SE	-	-	-	-	-	-	-	-	-	-	X
Innovatti	SE	-	-	-	X	X	X	-	-	-	-	-
JBS - Lins	SE	X	X	X	X	X	X	X	X	-	-	-
PBio MG	SE	X	X	X	X	X	X	X	-	-	-	-
Ponte Di Ferro - RJ	SE	-	-	-	-	-	-	-	-	-	X	X
Ponte Di Ferro - SP	SE	-	-	-	-	-	-	-	-	-	X	X
Soyminas	SE	-	-	-	-	-	-	-	-	-	-	X
SP BIO	SE	X	X	X	X	X	X	X	-	-	-	-