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Inclusion in sugarcane ethanol expansion:

Perceptions of local stakeholders in the Brazilian context

Dissertation

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by

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Front & Back: The cover is a painting of the Brazilian plastic artist Ricardo Ramos who uses the theme of perspectives in his art. In this oil on canvas painted in 2013, the artist put together to different scenes of Matisse reflecting some concepts addressed in this thesis as inclusion, different perspectives, new ways of understand the context and joint action. Ricardo Ramos, Sobrevoo, Matisse 2013, 80 x 80 cm. Photo: Sergio Vignes

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To my daughter Marília for teaching me new ways to perceive the world every day and for inspiring me to go further in building a better world.

Contents

Summary

The global search for alternative energies has put Brazil's sugarcane at the centre of the debate about the pros and cons of first-generation bioenergy as a supplier of global needs for cleaner energy. In fact, the already mature and structured sugar cane sector attracted important investments for its expansion. However, this led to global concerns about its social and environmental impact that soon became important planning criteria in the transition strategy to the bioeconomy. After all, the bioeconomy is intended to contribute to social development that is responsible for current and future generations.

However, the debate about the impact of Brazil's sugarcane was based on one hand on highly aggregated data and generalizations on the impacts of different raw materials, and on the other hand, on case studies with limited number of respondents, which conclusions are unable to reflect the whole sector. According to some authors, the low representation of local communities in the process of expansion impaired the otherwise positive impacts, especially for poverty reduction and social development. In order to identify whether the desired inclusion for sustainable development actually took place, we need an in-depth, broad and inclusive analysis of the most impacted actors, which were the communities surrounding the new plants being built. To fill this gap, this research was set-up to understand, value, systematize and incorporate local perceptions regarding the impact of sugar cane expansion areas. For this, literature review and analysis of secondary data are used as methodologies to support the content analysis of the interviews generated in expansion regions of 5 states in the Centre-South of Brazil, the main sugarcane expansion region in the country.

In its first stage, the research used the Responsible Innovation Framework (RRI) to identify which elements would be essential for the "responsible" implementation of biofuels in Brazil and in the world. It was identified that this theoretical framework does not encompass, except indirectly and subjectively, the analysis of the final impacts of innovation. Therefore, RRI does not allow to use the qualification of 'responsible' as an attribute of the innovation under study. In summary, the RRI framework deals with important elements of the innovation process dimension but not with the final results of the innovation in terms of expanding use and access to goods and services (impact dimension). "

The second part of the research focused on how the local stakeholders perceived the impacts generated, which themes were more or were less valued by the local stakeholders and how these outcomes were aligned with the global debate. From this it was concluded that the local population in general has a positive view of the impacts of sugarcane in the region, although there is room for improvement. Some themes turned out to have a different meaning for the local community than for participants in the academic debate (deforestation and air quality for example) which led to the third phase of the research.

In this stage, I sought to understand whether the exclusionary nature of the sector in Brazil (marked by verticalization of access to sugarcane, the concentration of land and income, poor working conditions, and also food security) had changed by the recent model of expansions and how these changes were translated into perceptions of inclusion by local stakeholders. This analysis was based on the content of the interviews.

The results showed that there was a perception of inclusive impacts mainly in terms of the business model (which allows local farmers to capture income from this value chain) and working conditions (which improved not only for direct workers but also for the entire region). In terms of food security, a better food purchasing power (due to better income and jobs) more than offset the rather small reduction in local food production. Only land concentration was not perceived in terms of inclusion, since the predominance of horizontal contracts for access to sugarcane (leasing and partnerships) was unable to prevent investors from other regions of acquiring land to capture value from the sector, which resulted in the concentration of land. Finally, there was also a relationship between the performance of coordination of institutions and the continuity of the positive impacts generated.

The general conclusion points to the importance of inclusion as an essential element in the transition to biobased society. However, such inclusion should not be limited to the "inclusion of impacts" such as those identified in the field interviews, but the transition should also pursue "inclusion in the process" of participation and decision-making processes of society, and this requires support of institutions able to make achievements of short-term economic cycles more perennial and sustainable.

Resumo

A busca global por energias mais limpas colocou a cana-de-açúcar do Brasil no centro do debate sobre prós e contras da bioenergia de primeira geração como supridora das necessidades globais por energias mais limpas. De fato, o já maduro e estruturado setor da cana-de-açúcar recebeu aportes importantes para sua expansão, não sem causar preocupações sociais e ambientais que logo se tornaram importantes critérios de planejamento na transição para a bioeconomia. Afinal, pretende-se uma bioeconomia que contribua para o responsável desenvolvimento social para gerações atuais e futuras.

Porém, o debate sobre estas preocupações baseava-se, por um lado, em dados altamente agregados e generalizações sobre impactos de diferentes matérias primas e, por outro lado, em estudos de caso com baixo número de entrevistados e cujas conclusões não são representativas de todo o setor. Segundo alguns autores, a baixa representação das comunidades locais no processo de expansão obscureceu os impactos positivos gerados, principalmente no tocante a redução da pobreza e desenvolvimento social. Para identificar se a inclusão almejada para o desenvolvimento sustentável realmente ocorreu, é necessária uma análise aprofundada, ampla e inclusiva da visão dos atores mais impactados, que são as comunidades do entorno das novas usinas recentemente construídas. Para suprir essa lacuna, esta pesquisa foi organizada de forma a compreender, valorizar, sistematizar e incorporar as percepções locais sobre o impacto das áreas de expansão da cana-de-açúcar. Para isso a revisão de literatura e análise de dados secundários são usadas como metodologias de suporte à análise de conteúdo das entrevistas geradas em regiões de expansão de 5 estados do Centro-Sul brasileiro, a principal região de expansão do país.

Em sua primeira etapa, a pesquisa utilizou o framework do Responsible Research & Innovation para identificar quais seriam os elementos imprescindíveis à implementação "responsável" dos biocombustíveis no Brasil e no mundo. Identificou-se que esse referencial teórico não engloba, senão indireta e subjetivamente, a análise dos impactos finais da inovação. Portanto, o referencial do RRI não permite utilizar o termo "responsável" como atributo da inovação em estudo. Em resumo, a estrutura teórica do RRI contempla elementos importantes da dimensão processual da inovação, mas não endereça a qualidade dos resultados finais da inovação em termos de expansão do uso e acesso à bens e serviços (dimensão do impacto).

A segunda parte da pesquisa se concentrou em entender como as comunidades locais perceberam os impactos gerados, quais temas foram mais ou menos valorizados por esses stakeholders e como tais resultados estavam ou não alinhados ao debate global. Como conclusão entendeu-se que a população tem em geral uma visão positiva dos impactos da expansão da cana-de-açúcar na região embora haja espaço para melhorias. Alguns temas apresentaram diferentes significados entre o olhar da comunidade local e os participantes do debate acadêmico (desmatamento e qualidade do ar, por exemplo), o que deu origem à terceira fase da pesquisa.

Nessa etapa, buscou-se entender se o caráter excludente do setor no Brasil (marcado por verticalização do acesso a cana-de-açúcar, concentração de terras, más condições de trabalho) havia se modificado diante do novo contexto de expansão e como essas alterações se traduziam em percepção de inclusão pelas partes interessadas locais. Essa análise baseou-se no conteúdo das entrevistas. Os resultados mostraram que houve uma percepção de impactos inclusivos principalmente ao nível do modelo de negócio (que permite aos agricultores locais captar rendimentos desta cadeia de valor) e das condições de trabalho (que melhoraram não só para trabalhadores diretos, mas também para toda a região). Em termos de segurança alimentar, tema relevante para o debate global mas considerado não prioritário entre os locais, o maior poder de compra de alimentos (devido a melhores rendimentos e empregos) mais do que compensou a redução bastante pequena na produção local. Apenas a concentração fundiária não foi percebida em termos de inclusão, uma vez que o predomínio de contratos horizontais de acesso à cana (arrendamento e parceria) não impediu que investidores de outras regiões adquirissem terras para capturar valor do setor, o que resultou na concentração da terra. Por fim percebeu-se também uma relação entre a atuação coordenada de instituições e a perenidade dos impactos positivos gerados.

A conclusão geral aponta para a importância da inclusão como elemento essencial na transição para uma sociedade de base biológica. Porém, tal inclusão não deve ser limitar à "inclusão de impactos" como os identificados nas entrevistas de campo, foco desta pesquisa, mas devem também perseguir a "inclusão nos processos" de participação e de tomada de decisão da sociedade e isso requer apoio de instituições capazes de tornar as conquistas dos ciclos econômicos de curto prazo mais perenes e sustentáveis.

Samenvatting

Door de wereldwijde zoektocht naar schonere energie staat Braziliaanse suikerriet centraal in het debat over de voor- en nadelen van eerste generatie bio-energie. De reeds volwassen en goed gestructureerde suikerrietsector ontving belangrijke investeringen om uit te breiden, maar dit ging gepaard met zorgen over de sociale en ecologische impact. Deze zorgen over impact werden al snel meegenomen in de criteria om de wenselijkheid van de bioeconomie te beoordelen. De bioeconomie is tenslotte bedoeld om op verantwoordelijk wijze de huidige en toekomstige generaties in hun behoeftes te voorzien. Het debat over de impact van de uitbreiding van de teelt van Braziliaanse suikerriet was echter enerzijds gebaseerd op sterk geaggregeerde gegevens en generalisaties over de impact van verschillende grondstoffen, en anderzijds op casestudy's met een laag aantal respondenten waarvan de conclusies niet representatief zijn voor de sector als geheel. Volgens sommige auteurs verzwakte de lage vertegenwoordiging van lokale gemeenschappen bij de uitbreiding van de teelt van suikerriet de positieve effecten die tegelijkertijd werden gegenereerd, vooral met betrekking tot sociale ontwikkeling en armoedebestrijding. Om vast te stellen of de gewenste inclusie voor duurzame ontwikkeling daadwerkelijk plaatsvond of niet, is een diepgaande, brede en inclusieve analyse van de meest getroffen actoren nodig, dat wil zeggen de gemeenschappen rond de nieuwe fabrieken die werden gebouwd. Om deze leemte op te vullen, werd dit onderzoek opgezet om lokale percepties over de al dan niet inclusieve impact van de uitbreiding van suikerriet teelt te begrijpen, waarderen, systematiseren en integreren. Hiervoor werden literatuuronderzoek en analyse van secundaire gegevens gebruikt als methodes ter ondersteuning van de gegevens uit interviews die zijn afgenomen in uitbreidingsregio's van 5 staten in het midden-zuiden van Brazilië, de belangrijkste uitbreidingsregio van het land. In de eerste fase maakte het onderzoek gebruik van het Responsible Innovation Framework-raamwerk (RRI) om te bepalen welke elementen essentieel zouden zijn voor de "verantwoorde" implementatie van biobrandstoffen in Brazilië en in de wereld. Dit theoretische kader bleek echter niet, of slechts indirect en subjectief, de analyse van de uiteindelijke effecten van innovatie te omvatten, en daarom kan de aanduiding 'verantwoordelijk' volgens RRI niet worden toegeschreven aan de implementatie van de innovatie die wordt bestudeerd. Dat wil zeggen: de inclusie die het RRI raamwerk behandelt, is een belangrijk element van het innovatieontwikkelingsproces, maar geen eindresultaat in termen van uitbreiding van gebruik van en toegang tot goederen en diensten.

Het tweede deel van het onderzoek probeerde vervolgens te begrijpen hoe de lokale belanghebbenden de gegenereerde impact ervaarden, welke thema's meer of minder gewaardeerd werden door de lokale cultuur en hoe dit in lijn was met het wereldwijde debat. Concluderend was het duidelijk dat de lokale bevolking over het algemeen een positief beeld heeft van de effecten van suikerriet in de regio, hoewel er ruimte is voor verbetering. Sommige thema's kregen een andere betekenis toebedeeld in de lokale gemeenschap dan in het academische debat (bijvoorbeeld ontbossing, luchtkwaliteit), wat ons naar de derde fase van het onderzoek leidde waar de analyse van de inhoud van de interviews de belangrijkste gebruikte methodologie was. In dit stadium werd onderzocht of het exclusieve karakter van de sector in Brazilië (gekenmerkt door verticalisering van de toegang tot suikerriet, concentratie van land en inkomen, slechte arbeidsomstandigheden en ook voedselzekerheid) was veranderd door de recente uitbreidingen en hoe deze veranderingen werden vertaald in de perceptie van inclusie door lokale belanghebbenden. De resultaten toonden aan dat er een perceptie was van inclusieve effecten, voornamelijk in termen van het bedrijfsmodel (waardoor lokale boeren inkomsten uit deze waardeketen kunnen halen) en arbeidsomstandigheden (die niet alleen verbeterden voor directe werknemers maar ook voor de hele regio). In termen van voedselzekerheid compenseerde een betere toegang tot voedselaankopen (dankzij een beter inkomen en banen) de kleine vermindering van de lokale voedselproductie ruimschoots. Alleen met betrekking tot het onderwerp landconcentratie werd inclusie niet waargenomen, aangezien het overwicht van horizontale contracten voor toegang tot suikerriet (leasing en partnerschappen) andere investeerders, behalve de suikerrietfabrieken, ertoe aanzette land op te kopen. Ten slotte was er ook een verband tussen de coördinatie van instellingen en de continuïteit van de waargenomen positieve effecten van de uitbreiding van suikerrietproductie. De algemene conclusie wijst op het belang van inclusie als essentieel element in de transitie naar een duurzame bioeconomie. Een dergelijke inclusie mag echter niet beperkt blijven tot de ‘inclusie van impacts’, zoals geïdentificeerd in de veldinterviews, de focus van dit onderzoek, maar ze moeten ook inclusie in de participatieve en besluitvormingsprocessen van de samenleving omvatten. Dit kan alleen via instituties die het mogelijk maken om de verworvenheden van economische cycli op de korte termijn te continueren naar de langere termijn.

Chapter 1

1. General Introduction

Chapter 1

1.1 Introduction

The growing debates about climate change and clean energy sources have increased interest in biofuels and biomass as alternative sources of energy. Although biofuels seem like a massive opportunity in terms of economic growth, environmental gains, rural inclusion and development, the appetite for new markets and profits has raised growing concerns about the potential social and environmental exclusionary impacts of such expansion processes. These concerns were generalised around the globe, although some scholars have called attention to the opportunities for rural poverty alleviation in developing countries with biomass sector expansion (Mol, 2007). In Brazil sugarcane ethanol was the main alternative to fossil fuels in the transport sector and it had many years of experience which led to a well-structured biofuel market and good performance in terms of CO2-saving emissions. However, the focus on the social dimension was reinforced as a result of the globally growing concerns and as a consequence of the historic exclusionary character of the sugarcane sector. This led to the question how to analyse such a system when there are so many diverging perspectives present.

1.2 Motivation/justification

In global terms, biofuels raise environmental questions regarding deforestation and biodiversity loss (Acheampong et al., 2017; Luiz A. Martinelli & Filoso, 2008; Schlesinger, 2014), impacts on soil and water quality (Marcatto et al., 2010; Rulli et al., 2016) and limited reduction of CO2 emissions (Mol, 2007). These questions were discussed in parallel to discussions regarding its potential for poverty alleviation (GNESD, 2011). These issues were global concerns and subsequently were discussed in many academic studies, predominantly within the domain of sustainability studies. The social dimension of biofuel was also questioned regarding its potential exclusionary impact on food production, (EASAC, 2012; Mol, 2007; Oxfam, 2007), labour exploitation, usurpation of land rights and expulsion from communities, (R. Bailey, 2008; Ribeiro, 2013; Wilkinson & Herrera, 2010), among other concerns (Eijck & Faaij, 2014a). In particular, the use of agricultural land became an issue when edible crops such as corn, beet, wheat and sugarcane became possible alternatives to energy supply. Concerns arose around the competition for land uses, such as food versus energy crops, thereby leading to the ‘food versus fuel’ debate around the argument that food prices would rise as a result of energy crop planting activities (Schlesinger, 2014). This argument was later rebutted by other scholars (Kline et al., 2017a; Tilman et al., 2009b).

The data which support these analyses around global issues are usually based on highly aggregated statistics which sometimes disregard the differences between various crops and local contexts but nevertheless lead to framing and opinion forming. Only very few peer-reviewed studies were published, documenting the social impact in the local production and processing sites as noted (Hodbod & Tomei, 2013).

Scholars noticed negative impacts in some case studies in Brazil's sugarcane ethanol sector, although some other authors argued that the last expansion cycle of the 2000s brought different impacts, which they argued should be considered as a positive outcome in the overall evaluation of biofuels from sugarcane in the transition to a cleaner energy matrix. The first group, using small sample case studies, highlighted negative aspects such as ecosystem services and biodiversity (Ortolan Fernandes de Oliveira Cervone et al., 2018), displacement of traditional knowledge and economic activities (Novo et al., 2012; Petrini et al., 2017), decreasing quality of life, impacts on water availability, unemployment with the mechanised harvesting (NEVES, 2019) and land-use change (Coutinho et al., 2017). The second group, usually using high-level aggregated data, argued that the last expansion cycle of the 2000s brought positive impacts in terms of inclusion, which they argued should be considered as a positive outcome in the overall evaluation of this source of energy in the transition to a cleaner energy matrix (Bernardo et al., 2019). The positive outcomes—including a high level of formal employment (Caldarelli & Perdigão, 2018), better working conditions (Moraes et al., 2015) and positive impacts for poverty alleviation (Machado et al., 2015)—were argued to be a result of major international scrutiny of sectoral practices and due to the new configuration of the expansion, with new shareholders profiles and new areas of expansion (Bunde, 2017; A. Marques Postal, 2014; Moraes & Zilberman, 2014). The result of this different sector configuration would put sugarcane as one of the best feedstocks for biofuels in terms of sustainability (Bordonal et al., 2018; Caldarelli et al., 2017; Coelho et al., 2006; Moraes et al., 2015; Rosillo-Calle, 2012b).

These two different perceptions about the Brazil context called attention to the importance to including local voices in a representative manner. To our knowledge, no such kind of comprehensive study has been published until now. Several studies (national and international) point to the importance of representative inclusion to close the knowledge gap of information when little information can be collected from databases (Novo et al., 2012; Petrini et al., 2017). Inclusion would help for understanding local specificities which are not captured

by highly aggregated data statistics or where there is no available data (Assato et al., 2011; Gomes et al., 2011; Ortolan Fernandes de Oliveira Cervone et al., 2018; Sparovek et al., 2007; Viana & Perez, 2013) and help to realise a responsible plan for societal well-being.

Given these different perspectives and approaches, a relevant and yet unanswered question to ask is how impacts are perceived by local stakeholders who are usually underrepresented in the global debate. Additionally, we must ask how the new elements of this expansion in Brazil allow us to consider this process as an inclusive one in contrast with the previous cycles, when exclusionary characteristics were predominant. We summarise these questions and concerns in the main research question of this dissertation: 'To what extent was the biofuel expansion in Brazil in the 2000s inclusive from the perspective of local stakeholders, and how can we design inclusive biofuels value chains to improve sustainable development?' To our knowledge, there has been no such kind of comprehensive study on inclusion from a local perspective and knowledge published until now.

1.3 Research questions and approach

It is suggested that the inclusion of multiple voices and perspectives within sustainability assessments are likely to help fill this 'equity void' and deliver more sustainable and equitable outcomes for people affected. (Blaber-Wegg et al., 2015)

The inclusion of local voices was one of the main concerns in this thesis. The fact that the global debate uses highly aggregated data without capturing local specificities, knowledge and perceptions, contexts and data shows a gap in the research agenda that should be addressed. New alternatives to climate change should be analysed not just from the points of view of consumers but also from the most impacted participants in the value chain, that being the production side, especially from those participants situated in developing countries such as Indonesia (palm oil), Brazil (sugarcane ethanol), India (sorghum) and others.

Inclusion of local community perceptions in a credible process of innovation, which can promote both the societal aims of cleaner energy and the social development for all layers of society, was a point of emphasis that drove us towards literature about responsible innovation. In this sense, three main sub-questions were considered using specific methodological approaches.

- RQ1 - What is a responsible process?

How can the Responsible Research and Innovation (RRI) framework be applied in contexts where several new biofuel projects are implemented? To answer that, a literature review focussing on the case studies of other authors was used in order to explore the structural elements of the RRI framework and their impacts on the common understanding of the 'responsible character' of innovation. The conclusions pointed out the importance of participation as a structural element of the framework, confirming our aim of including local voices in the debate.

- RQ2 – What are the local perceptions and main concerns about biofuels expansion impacts?

What is the representative picture of perceptions and concerns of local stakeholders in the sugarcane expansion process in Brazil? To analyse this question in a way that we could also address some methodological limitations of other studies (high level of data aggregation or small sample of case studies), we performed an extensive field research using software such as Fulcrum app[1] to collect data in the fields and SPSS to analyse the quantitative results of the whole sample. Although the data was already studied to analyse the answers' distribution (see appendix A), the research team works on multiple correspondence analysis and clustering procedures that fit categorical data (to be published further). However, we consider it to be out of scope for this particular thesis because it wouldn't add a substantial argument to answering the research questions. Appendix F presents respondents' distribution according to profile categories as the type of stakeholder, state, city, level of income, or education. The conclusions showed disagreement between respondents, mostly related to environmental and social issues, although the arrival of the sugarcane sector was generally viewed in a positive light.

- RQ 3 – How inclusive was the last biofuels expansion cycle in order to counterbalance the negative side-effects of this expansion process? Does this expansion cycle provide elements that positively impacted the search for an inclusive local development?

[1] This software was used to build the questionnaire in an easy way to be used in mobiles during the field research. The quantitative data was gathered and the recording of the interviews (when allowed) was captured. After that, the answers were upload and export to excel and cvs formats to be analysed in the office. www.fulcrumapp.com

From the descriptive quantitative analyses of the whole sample, we opted for a deeper thematic approach by assessing four main themes linked with social inclusion and related to the exclusionary character of previous sugarcane history in Brazil. Business model changes regarding sugarcane access, land concentration, food security and working conditions were considered in this task in order to address the question of whether this new expansion cycle helped lead to a reduction in inequality in the economy and society. How is this value chain sharing its value better than in the past? To what extent should such inclusion be considered an important element when analysing the balance between the negative impacts and benefits of sugarcane expansion? To perform this study, beyond the literature review, we transcribed and analysed the content of 859 answers on these topics using the software Maxqda. Additionally, some secondary data of related indicators were used in order to complement this analysis.

Finally, in the concluding chapter, we recap the two main types of inclusion identified in this research – inclusion as a process for responsible innovation and inclusion as an outcome for innovation (especially the analysed sugarcane expansion cycle in Brazil) and link this distinction with the framework proposed by Ros-Tonen et al., (2019), which discusses the scope of inclusion impacts and the pathways for social development. This concluding chapter contributes to discussing the importance of each kind of inclusion in the social development process and the role of the institutional coordination towards guaranteeing long-term outcomes and robust benefits for all layers of society.

1.4 Theoretical background

A theory serves as an organiser of the facts of real life. In this research, we worked on the basis of real-life experience (empirical knowledge) with the abstract theory that can explain at least part of the events. The analysis of the main research question used input from theories of differing fields of knowledge. This diversity helps in understanding the complexity of such a multi-dimensional theme.

1.4.1 *What is a responsible process? The Responsible Research and Innovation Framework*

Innovation for a better world always comes with lots of good intentions to solve some great global problem or dilemma. Usually, the general aim is complemented with unintended impacts that should be tackled and addressed in an appropriate manner. But how should we

define an ‘appropriate manner’? The RRI framework was used here to help to define what a ‘good innovation’ should be.

Many authors refer to four main pillars as the main elements of a responsible process of innovation (V. Blok et al., 2015; Owen et al., 2012a; Stilgoe et al., 2013). Although RRI has some limitations when used as an assessment tool and the pillars have been adapted and modified over time, the pillars present a good view of the aspirations of the framework. Through the attempt of capturing (or including) participants from the beginning of the process, potential impacts (**anticipation**), reflections on new potential impacts during the process of development (**reflectiveness**), addressing potential negative side- effects (**responsiveness**), and generating commitment and reflections about the innovation, are addressed. In order to ensure the effectiveness of each pillar, it is essential to have a good set of participants (i.e., a diverse group of stakeholders) who could contribute with their values, knowledge, world views and interests (**inclusion**).

However, when this framework is applied in contexts without strong and healthy institutions (Feinberg et al., 2006), the pillar of inclusiveness tends to be severely impacted (Balkema & Pols, 2014; World Bank, 2013). In fact, without an institution that can guarantee the balance of societal representation and the freedom of speech of each stakeholder, as well as give enforcement to group decisions, the inclusivity pillar is weak (de Hoop et al., 2016). With a weak inclusion process at the base of the RRI framework, it is probable that all processes of anticipation can be biased, and most reflection will not have the precious inputs of a diverse range of stakeholders. Additionally, how can one be responsive for a potential impact that doesn’t take in account some groups not initially included in the process? Without institutions which are able to effectively coordinate this RRI process, any conclusions tend to be vague and confusing.

It´s important to not confuse the results of the RRI application process with the responsible character of the innovation itself. Some authors wrongly have used that conclusion to judge the innovation itself instead of the quality of the RRI process in the specific situation, thereby jeopardising the opportunities of improving the implementation phase of the innovation and at same time limiting the benefits of the innovation itself (Balkema & Pols, 2014; de Hoop et al., 2016).

The RRI approach presented the importance of inclusion as a process of effective participation, and that inclusion is critical in order to maintain positive innovation outcomes for the long term. The stronger the commitment among those participants representing their society, (theoretically according to the society's demands), the stronger will be the outcomes of innovation for the long term.

1.4.2 Institutions

The importance of inclusion as effective participation and the understanding of the local context to apply the RRI approach brought us to the second theoretical framework used in the research. The theory of institutions (Ostrom, 2005) added to our work the idea of institutions as a 'must-have' element to coordinate and arbitrate the processes required for good implementation of a responsible innovation approach. We have highlighted here some of the institutional elements that are critical for the development of a responsible innovation as it is defined by the RRI approach:

1) Institutions as a 'crystallisation' of local culture, values, behaviours and rules. In fact, the way of operating, interacting and transacting is different in each country or region, and this is reflected in the structure of local institutions. Thus, one way of analysing the local context in order to define better strategies for applying RRI is to look at those local institutions (Acemoglu & Robinson, 2012; Aoki, 2011; Feinberg et al., 2006; Taebi et al., 2014; Vasen, 2017a).
2) Institutions usually have the legitimacy of knowing the local groups of stakeholders and therefore can better choose who to invite to participate in the discussions. In doing so, the institution should monitor the power balance among the participants, the degree of freedom of speech and the diverse range of interest groups represented.
3) Institutions as a 'local arena' or forum where debate and discussion happen. It is not a 'chat' but a real conversation aimed at achieving common agreement on some points and generating decisions embedded with enforcement, which are the outcomes of such inclusive participation or interaction (Ostrom, 2005; Zapata et al., 2010).
4) Institutions have the legitimacy to arbitrate the conflicts that naturally happen during debates. This arbitration should do be undertaken with the overall aim of improving quality of life for all (Acemoglu & Robinson, 2012; Ostrom, 2005). For this improvement to happen, it is necessary to have credibility among peers.

Without good state institutions to guarantee the requirements of a responsible process of innovation, other frameworks (Sustainable Development Goals, International Finance Corporation standards and others) whose targets rely on the private sector can also guide the process in order to put society´s demands as a central element of the analysis. However, since these standards and frameworks don't have the obligation or enforcement typical of institutions, they depend on high credibility and endorsement from other actors as credible multilateral bodies and international organizations.

These considerations discussed mainly in Chapter 2, led us to wonder: If the expansion process of biofuels is not done following RRI requirements, can it still be considered inclusive and therefore responsible?

The field research was run with the objective of understanding the feelings of local stakeholders, those which were most impacted by the production of sugarcane biofuels and which were not properly considered in global discussions about expansion impacts.

1.4.3 Inclusion

Through this process we arrived at the 'inclusion framework', instigated by the fact that the term 'inclusion' is usually used without a definition and most of the time reflects the pre-conditional contexts and values from the local debate. Thus, when talking about an underdeveloped region where basic needs are not fulfilled for all members of the community, inclusion is usually referred to as the process of getting access to these basic needs, and the 'excluded group' is excluded from getting access to some goods and services. In contrast, when the debate occurs in a more developed region, where most basic needs are accessible or affordable for everyone, then inclusion is more frequently referred to as a process of participation in the decision-making process of that community or society. In these cases, the target groups to be included are usually excluded from the decision-making process, and these groups must fight for the opportunity to establish their interests and world views as elements of the debate.

The Ladder of Inclusion, proposed by Foster & Heeks, (2013), was fundamental in clarifying these phenomena and in understanding the role of each level of inclusion in the process of the development of society. The authors, who were specifically focused on inclusive innovation, defined six types of inclusion that are based on increasing levels of complexity,

encompassing the previous levels and expanding the inclusive effects with each new step. Inclusion of intention is the first level, wherein the basic desire or intention to include an excluded group is enough. The second level is inclusion by consumption, where the excluded group can adopt or consume a good or service in a more affordable way that allows them to be included. The third level is inclusion by impact or outcome, when the outcome of the innovation or action allows for the creation of a positive impact on the livelihoods of the excluded group.

Until this third level, the aspects to be included are usually basic human needs that need to be fulfilled for their survival. From the fourth level onwards, the inclusion refers to more abstract aspects. In this way, inclusion of process occurs when innovation is developed with the participation of insights from representatives of excluded groups. The excluded themselves interfere, giving opinions about the innovation process. However, some of this process can fail in being effective if the structure or institution which coordinates the process is not inclusive itself. Thus, the fifth level of an inclusive innovation aims to coordinate structures which are inclusive themselves. The last and more advanced level is the 'post-structure' inclusion, wherein the innovation is developed into an inclusive structure of knowledge and discourse.

Although the Ladder of Inclusion is designed to address inclusion in innovation matters, it can also be used in a broader sense. The research project in this thesis showed the importance of each step for achieving a more complex and higher level of inclusion and social development. However, while the RRI framework focuses on inclusion as a process of effective participation, the field research interviews gave us pieces of evidence of inclusive impacts that are acknowledged as important outcomes for the local community and theoretically are necessary steps to further achieve higher levels of inclusion of process and structural inclusion in a given society.

In the RRI framework, most of the inclusion mentioned means inclusion as a process, and this was not clearly observed in Brazilian sugarcane expansion areas through the lens of local perception. However, those stakeholders did feel inclusion as an outcome of the process, and they were happy and generally accepting of these results. How to understand this difference between RRI requirements for inclusion in the process (to be considered a responsible innovation) and inclusion as an outcome of the process (as acknowledged by the local community)?

1.4.4 Social and economic development

A sustainable path toward ending extreme poverty and promoting shared prosperity would also involve creating an inclusive society, not only in terms of economic welfare but also in terms of voice and empowerment of all groups. An inclusive society must have institutions, structures and processes that empower local communities, so that the members of that society can hold their governments accountable. Inclusive societies also require the participation of all groups in society, including traditionally marginalised groups, such as ethnic minorities and indigenous populations, in decision-making processes. (WBG, 2014)

The aim of any policymaker and government is to achieve social development for all, and inclusion is a key ingredient in this recipe. As the World Bank (2013) states, inclusion matters. However, what type of inclusion is necessary in order to achieve social and economic development for all and in a sustainable manner? Are the different types of inclusion equally important, or do they have progressive value? What is the role of each kind of inclusion in the pathway towards an inclusive social development? In order to discuss these responses, Ros-Tonen et al. (2019) observed that the term 'inclusion' is used in different contexts and programmes, which differ in terms of scope and impact. We articulate this approach with the theory of inclusion of Richard Heeks et al., (2014) to argue that, in order to reach a developed society, a long-term journey is necessary that begins with access to basic goods and services for all, such as food, education and housing (inclusion of results) and then progresses to more abstract levels of inclusion, where models of effective participation are crucial to ensure that the interests of minority groups are considered in the planning decision process (inclusion in the process) which ultimately leads to inclusive social development.

1.5 Reader's guide

Following this introduction, Chapter 2 deals with a theoretical analysis of the RRI framework and the complementary role of the institutional approach. In this chapter, the importance of inclusiveness is highlighted as one of the key elements of the framework and a defining element of what a responsible process is. After discussing the possible reasons for the failure in the RRI application in contexts without strong institutions and the complementary role of the institutional approach, the chapter finishes by questioning how the expansion of biofuels in Brazil developed within the context of process inclusivity.

In Chapter 3, the results of an extensive field research with 353 local stakeholder interviews are presented in order to understand the most and least critical issues perceived by the community in terms of social, environmental and economic types of impact. Analysing the general results, we conclude that although several improvements can be done, in general the local community is satisfied with the perceived impacts. Some interesting testimonials provide insight about the potential reasons for these general results.

Chapter 4 starts with the general results of the previous chapter to further deepen the analysis on four themes directly related to the historic exclusionary nature of the sugar-energy sector in Brazil. The chapter focuses on understanding what modifications occurred in recent expansion which can explain local perceptions about the sector to radically change direction, and whether this process can be considered inclusive, at least in these aspects. To do so, the methodology adopted (beyond a literature review) was an extensive (around two-thirds of total interviews) content analysis of authorised qualitative interviews.

Finally, in Chapter 5, overall results are discussed in order to understand new elements that were identified during the research project. Based on these new elements, some recommendations for further research are presented.The overall scope of research is presented as in Figure 1:

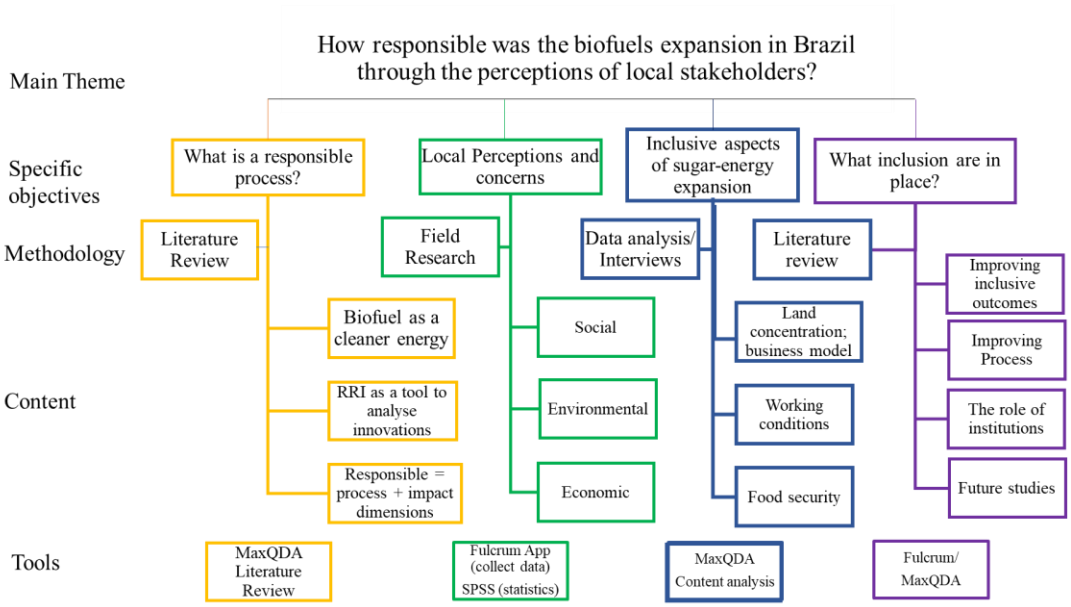

Figure 1 Overall scope of research

1.6 Author contribution

The author has written all the chapters of this dissertation, and Chapters 2, 3 and 4 have been co-authored as indicated in pages 15,41 and 69. The author was responsible for the conception of the research, field work preparations, software survey customisation, transcriptions, content analysis, codification, interpretation of results, descriptive statistical analysis, literature review and the writing of this thesis. All the co-authors worked together in the discussions of results and critical revisions of each manuscript. Table 1 summarizes these contributions.

Table 1 Author's contributions

Chapter	Context/ Situation	Rational behind the Research Question	Theoretical Framework	Methodological Approach	Conclusion
1 Introduction					
2 RRI Beyond Europe	Expansion of sugarcane caused several concerns How to assess those concerns – RRI is one option	Does the use of the RRI framework in contexts with high social inequalities reflect the responsible nature of innovation, or does it reflect the difficulties involved in applying guidelines that were designed to be highly dependent on institutions capable of coordinating the innovation process?	RRI framework (Stilgoe et al., 2013) Institution framework (Acemoglu & Robinson, 2012; Ostrom, 1995)	Literature Critical analyses of case studies and literature	Inclusion = process in RRI RRI = effective participation Importance of institutions to promote inclusive processes
3 General Local Perceptions	Spill over of sugarcane plantations from traditional areas of SP to other states	What are the local stakeholders' perceptions regarding sugarcane expansion?		Field Research Descriptive Statistic	Large sample General positive perceptions Main themes
4 Inclusive aspects of expansion process	Exclusionary character of sugarcane sector in Brazil Different characteristics of the last expansion New elements which potentially imply inclusion	Did this new expansion cycle really impact the inclusion of local society? How is this value chain sharing its value better than in the past? Are these changes perceived by society as generating positive results for community-wide development and not just for an elite with ownership of the sector's assets?	Ladder of Inclusion framework (Foster & Heeks, 2013) Inclusive development (World Bank, 2013)	Literature review Descriptive statistic Content Analysis	Inclusion as outcome Land concentration Food security Working conditions
5 Conclusion			Inclusive development framework (Ros-Tonen et al., 2019)	Literature review	Inclusion driven by private sector Role of strong institutions for a long-term inclusive process.

Chapter 2

2. The role of participation in the Responsible Innovation framework for biofuels projects: Can it be assessed?

This chapter was published as:

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Abstract

The growth in biofuels' investment brings with it concerns about the social and environmental impacts of the sector. Several tools and frameworks have been used to address these concerns, including the Responsible Research and Innovation (RRI) framework. This paper analyses whether this framework can be applied in contexts where local culture and values shape differently the freedom of speech and engagement, such as in developing countries in which biofuel innovation projects are often implemented. A literature review focused on eight case studies of other authors was used to explore the role of "participation" as a structural element of the RRI framework and the impact of its absence where effective participation in the innovation development process is not possible. In conclusion, we highlight how this inspirational normative framework, designed to influence innovation, is misused to judge its impacts. More than that, the conclusions of such misused applications reflect more the difficulties involved in applying guidelines than the responsible character of the innovation, whose impacts are usually defined upfront materially and measurably

Key words: Responsible Research and Innovation – biofuels – effective participation – inclusion – institutions

2.1. Introduction

There is a growing demand for alternative, renewable energies. One of them is biofuels, which are well-suited to the transport sector due to their liquid form and the diversity of raw materials and potential local production sources. However, along with the growth in this sector's investments, concerns have emerged regarding social and environmental impacts, such as land-use changes, food security, and biodiversity loss.

Different frameworks and assessment tools have emerged to analyse these social and environmental impacts, among them, the Responsible Research and Innovation Framework (RRI). The RRI framework was first employed in Europe after the economic crisis of 2008 and introduced the consideration of values and concerns related to innovation. As an inspirational normative framework aimed to influence researchers and innovators through its four pillars, the framework played a relevant role in the development of research and innovation in Europe since it was adopted by important research institutions in The Netherland and UK and is a transversal guiding principle of the "Horizon 2020 Research and Innovation Program" from the European

Union (V. Blok et al., 2015; Vincent Blok & Lemmens, 2015; Carbajo & Cabeza, 2018; Eizagirre et al., 2017; Hahn & Ladikas, 2014; Timmermans, 2017) .

However, biofuel projects are implemented in Europe's technological innovation centres and the US and countries far from the developed countries where the framework was created. As different cultures and values have different ways of interacting and building solutions, we must consider whether the use of the RRI framework truly reflects the responsible nature of innovation itself or whether it reflects the difficulties involved in applying guidelines that were, perhaps unconsciously, embedded with western values. Section 2 presents how the analysis through a literature review focused on case studies (from the biofuel and other sectors). The research about the framework's structural elements was used to complement the analysis and reach more accurate conclusions about the responsible character of innovations.

Section 3 describes the growing importance of biofuels in the transition towards a biobased society and some of this sector's characteristics. Section 4 is dedicated to exploring the origin and aims of the RRI framework to analyse innovation's responsible character. Aspects such as the participatory process and stakeholder engagement are at the core of the framework's recommended activities. However, the inclusiveness dimension encapsulates them and, because of that, demand more attention to the effectiveness of all other dimensions. These reflections highlight the processual meaning of the term "inclusion", as well as the meaning of the term "responsible" and the impact of these characteristics on the application of RRI in contexts where different values and behaviours shape matters of participation and engagement.

In Section 5, we introduce the "institutional approach" as a possible complementary analysis to understand these different contextual elements which shape the participatory process and the application of RRI. Institutions have a dual role: as "action arenas" or deliberative forums where stakeholder discussions take place and acquire deliberative functions and coercion; at the same time, institutions are key elements in understanding the local context, culture, values, and behaviours. Section 6 discusses what happens when such institutions are not in place, illustrating several case studies carried out by other authors. These cases are analysed to understand RRI applicability's limits as an assessment and the institutional analysis's complementary role.

Finally, we describe the research's main conclusions about using RRI in assessments to describe the "responsible" character of innovation and complementary ways to improve the analysis.

2.2. Methodology

We conducted a literature review using the Web of Science and Science Direct. The search terms on topics included "responsible research and innovation," "responsible research and innovation AND biofuel", "responsible research and innovation AND bioeconomy", "responsible research and innovation AND developing countries", "responsible research and innovation AND global South", "responsible research and innovation AND southern countries", and "responsible research and innovation AND South America". An overview of the search procedures is presented in Figure 2.

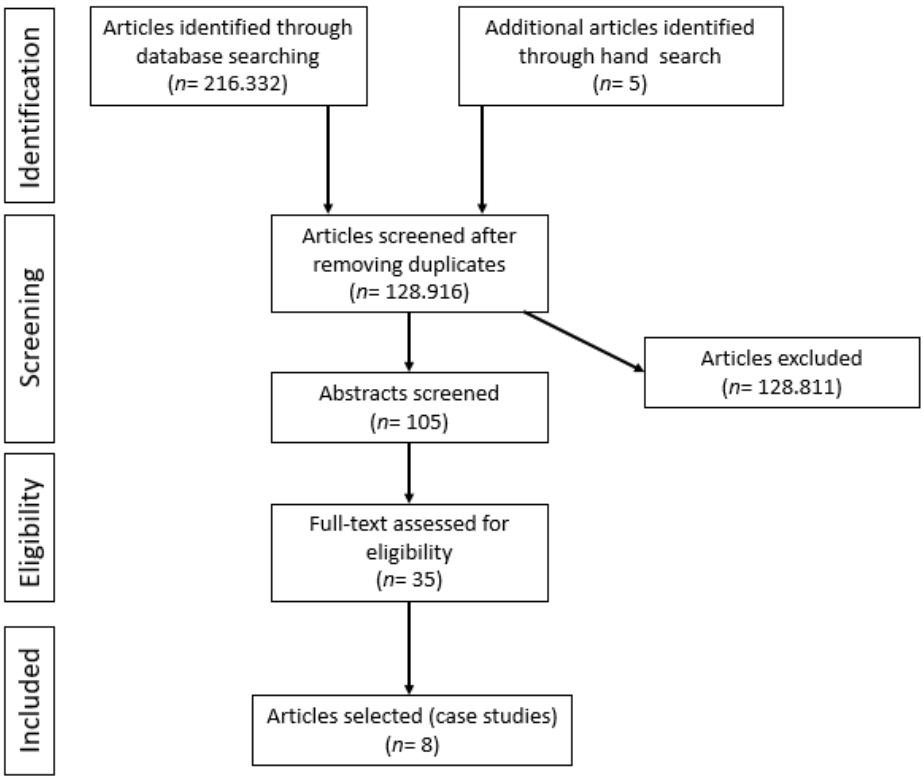


Figure 2 Search procedures

The details of the selected studies are presented in Table 2, by alphabetic order of authorship

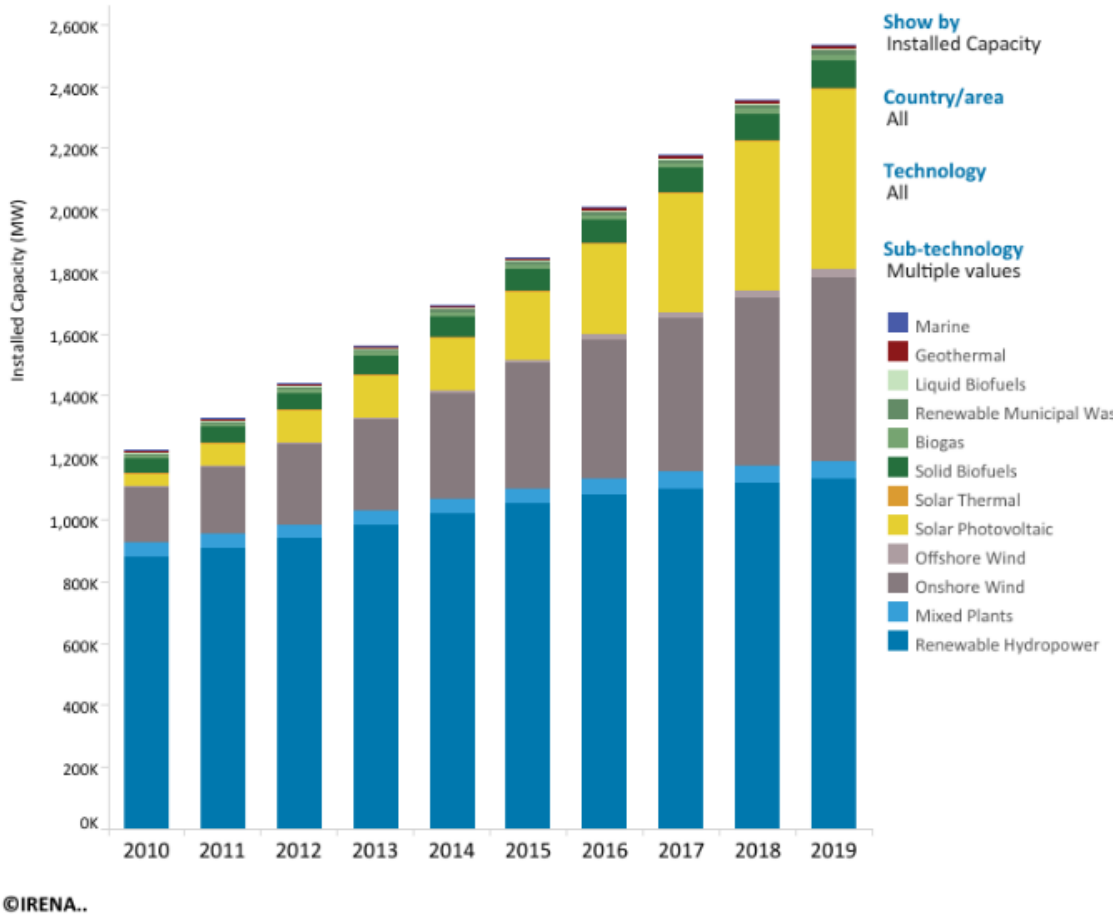
Table 2 – Articles selected

Authors	Title	Year of publication	Studied location	Innovation focus
Balkema, A.; Pols, A.	Biofuels: Sustainable innovations or gold rush? Identifying responsibilities for biofuels innovations	2015	Tanzania	Jatropha biofuels
Chaturvedi et al.	Agriculture technology choices and the (RRI) Framework: Emerging experiences from China and India	2016	India and China	Transgenic cotton
De Campos et al.	Responsible Innovation and political accountability: Genetically modified mosquitoes in Brazil	2017	Brazil	Genetically-modified Aedes Aegypt
De Hoop et al.	Limits to responsible innovation	2016	India	Jatropha biofuels
Hartley et al.	A retrospective analysis of Responsible Innovation for low-technology innovation in the Global South	2019	Europe and Africa	Low technologies
Macnaghten et al.	Responsible Innovation across borders: Tensions, paradoxes and possibilities	2014	Cross-cultural	RRI from a cross-cultural perspective
Vasen	Responsible Innovation in developing countries: An enlarged agenda	2017	Developing countries	RRI in developing countries
Voeten, J.J.; Naudé, W.A	Regulating the negative externalities of enterprise cluster innovations: Lessons from Vietnam	2014	Vietnam	Small informal enterprises

2.3. Biofuels as cleaner energy and global commodity

The worldwide concern about fossil fuels, both in terms of their environmental impact and energy security, has resulted in searching for alternative energy sources to replace or supplement countries' energy matrix. Such alternative energies include hydropower, wind, solar, geothermal, and biofuels, as presented in Graph 1.

Graph 1 Global installed capacity of renewable energies (IRENA, 2020)



Biofuels have been developed for some time now as a renewable, drop-in alternative for fossil fuels. They are well-suited for use in the transport sector. Their liquid form favours transportation to the final consumer and can be easily incorporated into the existing distribution infrastructure, for example, through blending (Sondergaard, 2018) . This makes biofuels an essential energy source in the transition from fossil fuels to clean energy. However, the global renewable energy debate is now shared with other alternatives, especially wind and solar PV, whose investments have grown significantly (Bórawski et al., 2019; Frankfurt School - UNEP,

2020). Support for renewable energies and energy efficiency in road transportation largely occurs by incentivizing biofuels, electric cars, and fuel efficiency. Another benefit of biofuels is that they can be obtained from various raw materials produced in a range of locations, which may improve countries' autonomy and energy security and reduce their dependence on fossil fuels.

Many countries now have blending targets in place, which has led to an increase in the demand for liquid biofuels, especially in the United States, the European Union (EU), and Japan, and reflected a rise in the trade and import of biofuels, such as Brazilian ethanol, Jatropha, palm oil, and other sources of vegetable oil and biodiesel, from the United States, Latin America, and Southeast Asia. The production of biofuels has created new markets, and energy trade flows worldwide (Proskurina et al., 2019). Based on the international liquidity of capital during the 2000s and the increased demand for biofuels worldwide, several investments were made in different countries, in other crops and contexts.

2.3.1. Concerns about Biofuel Expansion

However, the growing demand and investment in biofuel production implied new environmental and social concerns. Questions about the impact of biofuels on land-use changes (Borras et al., 2010a; Miyake et al., 2012; Nassar et al., 2011), food security (Escobar et al., 2009; Rosillo-Calle, 2012b; Ruth Williamson, 2012; Schlesinger, 2014), deforestation and greenhouse gas emissions (Filoso et al., 2015; Gallardo & Bond, 2011; Mol, 2007; Ribeiro, 2013), have formed the core of the biofuel expansion debate [23–25]] . The literature recognizes different types of impact depending on the source of the biofuels (1st generation, 2nd generation or biodiesel). However, the usefulness of an assessment approach to verify the extension of those impacts keep useful regardless the type of the biofuels in question.

On the other hand, positive aspects have been added to the food/energy/forest "trilemma" debate (Harvey & Pilgrim, 2011a; Pilgrim & Harvey, 2010; Tilman et al., 2009b) to analyse the trade-offs involved. Examples include job creation and improved working conditions in the value chains (Assato et al., 2011; Bacchi & Caldarelli, 2015a; R. A. Diaz-Chavez, 2011; Eijck & Faaij, 2014b), rural development (GNESD, 2011; Moraes et al., 2015; Rutz & Janssen, 2014) and integration with smallholder farming practices (Creutzig et al., 2013). Therefore, if biofuel production is to attain sustainable decarbonization and other

renewable energy targets, the societal context must prevent or minimize negative outcomes and increase benefits.

2.3.2. How to Address These Concerns

In Brazil, where developments in the bioenergy sector are centred on advanced biofuels (first-and-second-generation ethanol), interest has been shown from relevant sectors to address these concerns. Emerging bioenergy sectors include, for example, second-generation ethanol, new drop-in applications such as jet fuels, and the diversification of biodiesel sources and technologies for lignin extraction. The processes involve mature technologies and intermediate and emergent sectors (Bueno et al., 2018; Souza et al., 2015). This interest is illustrated by the growing partnerships between biofuel developers and users, and societal actors such as NGOs, as well as their participation in voluntary sustainability certifications such as the Better Sugarcane Initiative, now Bonsucro (https://www.bonsucro.com/), Roundtable on Sustainable Biofuels (https://rsb.org/) (RSB), among others (Cheyns, 2011; R. A. Diaz-Chavez, 2011; Fortin, 2013; Mousavi & Bossink, 2020; Pashaei Kamali et al., 2018).

One way to address societal concerns is to influence the researchers and entrepreneurs when the innovation is at the initial stages of development. In Europe and the United States, Responsible Research and Innovation (RRI) guidelines were drawn up to increase all interested stakeholders' participation to promote the alignment of social needs and values with the technology being developed (Owen et al., 2012b; Stilgoe et al., 2013). Besides its use as an analytical framework, the RRI approach can address emerging societal and environmental concerns in ongoing developments in the biofuel sector or any other emerging technology field. The implementation of RRI is not only in the interest of the public and the RRI community but also in the biofuel sector's interest in addressing concerns.

However, since many biofuel projects are implemented in developing countries in the Global South (de Hoop et al., 2016; Hahn & Ladikas, 2014; Macnaghten et al., 2014), it is not clear whether the RRI approach can be used in contexts other than Europe for this purpose. In the following section, we describe the main concepts of the RRI framework and the reasons for these doubts.

2.4. RRI framework and the role of "participation" in innovation projects

The RRI approach fundamentally looks to generate ethical practice and awareness by influencing emerging technologies in innovation research and ventures. The strategy to do so

is to inspire the innovation process through the effective participation of a range of stakeholders that guarantee the consideration of sustainable aspects in socially desirable projects and, in doing so, respond to the main problems faced by humanity (Asveld et al., 2015; V. Blok et al., 2015; Owen et al., 2012a; Stilgoe et al., 2013). Its design emphasizes that innovation is a collective action involving several agents and institutions engaged at all stages of the process, from agenda-setting to design, implementation, and evaluation. Agents include researchers, policymakers, educators, entrepreneurs, and civil society organizations, encompassing the people directly impacted by the innovation. These ideas were promoted by the EU and incorporated, for example, into the Dutch Research Council (NWO) guidelines, and as a result, spread throughout the academic arena in Europe and the US (Asveld & van Dam-Mieras, 2017). It is important to note that the societal context that shaped this framework was marked by essential debates in society on ethics, the role of science and innovation, sustainability, climate change, nanotechnology, and increasing demand for participation in the decision-making process in democratic societies (Wong, 2016).

However, the framework presents some limitations (V. Blok et al., 2015; Bronson, 2020; Noorman et al., 2017; Stober et al., 2021; Taebi et al., 2014). Its normative character is considered one reason why it doesn't have a central role in Horizon Europe. However, its principles and aims remain relevant in the context of this new phase of the European research agenda and academic debates. In this section, we aim to analyse how "effective participation" is a core attribute for its four pillars' efficiency and, therefore, a reason why using the scheme as an assessment tool is inappropriate. This is because local culture and historical contexts shape the ways of interaction in each country or region differently and, therefore, produce variable results in the process of participation and applicability of RRI pillars, which may have no connection to the positive impact of the innovation itself.

2.4.1.The main pillars of RRI

The framework was built based on four main pillars that continuously reinforce each other. The proposed dimensions have been broadly accepted as requirements for responsible research and innovation through normative guidelines, although many authors have made amendments and additions. The framework is meant to be used as a proactive and inspirational guideline to meet societal expectations. Therefore, its use in a retrospective way should be avoided or, at least, used with care to avoid conclusions and judgments over innovation impacts while assessing just the innovation development process. The same holds for actors and

activities that were not planned to be aligned with such a framework built afterward. We also question its use as an assessment tool due to the lack of objectivity and defined comparable parameters.

According to Stilgoe et al., (2013), the four dimensions are:

Anticipation: to consider what we know and what is probable in terms of technology use. Anticipation aims to foresee the potential risks of the new technology and require a "well-timed" approach to be meaningful and constructive. Another essential requirement is "transparency" since the shared knowledge and information are crucial to enabling participants to assess the risks and future impact of innovations.

Reflexivity: to recognize the moral views, interests, and roles of all relevant stakeholders and critically examine the assumptions behind them. Stilgoe et al., (2013) also highlight that reflexivity should be present not only at the laboratory level but mainly at the "institutional" level (research funders, regulators, and other institutions). These organizations should help build the reflexive capacity among engaged stakeholders and reflect on their value system, shaping the innovation process. To do so, the independent thinking of the participants is crucial.

Responsiveness: the capacity to respond to the questions and insights raised during the innovation process. In this sense, the "actors" involved should have enough power, resources, capabilities, and skills to do so. According to Stilgoe et al., (2013) , it implies the notion of innovations being shaped so that they are "as responsive as possible" to the adjustments that occur throughout their development while recognizing the insufficiency of knowledge and control. However, the authors point out the need for diversity (of stakeholders) to have a responsive innovation system.

Inclusion: refers to how relevant stakeholders are engaged in the innovation process. To achieve qualified outcomes of the inclusiveness process, Stilgoe et al., 2013) refer to three criteria as proposed by Callon et al., (2009): intensity, or how actors are invited to participate promptly; openness, in other words, how the group is composed and how diverse it is; and the quality of the discussion which depends on the participants' critical thinking skills.

One crucial challenge highlighted by the author regards the power imbalance among the participants, which can jeopardize discussion outcomes. Additionally, issues such as

confidentiality, information asymmetry, and power imbalance are frequently observed during the use of the approach. All these elements highlight the importance of effective participation to achieve "substantive inclusion," which can achieve the framework's aimed outcomes (Bronson, 2020; Cheyns, 2011).

2.4.2.RRI demands an effective participatory process

Through its architecture and dimensions, the RRI framework emphasizes inclusion as a process of participation and engagement, and this is based on a belief that, if this processual inclusion is well-executed (effective participation), we will have a substantive inclusion (Bronson, 2020), the stakeholders will together be able to build the best solution (or material results), taking into account society's needs and the interests of all groups. This characterizes RRI as a processual framework where the stakeholder's inclusion and participation are key to achieve the desired societal outcomes brought to the table by these participants (Noorman et al., 2017). Participation is, therefore, a key element to the successful execution of all RRI dimensions. Still, it requires the right set of stakeholders to produce results aligned with the RRI framework effectively. The right set of agents, who would be chosen or invited by trustable organizations, would have characteristics such as representing a diverse range of stakeholders, consisting of independent skilled people with a high level of critical thinking who can discuss and avoid manipulation. Only the right set of stakeholders in a process coordinated by a trustable organization would deliver the anticipation, reflexiveness, and responsiveness dimensions required by the framework.

Therefore, it is reasonable to deduce that the term "responsible", as pursued by the RRI theoretical framework, is directly related to organizing a participatory process (by inviting relevant audiences who would perform the four pillar activities) effectively. This "effective participation" could ensure the four pillar activities' satisfactory performance while indirectly achieving the innovation process's material outcomes. What are the requirements for "effective participation" in the implementation of a biofuels project?

Having the RRI and the SDGs as principles which shape the search for sustainable innovations, I understand that two requirements are essential to guarantee an effective participatory process to achieve the final goal of the RRI approach: (a) an adequate set of stakeholders and (b) adequate institutions for coordinating the process and working as an "action arena" with deliberative power to achieve responsible innovation impacts.

The former, referring to the set of stakeholders, is relevant since the outcomes of each one of the four pillars are not given upfront but are defined by the participation and positioning of the group of invitees representing their interests. It can also be extracted from an in-depth analysis of the four pillars' implementation (Stilgoe et al., 2013). Each one of the posts requires specific attention to the definition of representativeness to attain the best results. Thus, the anticipation pillar requires a well-informed and diverse range of participants who can challenge and question potential risks. The reflexiveness pillar requires stakeholders' independence, the ability to rethink moral values, enriched with different stakeholders' perspectives. The responsiveness pillar requires openness, transparency, and response capabilities, which can only be attained through the participants' assertive group invited to the process. Finally, the inclusiveness itself requires different views from a range of interests and fields (scientists, governments, laymen, community leaders, and external experts) with different perspectives and a good representation of society.

Therefore, effective participation is a crucial element to discuss the future perspectives of emerging biofuel technologies, which are inherently uncertain and depend on the set of representatives' best configuration. Thus, it is necessary to consider the requirements these actors must fulfil to reach the process's best outcomes.

In fact, "effective participation" assumes that some values are present or given in any context or society (Wong, 2016). However, the forms and patterns of interaction among stakeholders seem to differ in each country or region (Stober et al., 2021). It is crucial to understanding how the local context, culture, and beliefs interfere with and shape the discussions on achieving the desired responsible innovation. This is particularly important when discussing research and innovation, which are developed in one place and implemented in another, as is usually the case of biofuels and other technological innovations (Pansera & Owen, 2018; Setiawan & Singh, 2015; Taebi et al., 2014; Wong, 2016).

Effective participation is related to the definition of groups and names and a second important element: the institutions where the discussions take place. This element from institution analysis theory (Ostrom, 1995) is usually responsible for answering organizational questions: when does the discussion occur? Is the frequency of meetings sufficient? Are the meetings multidimensional or just one-way communication events? Where do these meetings take place? Are all stakeholders able to attend? How do people interact with each other? How

much freedom do they have to speak freely? How do gender and religion affect the ability to speak out and develop the right solution for everyone?

Answering these questions is out of this study's scope; nevertheless, they are mentioned here as they reveal the importance of understanding local practices. Some of these details are efficiently managed; others, however, are more difficult to deal with since they have hidden rules, behaviours, and beliefs that are difficult for an external stakeholder or an assessment body to understand and create global metrics to measure it, especially when discussing transcontinental projects where long distances impact closer coordination and recognition of context limitations (Cheyns, 2011; Wells & Zapata, 2011) . In all cases, institutions are critical to effective participation and responsible innovation analysis. Because of this, their importance is further explored in the following section.

2.5. Institutions as Key Elements of The Innovation Process Analysis

> *Social and economic structures give rise to different configurations of actors in different countries at different times, who exercise influence not only on the making of policy but also on the making of institutions* (Feinberg Et Al., 2006).

2.5.1. Institutions as A Proxy for The Local Context

Barney et al. (Barney et al., 1987) define an institution as an organized pattern of constitutive collective behaviour and its evolution. In this sense, institutions are made up of values, norms, beliefs, meanings, symbols, customs, and socially learned and shared standards, which define the range of expected and accepted behaviour in a particular context. Aligned with this, Taebi et al(Taebi et al., 2014) explain that technological development occurs in specific institutional contexts involving individual stakeholder dynamics. These contexts, constituted by formal and informal institutions, reflect values that have significant ramifications for the governance structure, the distribution of power between stakeholders, transparency processes, gender equality, and the definition of priorities.

Echebarría et al (Feinberg et al., 2006)explains that institutions are path-dependent since the historical facts influence institutional evolution and its characterization. The institutional path and the social development path are not easily comparable or compatible with each other historical, economic, social, political, and cultural aspects influence the constitution of an

institutional network, establishing specific and local forms of the development pattern (Acemoglu & Robinson, 2012). All these factors set the limits within which the actors involved in these processes can act. Specifically, with regard to impact assessment, the mentioned factors can also limit the supervisory role of the responsible institutions. There are difficulties in carrying out impact analysis, financial and methodological challenges stand out. Once these studies are in place, even if measurable, there are also limitations in translating the results into norms and laws, and incorporating them into policies and the policy agenda.

In their place, important debates or frameworks can create resistance from stakeholders, as local organizations or society. The main reason is that, in general, these models are impregnated with values and realities that are very different from the local ones. In this sense, the network with other organizations and institutions is important to maintain objectives and inspire adaptations. Then, local multilateral organizations can act on adapting more general parameters to local realities. At the more concrete level, we can mention agencies responsible for the regulation of biofuels, social policies and rules, even civil society represented by NGOs. The institutions, treated on a more general level of action arenas, manifest themselves in a dispute in the general plan of laws, rules, values and behaviours. This arena starts from the parliament, responsible for formulating rules and laws. In democracies, the members of the parliaments are elected, which theoretically, gives them independency to challenge agencies, institutions, organizations, and even the government (Feinberg et al., 2006).

Ostrom (Ostrom, 2005) also emphasizes the importance of local context, stating that exogenous variables such as (a) the biophysical and material conditions; (b) community attributes, including values, behaviours, and traditions; and (c) rules—formal and informal—that affect the action arenas (or institutions) where a group of participants (or stakeholders) interact with a specific purpose (or action situation). In this approach, “action arenas” shape and characteristics depend on the local contexts’ exogenous variables.

Therefore, we argue that institutions are a proxy for analysing and incorporating local context specificities and that RRI should take these aspects into account. After all, each context manifests a specific reality that can impact the implementation of the dimensions and objectives of RRI. Incorporating these aspects would enable researchers and policymakers to shape and adapt the framework elements to the specific necessities regarding responsibility in the research and innovation processes.

Understanding the institutional contexts is important since limitations concerning the implementation of RRI may be more related to broader and deeply rooted socio-political factors and institutional contexts than to specific initiatives. Regarding this, Wickson and Carew (Wickson & Carew, 2014) classify the "clear and explicit identification of institutional and contextual limitations and a structured effort to acknowledge and improve upon these conditions" as an exemplary criterion of reflexiveness and responsiveness.

2.5.2. Institutions as "action arenas" for innovation process discussions

Another critical factor in incorporating an analysis of institutions into the RRI approach is that they represent the arena (or deliberative forum). The controversies surrounding and evolution of the innovation process occur. In Ostrom's words, an "action arena" is the "social space where individuals interact, exchange goods and services, solve problems, dominate one another, or fight" (Ostrom, 1995). In sum, action arenas are collective spaces where the participation process takes place and, because of this, the characteristic of institutions is fundamental.

The question arises: which factors differentiate contexts with weak institutions from those with strong institutions? How is this linked to a potential RRI application? Levitsky & Murillo,(2013) highlight some features that support the differentiation of these institutional contexts: (1) socioeconomic inequality, (2) institutional borrowing, and (3) hasty institutional design.

Socioeconomic inequality is a factor that contributes to distancing society from important debates, particularly in contexts where there are low levels of education and access to information. There is a reduction in society's confidence in the institutions. Institutions are often imported from abroad without reflecting on the alignment with pre-existing domestic power structures or norms, leading to discrepancies. The rapid institutional design, in turn, affects institutional quality and durability, as there is inadequate time to anticipate impacts, include stakeholders, or further discuss issues.

Based on the argumentation described earlier, nations with a strong institutional configuration can conform to the RRI principles more easily than countries with a weak structure. The difficulty lies mostly in the concentration and imbalance of power, the lack of collective prioritization, aspects that impair representation (such as educational level), and political instabilities, to give some examples (Levitsky & Murillo, 2013; Randles et al., 2012).

There may be no commitment to being “responsible” in these local contexts, one of the RRI framework aims.

To summarize, we have so far argued that (1) institutions are a proxy of local context and because of this can be used to improve strategies to implement RRI approach, and (2) institutions work as action arena or deliberative forum and are fundamental to coordinate the participatory innovation process. In the following section, we aim to illustrate these two points by presenting selected case studies from outside Europe (based on literature) that used RRI as an analysis tool to show how they failed to be objective and provide relevant comparisons. Several studies indeed illustrate the relevancy of the impact of institutional context on the performance of RRI pillars.

2.6. The Challenges of Using the RRI Approach in A Weak Institutional Context

Following the previous section, institutions play an essential role in coordinating the innovation process since they represent the local context’s crystallization. At the same time, institutions act as an approximation for understanding the values and behaviours behind how people interact and work as a “locus” or as an “action arena” that legitimizes the outcomes of such interactions. Therefore, the quality of the institutions is essential since it controls the different ways that stakeholders interact, different levels of effective participation and, thus, impacts the ability of members of the local community (researches, entrepreneurs, policymakers, NGOs) to perform RRI activities to achieve responsible innovation process effectively.

Strong institutional contexts facilitate the effective participation of stakeholders. In such cases, RRI guidelines, which demands freedom of speech, gender equality, power balance, among other attributes to perform effective participation, are easier to apply, and the results from the participatory process can be interpreted as an indication/good representation of how participative the innovation process is. On the other hand, the effects are the opposite in the case of weak institutions when the participatory process required by the RRI framework can be jeopardized by a lack of coordination in the process of engagement, an imbalanced discussion impeding the free access to information and freedom to speak out (Vasen, 2017b).

It is the case for most biofuel innovation implementation processes since biofuel production often occurs in rural areas in developing countries, far from the large urban centres where the developers of the technology or the framework's creators are found. It highlights the inherent difficulties in the implementation phase in regions where the culture of participation, history, and economic context are very different from the Western developed countries, where these contextual RRI elements are largely accepted and implemented through traditional and robust institutions. Brazil is an interesting case since it is considered technologically developed and with good institutions. However, due economic history, cultural values, and deep inequality context, the implementation phases are often done in top-down manner and therefore, is not aligned with the participative process as required by the RRI framework. Even though this lack of participation in the implementation process of biofuels projects, the outcomes of these projects for the local communities seem to point to inclusive impacts (A. Marques Postal et al., 2020) . Timmermans, (2017) described the RRI approach as still a "predominantly Western affair". The absence of credible and stable institutions can jeopardize the free and effective participation of less privileged people who may not have full knowledge of their rights or access to information and, consequently, may have a limited capacity to analyse innovation's potential issues.

In a case study carried out in Tanzania described by Balkema & Pols, (2014), Jatropha's investments were stimulated by the 2003 EU directive to promote biofuels. However, the authors noted that small biofuel producers were left behind in the discussions on Jatropha's expansion. The "exclusion" of this vital stakeholder has led to missed opportunities. Considering this "weak inclusion" or failure to assure "effective participation" of the right set of agents, the authors claim that the EU failed to anticipate the impacts of its biofuel policy and did not include small farmers' voices.

There was a shift in expectations regarding biofuel production from Jatropha from the large-scale cultivation of a "miracle culture" that could provide sustainable biodiesel for Europe to a "biofuel niche culture". It turns to be viewed as a crop with relatively low yields, suitable for bio-oil production for local use. The authors conclude that the impacts of large-scale production of Jatropha have contributed to a series of problems that conflict with sustainability ideals, such as food insecurity (through land-use changes that negatively impacted food planting), the marginalization of small farmer participation as an actor of interest, loss of soil

fertility and biodiversity loss. They, therefore, concluded that the case has proven to be unsustainable and irresponsible.

However, the article did not analyse the role of Tanzania's historical and economic context. How can an external institution such as the EU, with such a major difference in values and culture to an Eastern country, be responsible for identifying the legitimate stakeholders who should sit at the negotiation table? To what extent did small-scale farmers trust the process and the mediators? Were these farmers able to make their voices and concerns heard? It seems that the lack of a local institution as coordinator, with a better understanding of Tanzania's context and traditions, has jeopardized the whole RRI process, failing to establish an adequate set of engaged stakeholders.

Therefore, what can be concluded from the use of RRI in this case study is the failure to achieve effective participation. These failures led to a poorly implemented innovation with negative impacts. The "irresponsible character of the innovation" is connected with the implementation process and not with the biofuels innovation's direct material impacts in this local context. Indeed, we could judge biofuels as irresponsible if the framework had specific impact criteria to do so. For example, about food security (total food imported versus locally produced), loss of soil fertility (percentage of fertilization need compared to the past), and biodiversity loss (percentage of deforestation). Although RRI is about meeting grand challenges and aligning with society's values [70], the framework does not have these direct material criteria. Material issues as food security, loss of fertility, biodiversity loss, and others can appear if, and only if, the chosen set of invited stakeholders effectively participate in the discussions and bring those themes to the negotiation table. Instead, the RRI as a normative processual framework has the criteria of inclusiveness, which were done without considering institutions. Then, its results are not enough elements to judge the impacts of the innovation itself as irresponsible.

In another study on India, De Hoop, Pols, and Romijn de Hoop et al., (2016) studied a Jatropha project carried out by the University of Agricultural Sciences in Bangalore (an entrepreneurial actor with an academic profile). One of the project's main goals was to improve the natural environment's quality and the lives of the people involved (inclusion as an outcome). In practice, however, several problems were highlighted due to the lack of proper inclusion of local producers in the project's design (inclusion of process or effective participation).

Although the authors mention that the process respected the inclusion pillar, they expressly pointed out the low quality of involvement, which meant that farmers failed to adhere to the project due to restrictions on water access for irrigation (failure in participation implied failures in anticipation process activities). Both the farmers and the researchers had to deal with power structures. The local institutions responsible for carrying out the process were not strong enough to mediate these power differences or effectively include a range of stakeholders and guarantee their right to free speech (failure in responsiveness). The authors concluded that, although the project did not negatively impact the local population and the environment, it also did not result in the expected positive impacts. The authors present evidence that the project did not sufficiently meet the four dimensions of RRI. Therefore, it concluded that the innovation project should not be implemented since RRI is about 'innovating responsibly – or not innovating at all' (de Hoop et al., 2016, p. 129)(p. 129).

However, our interpretation of the proposal of .Stilgoe et al., (2013) together with other authors on institutional theory such as Ostrom, (1995) and Acemoglu & Robinson, (2012) leads us to conclude otherwise. We understand that due to the lack of effective local actors' participation, the inclusion, anticipation, reflexivity, and responsiveness dimensions were jeopardized. There was no vital institution to lead the project that impaired the RRI dimensions, and idiosyncrasies emerged. For example, should a university that does not have an entrepreneurial mindset be responsible for carrying out a "business enterprise" with all inherent conflicts of interest of these roles? Should universities be responsible for advocating biofuel policy or negotiating trade agreements with biofuel dealers? Would the recommendation of "abandoning the innovation process", as proposed by the authors, be considered a well-thought-out and fair decision for the local community? Would that put the potential positive impact of the venture at risk just because it did not meet the expectations of participation included in the assessment tool created according to values different from the local culture? Again, the question is posed: should this conclusion be interpreted as a failure on the part of the biofuels project in India or the failure to adhere to, adapt, and implement the core RRI concepts? The analysis must first examine contextual elements of governance and local institutions in greater depth to be considered valid alternatives. After all, is it better to achieve some benefits or no benefits at all? The academic community must address this ethical question.

The two cases above did not consider the local contexts in their analyses to interpret the "possible participation process" to be implemented. As a result, we understand their conclusions

reflected more a lack of adherence or adequacy of the RRI process to those contexts than the "irresponsible character of the innovations developed" in terms of its potential impacts. Both cases make conclusions about the final impacts of the innovation (calling them irresponsible or suggesting to give up the innovation) using an assessment tool (RRI) that focuses mainly on its development's participatory process. When the participation is not ideal according to RRI requirements, instead of analysing the role of institutions that coordinate the process, the author criticizes the impacts of the innovation itself.

In contrast, reflections on the RRI approach's limits and claims for a local context analysis through an institutional approach were echoed in several studies.. Chaturvedi et al., (2016), for example, analyse governments' role in defining the pathways to develop innovations in the transgenic cotton sector. The authors highlighted the lack of transparency (China) and credibility (India) as evidence of weak institutions that jeopardize the RRI process and responsible innovation. Hartley et al., (2019), from a different angle, analysed the difficulties in implementing low-tech innovations using the RRI approach in transcontinental projects (Europe and Africa) and, even when the research team considered the approach, the "inclusion pillar" reflected "a process of discursive exclusion." In the case of Vietnam, Voeten & Naudé, (2014) analysed the impact on weaker institutions' responsiveness dimension previously co-opted by entrepreneurs. They were unable to coordinate the process to reap benefits for society as a whole.

In Latín América, de Campos et al., (2017) defend an interconnection between the notion of political accountability (one aspect of responsiveness) and institutions, since the difficulty in predicting the trajectory of innovation and the absence of a deliberation arena can strongly impact the innovation trajectory of a vaccine for the dengue mosquito.. Macnaghten et al., (2014) and Vasen, (2017b) explore the difficulties and limitations of employing the RRI framework in contexts with different capabilities, values, and institutions, and the risk that this can be perceived as a new model of intellectual neo-colonialism.

Figure 3 represents how the complementary analyses of institutions can help define strategies to implement the RRI approach to achieve the effective participation required and how to analyse the results of the RRI application when the local institutions are not capable of achieving an effective participatory process.

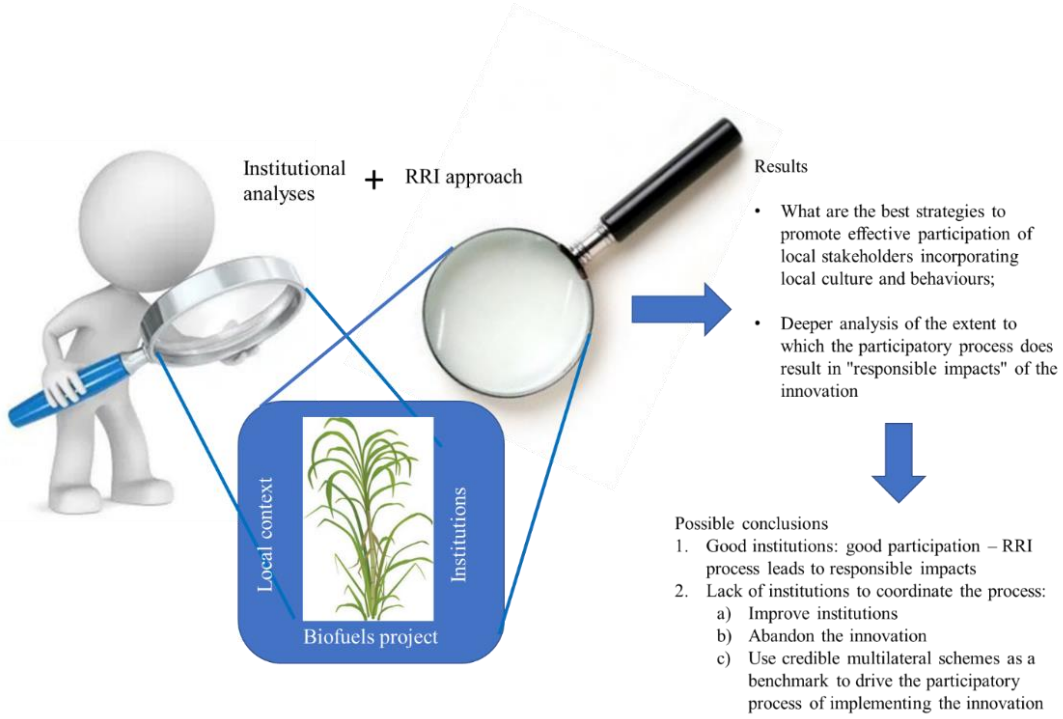


Figure 3 Complementing Responsible Research and Innovation Framework (RRI) analysis (created by the authors)

A preliminary institutional analysis is required to understand actors' ability in different contexts to implement effective participation. When local institutions can guarantee effective participation, the four pillars of RRI will probably achieve their aims. The participative process tends to generate positive impacts of the innovation, achieving the responsible innovation's ultimate goal.

However, when the institutional framework is not capable of coordinating the process (lack of trustable organization or properly enforcement power, for example), the institutional analysis helps to explore alternative strategies to improve local stakeholders' participation, taking into account their culture, value, beliefs and ways of interacting. In such cases, three possibilities are listed below, based on the literature referred to in the previous sections and the author's reflections:

Improve institutions. As stressed by Taebi et al., (2014) and Acemoglu & Robinson, (2012), this alternative is a lengthy process and one that requires strong political capabilities with solid social movements. Although it is the most laudable and sustainable alternative in the long run and hence it should be strived for continuously, it is not an option for some projects since institutional strengthening requires a longer timeframe than the innovation processes

usually addressed by the RRI. It is possible that, in some cases of grassroots innovation (one which is raised from the ground or by the community), it may be an option

Abandon innovation. The second option, the most radical, should not be considered without in-depth institutional analysis. As discussed above, abandoning an innovation because the effective participation required in the RRI pillars are not strictly followed would impact communities and hinder the local development process. Would this effect be ethical and fair to local communities, just because the innovation process did not match the mindset of a framework designed externally? This option seems to be applied when the institutional analysis has demonstrated a lack of institutions that can minimally guarantee to use the RRI principles, therefore showing that no participatory process is possible. Even in this case however, the impacts of the innovation can be positive in amplifying the access to goods and services for a larger part of the population. Should such kind of innovation be called irresponsible because of the lack of a participative development process? Or its impact is what defines the responsible character of the innovation?

Using alternative external schemes or standards as a trustable guide for a more participative implementation process. For example, the Sustainable Development Goal (SDG) or the IFC Standards, Principles of Responsible Investment, and other sectorial schemes aim to assure an inclusive and participatory process as principles of action. From this, it is possible to define strategies to guarantee the most participative process as possible (thus, responsible through the RRI lens and given that specific context) and, as a result, the accomplishment of positive outcomes in terms of inclusion, anticipation, reflexivity, and responsiveness.

It is important to emphasize that the three options above are alternatives to improve participation during the innovation development and implementation phases and raise the chances to achieve the positive impacts of the innovation. None of the options scanned guarantees that participation alone will produce outcomes aligned with society’s needs. It depends on quality, diversity, critical skills, access to information, and other factors. It is precisely the problem of considering the framework to assess the responsible character of the Innovation. RRI is useful to inspire a participative process but what can be evaluated through the RRI approach is the process of participation and engagement, and not the innovation impact itself.

2.7. Limitations

Although mentioned in the literature review and discussion among our peers, we intentionally do not describe the contours of "strong" or good institutions because they are context-specific and we do not want to repeat the approach of crystallizing a vision of institutions that do not consider the local contexts. The same reasoning is applied to the definition of the 'minimum requirements' for a trustable private sector organization to coordinate the development process when the institutions are not strong.

2.8. Conclusion

Worldwide biofuel expansion is essential if we are to transition to a biobased economy. In this sense, emerging technologies cannot disregard societies' social and environmental demands in which the innovations are implemented. Several frameworks emerged to assess how sustainable is the innovation in question, RRI among them.

To address the "responsible character of the innovation" as framed by RRI, it is important to understand what "responsible innovation" means. Is it the innovation that counted on stakeholders' effective participation during its development process or the innovation whose impacts are aligned with society's aims and needs? RRI framework seems to incorporate the premise that effective participation (as extracted from the good performance of the four pillars) will guarantee responsible impacts as defined by the participants and, therefore, the alignment of the innovation with the society needs.

However, there are three problems with this premise:

It requires a quality of the participatory process dependent on culture, values, and behaviours that vary among the countries and regions. What makes it difficult to define upfront processual indicators that could assess effective participation quality in any context.

Regarding the material elements that would generate indicators, metrics, and measurements to assess the responsible innovation impacts, those elements are dependent on the quality of the participation process. They cannot be upfront defined as common material metrics and indicators.

Even when the process dimension of the innovation development in RRI does consider those contextual elements (culture and values) as fundamental requirements to perform

effective participation, nothing can be predicted about how positive are the innovation's impacts. The improvements over the process of participation cannot automatically guarantee the positive impacts of the innovation.

Through the analysis of the literature about different case studies, we identified that conclusions about the responsible character of innovation that uses the RRI as an assessment tool usually reflect more the difficulties in applying the framework (the ideal participatory process in regions with a different culture, types of institutions and values) than the real "responsible" impact of the innovation in the study. RRI is a normative framework designed to influence the process of innovation and not to define the quality of the innovation's impacts.

We then conclude that using the RRI framework in regions of biofuels implementation projects reflects more the difficulties involved in applying guidelines that were, perhaps unconsciously, embedded with western values than the responsible character of the innovation impacts, which usually are defined upfront materially and measurably. Thus, RRI cannot be used as an assessment tool since it does not have the material metrics to measure how responsible or positive or negative the impacts of the innovation are implemented.

Irrespective of the critics, RRI remains a necessary normative framework to inspire and guide responsible innovation through the participatory process (the core element to the effectiveness of anticipation, reflexiveness, responsiveness, and inclusion) and achieve the innovation whose impacts are good for society. Its application should complement an initial analysis of institutions' quality to encapsulate local context and values. Understanding the institutional context before RRI application can help map the limitations and gaps and better define strategies to improve stakeholders' participation in the four pillars of the RRI framework and, consequently, raise the chances of promising outcomes regarding inclusive impacts of the innovation.

Future research should be carried out to understand whether innovation can be considered as responsible when substantive inclusion or effective participation is not entirely possible; whether it is possible to achieve inclusion as an outcome of a biofuel implementation project without proper participation (inclusion of process) in the innovation process, and how inclusive has the biofuel expansion been in different contexts.

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Chapter 3

3. The impact of sugarcane expansion in Brazil: Local stakeholders´ perceptions

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Abstract

Sugarcane expansion in Brazil during the 2000s was partly restricted by several discussions about the sustainability aspects of its cultivation. These discussions were mainly based on surveys that sometimes use highly aggregated data not including local perspectives and particularities, and sometimes used case studies with small samples which, while listening to local perspectives, cannot be considered representative of the whole sector. This work aims at filling this gap by considering both the perceptions of the local community, which add primary data on impact, and a large sample, to increase the research representativeness. To do so, we present the results of 353 interviews, covering 33 municipalities in five states of the Centre-South region of Brazil (the largest cultivation area in the country). The results show that the expansion of biofuels has generated conflict mostly related to environmental and social issues, although there is good acceptance of the sugarcane mills in general. Our conclusions point to the importance of including local voices for a deeper understanding of the advantages and limitations of the expansion of biofuels.

Keywords

Sugarcane expansion, stakeholders' perceptions, social impact, environmental impact, economic impact

3.1. Introduction

The debate about renewable fuels and its role in global warming and the environmental limits to world economic growth intensified in the early 2000s. As a possible alternative with regard to climate change and taking advantage of the great liquidity of capital available until the financial crisis of 2008 (Bunde, 2017; A. C. Marques Postal, 2014b), the emergence of large investments in the biofuels sector in Brazil and in the world took place. Palm oil in Indonesia, sugarcane ethanol in Brazil and corn ethanol in the US were soon announced as promises of renewable and sustainable energy.

However, criticism soon arose when the consequences of this unbridled race for cleaner energies began to appear. Environmental questions regarding deforestation, minority land rights, biodiversity loss, soil degradations and weak GHG savings were pointed out when palm oil cultivation in Indonesia became better known. Also, the food value chain became an issue especially when edible crops like corn, beets, wheat and sugarcane became possible energy alternatives. These issues were identified as global concerns and discussed in many academic studies, predominantly within the theme of sustainability. Even though a heated debate, regarding Brazilian sugarcane, most arguments used were basically based on two types of knowledge: (a) research, publications, and reports based on highly aggregated statistics; and (b) case studies with small and non-representative samples. Both approaches have limitations and need complementary information.

The first approach was more frequent in the global arena and uses, besides highly aggregated data, analysis and comparisons between different crops and countries. Numerous studies indicated the negative impact of biofuel production (Actionaid, 2010; Robert Bailey, 2007; Bernstein et al., 2007; Fulton, 2004; Giampietro et al., 1997; Harvey & Pilgrim, 2011a; Ho, 2006; S. Hunt, 2008; Lenk et al., 2007; Mol, 2007; Vasudevan et al., 2005). The impact is mostly related to the environmental dimension, such as greenhouse emissions, soil erosion, water quality and biodiversity loss, as well as social matters in all parts of the value chain (e.g., food security, land degradation, displacement of traditional communities, health, and land conflict issues). Some studies and reports stated that the total environmental cost of biofuels is higher than that of gasoline, despite the fact that some biofuels produce smaller greenhouse gas emissions in comparison to fossil fuels (R. Bailey, 2008; Dahlbeck, 2004; R. A. Diaz-Chavez, 2011; Ho, 2006; S. C. Hunt, 2006; Luiz A. Martinelli & Filoso, 2008; Scharlemann & Laurance,

2008). Other studies indicated that there are more "problems to solve than insolvable problems" for these alternative energy sources to be more utilised in a sustainable way, such as the creation of infrastructure, new markets, new technologies and new products (Amigun et al., 2011; Escobar et al., 2009; Harris, 2007; S. Hunt, 2008; S. C. Hunt, 2006; Koh & Ghazoul, 2008; Masiero & Lopes, 2008; Nassar et al., 2011; WWF Global Freshwater Programme, 2005). It is recognised that the increased production of biofuels is unavoidable and some amount of impact on land use, as well as social and environmental impact, should be expected. Because of this, international cooperation, regulation, and certification mechanisms become even more important to stimulate innovation, adequate legislation, and strategies.

On the other hand, a different approach was used in a number of studies, which emphasised local conditions in a Brazilian context and went deeper into analysing the impact of sugarcane expansion. For example, Gilio et al. (2016) focused on the state of São Paulo and concluded that the presence of an industrial plant in the region had a positive effect on socioeconomic development (average income and welfare); however, there was a negative effect on employment due to the process of crop mechanisation. Additionally, the economic activity shows a significantly greater economic dynamism when compared to the production activities in the sector of oil and by-products. The positive economic impact of sugarcane expansion can also be analysed through the studies by Bacchi and Caldarelli (2015a), Brinkman et al. (2018), Moraes et al. (2015a), and Wilkinson and Herrera (2010).

The local approach was also used by (Petrini et al., 2017) to shed light on the perspective of 28 local family producers of agricultural products in the city of Ipiranga, in Goiás state. The results of the study show that the farmers did not have consensus on their perceptions about the sugar and alcohol industry. They indicated the risks and threats of this activity and highlighted the need for a wider understanding of local issues for the formulation of public policies aimed at mitigating the negative aspects of the sector and, at the same time, stimulating the potential benefits to the value chain in that region. In another study, (Ortolan Fernandes de Oliveira Cervone et al., 2018) interviewed 42 families to compare perceptions about the impact of sugarcane cultivation in ecosystems in two city areas: Rancharia, in a sugarcane expansion area, and Capivari, a traditional area close to Piracicaba. The study concludes emphasising the importance of including local voices to bridge the knowledge gap concerning some types of information with few or no statistics or database. (Novo et al., 2012) also describe the impact of biofuel expansion on dairy farmers' activities based on 34 interviews in two regions of São

Paulo state; they concluded that the lack of workforce, increasing labour costs, and the advanced age of the landowners are the main reasons for those leaving the sector and leasing their land to sugarcane companies. (Coutinho et al., 2017) interviewed 32 experts from academia to test their views on the impact of sugarcane cultivation through a participatory impact assessment tool in southwestern Goiás; they concluded with the importance of including health care and quality of life as new indicators for assessing impact. Further, (Duarte et al., 2013) interviewed 14 local stakeholders representing local government, mill management, and local residents and concluded that five main topics need to be taken into account regarding the sustainability of sugarcane cultivation: water availability, biodiversity, processes of mechanised harvesting, land use change and employment / income opportunities.

Several other studies concerning the Brazilian context use case study methodology (Assato et al., 2011; Egeskog et al., 2016; Galindo & Carvalho, 2016; Gomes et al., 2009; Marcatto et al., 2010; NEVES, 2019; Viana & Perez, 2013). These studies aim to develop a better understanding about local conditions which are not taken into account in highly aggregated data statistics, or the studies put forth some aspects that have no available data. Nevertheless, it is difficult to isolate the impact of sugarcane cultivation from other aspects within its local economic or historical institutional context.

Both types of studies, however, are limited in their conclusions due to common limitations regarding their methodologies. The studies using a highly aggregated level of data have difficulties showing important social and environmental effects at the local level. Other studies, which emphasise local conditions and case studies, usually use small data samples and are not able to show a larger picture that is representative of the whole sector.

To address these gaps, in this study, a large field research and primary data gathering process was conducted to answer the question “what are the local perceptions and main concerns about biofuels expansion in Brazil? With more than 300 interviews in the five major producer states in Brazil, this field research provides a good picture of the pros and cons of the biofuel expansion in the country in the 2000s. Even though these perceptions are not accurate in terms of technical knowledge, they can serve as a proxy and provide us with a good overview of the effects of sugarcane cultivation as it pertains to the well-being of the local community. Table 3 summarises the main shortcomings of each approach, and the potential contribution of this research.

Table 3. Gaps in the debate and research aims.

	Data	Crops	Place	Shortcomings
Global concerns	Highly aggregated statistics	Corn, palm oil, sugarcane, wheat	Several countries	Does not address local impact when statistical data is not available
Local studies	Small samples used; number of interviewees limited	Sugarcane	Some (2 or 3) cities in Brazil – usually in just one state	Wider representativeness for the sector is unknown as the sample size is too small due to cost issues
This research	353 interviews	Sugarcane	Brazil, in 5 states and 33 cities	Perceptions as a *proxy* when local data is not yet available

3.2. Methodology

Different methodologies were used in each phase of this research to analyse the stakeholders' perceptions regarding global concerns about sugarcane expansion. These methodologies are organised in three phases: setting themes, data collection and data analysis. Each phase is detailed in the following paragraphs.

3.2.1.Setting the themes

To define the set of concerns to be assessed, this research was based on issues expressed in the following academic articles (Borras et al., 2010b; R. A. Diaz-Chavez, 2011; Eijck & Faaij, 2014b; Escobar et al., 2009; Gallardo & Bond, 2011; Mol, 2007; Ribeiro, 2013; Tilman et al., 2009a) and international NGO reports or statements (Actionaid, 2010, 2011; Biores, 2008; Marshall, 2009; Oxfam, 2007; Solidariedad, 2013; Valenti et al., 2012; WWF, 2011). Both groups have importance as they influence policymakers and the media. While NGOs have the ability to transform difficult matters into simple ones to reach their target audience, the academy typically looks for evidence and scientific criteria to assess the knowledge. Both groups, academics and NGOs, have both contrary and favourable positions regarding biofuels and often their views are not aligned.

The themes of national Brazilian interest that are put forth are based on the arguments of opinion makers (big Brazilian media) and local industry representatives of the São Paulo

State Power Plants Association2 (Kutas, 2010; UNICA, 2010). This mix aims at providing the respondents with a wide range of advantages and disadvantages of the expansion in their region, so that the final balance may contemplate all dimensions of the issue. On February 2016, a workshop was held to validate the language and feasibility of each statement (There were eight representatives: three from academia, two from industry, one from an NGO, and two policymakers). The initial analysis generated a list of over 30 themes, which were then filtered according to the criterion of suitability to the local perspective. The themes within the social dimension are: food insecurity, decent work, violence, health, traditional communities, and land concentration3. Themes for the environmental dimension are: air quality, soil quality, water quality and availability, biodiversity, and deforestation. Finally, the themes for the economic dimension are job creation, income generation, tax collection, the business model and increased prices. Themes such as global climate change, energy balance and reduction of greenhouse gases were left out since they demand highly complex and abstract analysis, which would not be easily understood by lay people.4

The questionnaire was built using a five-point Likert scale (1−5), with "no opinion" as an alternative answer. The main concerns identified at a global and national level were put forth affirmatively; respondents either agreed or disagreed (see Figure 1.) The answers generated quantitative (their positioning) and qualitative data based on their speech, which was recorded and transcribed when permission granted. The survey was written in Portuguese and was pre-tested, after which it was refined and the wording adjusted.

[2] UNICA – União da Indústria de Cana-de-açúcar.
[3] Land concentration – increase of land ownership for a small group of people
[4] For a complete view of the themes and statements, see Appendix B.

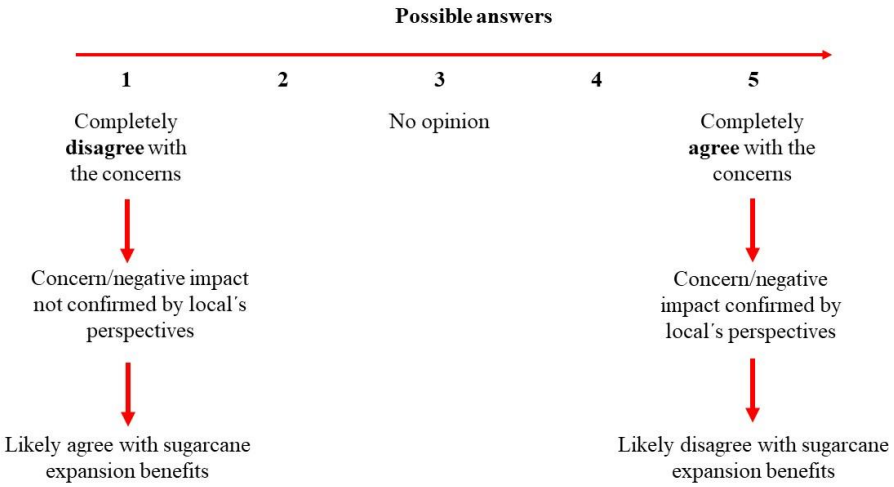

Figure 4 Positioning interpretation

3.2.2.Data collection

The data collection has three orientations:

- Geographic scope;
- Definition of the representative groups;
- Identification of formal stakeholders in each municipality.

3.2.2.1. Geographic scope

We chose the regions to be studied based on the growth rate of sugarcane cultivation in each municipality after 2000. The idea was to focus specifically on areas of recent expansion in order to record the perceptions of residents witnessing the changes in their local environment. This task required a three-step approach: (1) identifying the states with greater sugarcane expansion in the Centre-South region (Appendix C); (2) analysing the growth rates of sugarcane cultivation in the city area, in relation to the total potential area for cultivation (Appendix D); and (3) identifying new or expanded processing plants/distilleries with regional impact, and noting their opening dates (Appendix E).

As a result of these three steps, the study was defined to take place in five states in the Centre-South region of Brazil (Goiás, Minas Gerais, Mato Grosso do Sul, Paraná e São Paulo) and 33 cities were identified as having the best mix between being a cultivation area experiencing rapid expansion, having a "new" industrial processing site (with operations beginning after 2000), and proximity among the cities due the logistical constraints of this study. Figure 5 shows the area of sugarcane plantations and the researched geographic scope.

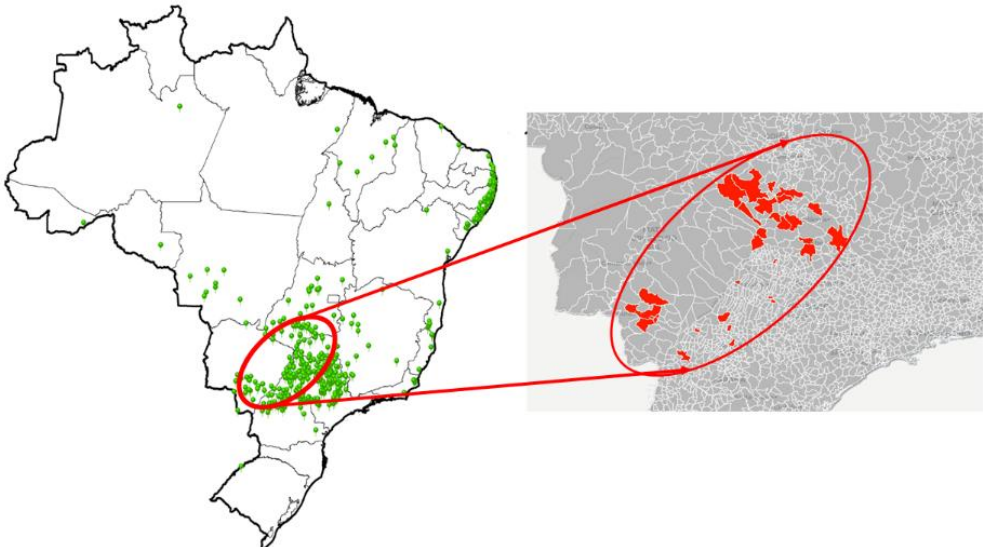

Figure 5 Spatial distribution of the "active" sugar, alcohol and electric energy producing units in Brazil and the researched area in detail (by the authors).

Source: adapted from (Sanches et al., 2017)

3.2.2.2. Definition of the representative groups in the local community

In order to have representative results covering a wider scope of those affected by sugarcane cultivation in Brazil, we aimed at assessing a diverse range of opinions. This we did by including stakeholders from the first sector (local municipal government officials), those in the private sector (urban entrepreneurs, sugarcane producers, and other crop producers) and others in civil society (workers, researchers and community leaders). These groups were validated at the same workshop which defined the statements of field research.

3.2.2.3. Respondents identification and appointments

The field research was carried out from April 2016 to October 2017. In the selected cities, we arranged interviews with formal representatives of municipal government (preferably the mayor), sugarcane and other crop producers (usually represented by land owners and producers trade unions in each municipality), workers' representatives (union of rural workers

of the city) and urban entrepreneurs represented by local commercial associations. The experts' group were accessed through rural agricultural department offices (Embrapa5) and professors and researchers from local colleges, when available. Lastly, the local communities' group were identified after initial approaches to local religious leaders, usually a catholic priest; from these interviews, new potential interviewees were generated using the snowball method (Atkinson & Flint, 2013; Biernacki & Waldorf, 1981; Browne, 2005). In order to avoid potential bias within the local sample, we sought for a balance between interest groups, looking for potential non-peers with different points of view in each town. Besides this, the large number of samples from local states, municipalities and neighbourhoods help to attenuate any influence from a major opinion maker in the region.

The interviews lasted on average 40 minutes, generating quantitative data (their positioning) and qualitative data based on their speech. As mentioned, the interviews were recorded and transcribed when permission granted, and using the software Fulcrum app.6 In the first stage of the meeting, the purpose and details of the interview were explained. The interview started with a section regarding the respondents' contact information, following some profile characteristics such as income, education level, age, how long they lived in the area, and whether they lived in a rural area or not (see appendix A). The respondents were then invited to score 17 themes - six social, six environmental and five economic topics.

3.2.2.4. Data analysis

In this paper, we use descriptive statistics to analyse the positioning of respondents recorded in our field research. For frequency analysis, we focused on the frequencies of the scores 4 and 5 (agreeing with concerns and seeing problems regarding each theme). In addition, the homogeneity of the scores for each issue was assessed using standard deviation.

The oral testimonials were then analysed using content analysis methodology (Bardin, 1977) with support of the software "MAXQDA7", which helps to illustrate the main reasons

[5] Embrapa (Empresa Brasileira de Pesquisa em Agropecuária) is the Brazilian Agricultural Research Corporation, a state-owned research corporation affiliated with the Brazilian Ministry of Agriculture.

[6] See www.fulcrumapp.com .

[7] See www.maxqda.com

and arguments behind the quantitative results. Such analysis allowed us to identify the main arguments behind the prevalent score of each theme presented, and to identify which groups of respondents are better aligned or not with the expansion of the crop. These results do not represent any kind of prioritisation of the interviewees since the question was not put in this way, even though some of them expressed their feelings on the theme during the open interviews. Lastly, secondary data and a literature review were used to confirm or not some of the information recorded in the interviews.

3.3. Results

Each of the 353 interviewees indicated their level of agreement/disagreement to 17 statements. However, in this paper we will focus on the general results of the whole sample. In the future, we will analyse the results for each of the profile categories, such as stakeholder, state, city, level of income or education. Appendix D presents the distribution of respondents according to these profile categories.

3.3.1. By thematic dimension

First, we present the aggregation by thematic dimensions, which reveals that the environmental issue is more prone to controversy than the others, since it has the least agreement compared with the two other dimensions. Table 2 describes the average rates by social, environmental and economic dimensions. For distributions of answers see appendix A

Table 4. Average rates by thematic dimension.

Dimensions	Social	Environmental	Economic
Mean	2.12	2.63	1.98
Standard Deviation	1.46	1.60	1.28
Frequency of "No opinion" %	5.23	6.45	3.96
Frequency of (4&5) %	27.18	39.10	22.68

On a scale from 1 to 5, the mean of results was situated around 2.5. The results show that the economic dimension is followed by the social one (2.12 mean and 1.46 standard deviation) as the most positive dimension for the respondents.

3.3.2.By sub-themes

The general analysis by sub-themes helps to understand which themes present greater contrast of views between local perception and the initial concerns of world civil society and academic representatives. The general results are described in the table 5:

Table 5Mean, standard deviation and frequency of disagreement regarding the stated concern.

Theme	Mean	Standard deviation	Frequency of "No Opinion" (%)	Frequency of 4&5 (%)
Inflation	3.41	1.579	5.10	61.80
Biodiversity	3.24	1.663	3.60	58.40
Air quality	3.07	1.595	1.40	55.50
Deforestation	2.82	1.671	11.60	37.40
Land concentration	2.59	1.649	10.40	36.30
Health	2.38	1.555	3.10	35.40
Violence	2.38	1.573	3.40	35.10
Soil quality	2.35	1.566	8.50	30.60
Water quality	2.17	1.545	7.70	26.60
Water availability	2.11	1.556	5.90	26.10
Traditional communities	2.01	1.411	12.50	21.20
Food security	1.76	1.384	1.50	19.50
Decent working conditions	1.62	1.193	0.50	15.60
Tax collection	1.80	1.319	9.90	14.70
Income generation	1.65	1.259	1.40	13.90
Business model	1.59	1.152	3.10	12.50
Job creation	1.45	1.092	0.30	10.50

See Appendix B for a full list of themes and statements.

The themes with a high level of agreement with global negative concerns are the inflation of prices, biodiversity, and air quality. Those themes also present the highest rates of

standard deviation, meaning larger differences of answers among the respondents with different interpretations.

The main disagreements from the initial concerns are job creation, the business model, income generation, decent working conditions, and food security. These disagreements show, additionally, the lowest levels of standard deviation, amounting to a more homogeneous set of responses. The disagreements of stated concerns mean the respondents did not validate those concerns as a real issue in their communities.

3.4. Discussion

The analysis of results uses the interview content to better interpret the quantitative results of the stakeholder positions. We will focus on the main reasons presented by the respondents to justify these perceptions.

3.4.1. Thematic dimension analysis

The highest level of disagreement regarding negative concerns on the economic and social dimensions shows that those concerns were not confirmed by the local stakeholders. Most of the time, those answers were followed by explanations and examples of opposite effects, in this case, positive impact. This is easily understood since economic and social themes are more tangible and easier to directly connect to the respondents' lives.

On the other hand, environmental issues have had a greater variability of perceptions and also received a higher frequency of "no opinion" among the respondents. Frequently those themes are not directly connected with the daily life of the respondents, especially those living in urban areas, and their opinions/perceptions are usually based on "I guess" or "I heard that" than from direct experience concerning the topic. In any event, even if those perceptions are not strong or based on the direct experience of the respondents, they represent the average opinion of the respondent´s network and remains valid for the purpose of this research.

We proceeded to the analysis by sub-themes, bringing elements from descriptive statistics, and taking into account local perceptions and relevant literature to consider and examine those results.

3.4.2.Sub-themes analysis

Even though the results showed that themes were situated around the mean (with none extremely bad nor extremely good), we classified the results into four groups regarding the perception of impact: (a) the most negative impact; (b) the most positive impact; (c) less relevant impact, and (d) new issues put forth.

3.4.2.1. The most negative impact

Higher means represent the greatest agreement with global concerns, meaning those concerns were mostly confirmed by local stakeholders. Themes with the highest standard deviation show that there is less homogeneity in the perceptions of stakeholders. Themes included in this group are:

Inflation (Frequency of agreement: 61,80%) – The results show that the highest agreement was with negative impact, mainly on land and rental prices. It was mentioned that, from the beginning of sugarcane cultivation to the construction of the plant, land and rent prices in the town increased due to the high influx of people coming to work on construction projects and also with the new perspective of the local area thriving. This perception is more intense/stronger in small cities, where the impact of the new business is higher than in medium-sized cities. Some respondents considered this impact as positive since it added value to owners' properties. In fact, if we consider the states of São Paulo and Goiás as a proxy, the value of agricultural land in expansion areas rapidly increased when the sugarcane sector arrived in the region (A. C. Marques Postal, 2014a).

Biodiversity (Frequency of agreement: 58,40%) - There were strong perceptions related to the existence of impact, but the descriptions by respondents varies from negative to positive. This variation is also shown by the high level of standard deviation of the theme. Examples of negative impact of the arrival of sugarcane cultivation on biodiversity are the decreasing number of animal species, especially many types of birds which cannot find places for their nests since the trees have been removed from the moors. In addition, "stable fly" (Stomoxys calcitrans) numbers have very greatly increased, which causes stress to cattle and therefore influences the milk industry, as the cattle fight the flies all day, losing weight and decreasing milk production. The appearance of this plague has been mentioned in many regions as a consequence of the arrival of sugarcane cultivation, since the irrigation of stillage in the crops would attract and foster the uncontrolled growth of this plague (Corrêa et al., 2013; EMBRAPA, 2009; Grisi et al., 2014; TV TEM, 2016) .

A third aspect connected to the theme of biodiversity is related to large and medium-sized species, such as mammals and reptiles. While some respondents attribute the disappearance of some species to sugarcane plantations, others defend that after the sugarcane arrival there is a larger number of medium- and large-sized species, which benefit from the existence of sugarcane crops, with no burning process, as a hiding place favourable to these animals' migratory routes. However, the polemic remains: the most frequent "sighting" of animals is due to a positive impact – the larger presence of species – or is it a sign of negative impact since these species do not find places in the forest and therefore migrate to areas around urban centres, where they are more frequently noticed? More technical research is necessary to better understand and clarify this perception.

Air quality (Frequency of agreement: 55.50%) - The third item with the highest level of agreement regarding the concerns was initially defined as associated to CO2 pollution. However, most respondents who agreed with this concern commented on three different aspects, namely: (a) the high incidence of dust on the roads and public streets, caused by frequent truck traffic during the harvest season; (b) the bad smell released by the stillage; (c) the burning of sugarcane, which spreads soot throughout the whole area.

Regarding dust on the roads, some respondents did mention that some sugarcane companies usually water the roads to avoid dust. The bad smell due to stillage is argued to be a brief problem since plants have frequently used the product as a crop fertilizer, preventing it from accumulating and causing a bad smell for the city, which is often far from the crop areas. Also, the process of burning sugarcane, a frequent source of complaints and impact on air quality, was common at the beginning of the operations but not anymore, since the compulsory mechanisation of harvesting and the use of straw for electricity generation now prevents sugarcane from being burnt.

Deforestation (Frequency of agreement: 37.40%) - This theme needs special attention because, even though most people do agree with the occurrence of this process, their explanations about it seem different from the formal definition of deforestation (Amacher et al., 2009; FAO, 2007; Mola-Yudego & Gritten, 2010; Moutinho & Schwartzman, 2005; Wunder, 2000). Therefore, the results should be carefully analysed. In fact, most respondents confirm that no native area, as defined by FAO (Løyche & Senior, 2010; Vermeulen & Cotula, 2010), was deforested for sugarcane expansion because their regions have been already used for other

agricultural or livestock activities. Also, the native forest deforestation actually happened a long time ago, usually more than 50 years previously. What interviewees call now as “deforestation” is, in fact, the legal removal of isolated trees in pasture areas, which had to be removed to facilitate harvest mechanisation and end the sugarcane burning process. Respondents refer to the impact of this removal on landscape and biodiversity, especially on birds, which cannot have their nests in these areas anymore.

Another fact of concern reported by several respondents, in all regions, was the illegal practice of burying cut trees in order to avoid the obligation of having to plant new trees in a new area. An explanation is necessary: even though the removal of isolated trees is allowed by law, the farmer must report it to authorities and plant new trees in a proportion which varies from 5 to 10 depend on the state or the type of removed tree. (For example, for each removed tree, 10 new or replanted trees are required in the state of Minas Gerais). The reported action was usually the same: trees are cut at night to avoid detection by local witnesses and authorities, and the trees are buried to hide the evidence.

Land concentration (Frequency of agreement: 36.30%) - This theme is naturally considered an issue in sugarcane cultivation activity since this sector has a history of vertical integration of production (when all feed-stock is provided by the own mill owner), which usually puts the land in the mill owners’ hands. However, during the 2000s expansion phase, the predominant business model to access sugarcane production was horizontal arrangements (with the raw sugarcane belonging to other land owners and producers, then bought by sugarcane companies through contractual arrangements), which avoids the land concentration effect (A. C. Marques Postal, 2014a)8. Nevertheless, some concentration of activities may have occurred as 36.3% of the respondents agree with this concern. The explanation is that even though mill owners prefer leasing the land, several land owners in traditional areas saw a new opportunity to increase their activities in a new frontier with cheaper land prices, while leasing their land to reputable, established companies and with that assurance. This is referred to by some stakeholders that mention “the size of properties does not change in the city [area] but

[8] See also the explanation of business models further in this paper.

several new owners from other cities or states have bought some medium/large farms and rented them to sugar mills." From a local viewpoint, there was no land concentration; but from a national point of view this concentration is clear, as owners from other states bought the land. More studies should be done to further explore and examine this topic.

3.4.2.2. Positive impact

The lowest frequency of agreement and, consequently, of means, indicates the lowest agreement with global concerns, being also a proxy to assess perceived better benefits of the arrival of sugarcane cultivation. Actually, the content analysis of these responses indicates there are several arguments and justifications for those with the lowest frequency of agreements. Additionally, these themes present a lower standard deviation value, showing a greater consensus among the respondents. Themes perceived as with positive impacts are:

Job creation (Frequency of agreement: 10.50%) - It is largely agreed among the respondents that the creation of jobs is seen as the greatest benefit of the sector's arrival in the region. This was one of the themes which generated the highest number of positive perceptions in the interviews, with various reports mentioning the increase of formalised contracts, higher salaries, more medical assistance, improved transportation, increase in security equipment, etc. In fact, according to (Moraes et al., 2015), during the period of 2000-12 the net increase of jobs in the sector was 69.8% (with a decrease of 7.4% in sugarcane plantation employees due to harvest mechanisation, an increase of 153.9% in sugar industry employment, and an increase of 205.2% in the ethanol industry). This effect exceeded the sphere of the mill employees, bringing indirect jobs to other sectors in the region enhancing the whole value chain. This conclusion is aligned with different studies by (Bacchi & Caldarelli, 2015a; M. L. J. Brinkman et al., 2018; Caldarelli et al., 2017; Caldarelli & Perdigão, 2018; IRENA, 2013; Mann et al., 2014).

Business model (Frequency of agreement: 12.50%) - Disagreement on the prevalence of vertical integration (via land acquisition) as the most common way of cultivating and processing sugarcane shows that horizontal arrangements as the new business model prevalent in the sector. These horizontal arrangements are based on different types of contracts and relationships between companies and farmers (leasing land, sharecropping, or spot buying from independent farmers) and usually means a more inclusive business model. When compared with vertical integration, this is a way for local farmers to participate in the sugarcane value

chain (Marques Postal 2014) and for including them in a share of those profits. Further, the farmers can continue working in the region where they live and invest their extra income from sugarcane activities into other local business activity.

Income generation (Frequency of agreement: 13.9%) – The growth of income in the region is a consistent perception among the respondents and aligned with academic literature (Bacchi & Caldarelli, 2015a; M. L. J. Brinkman et al., 2018; Caldarelli et al., 2017; Caldarelli & Perdigão, 2018; Satolo & Bacchi, 2009). These studies describe the relationship between the arrival of sugarcane cultivation and the growth of GDP per capita especially where the industrial mill is located. The respondents' comments that agree with this focused mentioning the growth of local commerce and the arrival of new business to the city, such as machinery maintenance, hotels, restaurants and other suppliers of the sugarcane company. This economic dynamism goes beyond the sector and people directly linked to the mill. Most respondents that agreed with the concern that the sector would not make a relevant difference on community income come from the largest cities in the sample, such as Rio Verde - GO, Umuarama - PR, or Dourados – MS, where economic dynamism was already in place.

Tax collection (Frequency of agreement: 14.70%) - Just 14.7% of the respondents agree that the increase of tax collection is not relevant to compensate for the negative impact of sugarcane arrival. Most of these respondents, 14.7%, live in cities where there is no mill and, consequently, the tax revenue remains low due to the absence of an industrial plant in the city, which would pay a kind of sales tax or VAT, the ICMS.9 This claim is a constant demand of small municipalities on the surroundings of mills. Since the ICMS tax goes just for the city where the industrial facility is situated, the small municipalities on the surroundings of mills often have to support the increased social costs of a larger number of inhabitants relocating to the region, without receiving enough taxes to pay those additional costs. However, the situation is better now with the current predominant horizontal business model, than it was in the previous expansion cycle. On leased land and sharecropping plantations, taxes are collected based on the services performed on the plantation. Therefore, at least the tributes over those

[9] ICMS – "Imposto sobre circulação de mercadorias e serviços", a type of sales tax or VAT or tax over sales activities

services (ISS)10 should be distributed to cities with sugarcane plantation area. The impact of sugarcane expansion on the municipalities' budgets was the object of studies of Chagas et al. (2011), which concludes that there is positive direct and indirect impact related to sugarcane expansion.

Decent working conditions (Frequency of agreement: 15.6%) - One of the main concerns of Brazilian academics and humanitarian organisations has been the quality of work conditions due to the historically degrading conditions for workers in this sector, especially because of the traditional manual process of cutting sugarcane. The hard task and the absence of minimal labour rights, such as having a formal contract or minimum wage, were common until several protests and the emergence of new legislation and monitoring of the sector (Laat, 2010; Ministério do Trabalho e Emprego Secretaria de Inspeção do Trabalho Para, 2010; Moraes et al., 2015).

This theme was one of the top concerns in the social dimension, but surprisingly the results in our field research show a different scenario. In fact, just 15.6% of all respondents agreed partially or completely with the statement that sugarcane expansion impacts negatively on working conditions. For the majority, 84.4%, the perception is a positive impact and exceeding the sphere of the direct mill employees, pointing out benefits also to workers in other sectors in the region due to the increase in demand for labour.

The most reliable explanation for the positive result regarding this theme is a combination of three factors: (a) the evolution of harvesting mechanisation (Bordonal et al., 2018), making the process much easier for workers and requiring more skilled employees (Carvalho, 2013; Novacana, 2015; Walter et al., 2014); (b) the scarcity of labour in regions of sugarcane expansion (with low-density populations), while at the same time huge dam projects were being carried out in the north of the country (Cavalcante et al., 2008). This created increased demand for labour, while the construction sector in Brazil was substantially absorbing people available for the mechanisation of harvest processing. These factors caused a competition for available workers, contributing to wage increases and better working conditions

[10] ISS – "Impostos sobre serviços", a tax over services provided

not only for the employees in the sugarcane sector, but also for workers as a whole; and (c) the increased scrutiny of importers from the EU and US, the main destination of Brazilian ethanol exports, that increased pressure to meet sustainability standards (R. Diaz-Chavez et al., 2015; Moraes et al., 2015). As a result, most cities reported better working conditions and higher wages for all sectors due to the competition for employees (Bacchi & Caldarelli, 2015b).

3.4.2.3. Less relevant impact

In the middle of the two extremes are those themes that have a frequency of agreement with global concerns scored between 19.5% and 36%. Although these numbers are still below the majority of respondents, meaning they see more benefits than problems on that set of themes, those themes were less "emphatically defended" by the respondents as a positive or negative aspect. Most arguments used to defend their points of view were linked to specific characteristics of their city or community.

Food security (Frequency of agreement: 19.5%) - This theme was considered to be worrisome by international organisations, and one of the main arguments against biofuel expansion (R. Bailey, 2008; Gomes et al., 2011; Marcatto et al., 2010; Schlesinger, 2014; Searchinger & Heimlich, 2015). The concern was distributed across many fronts, highlighting the decreasing land for planting food crops that, in their vision, would lead to a local lack of supplies and increased prices for the items, which would constrain access to food. From the literature review on this topic, a broad spectrum of aspects is included in this issue and their importance can vary depending on the specific geography that is been study. For this project we refer to the food security concept defined by Brazilian law (Lei de Segurança Alimentar e Nutricional, 2006), which focuses on regular access to quality food without compromising access to other essential needs (Frate & Brannstrom, 2015a).

The results of the interviews were analysed through descriptive statistics and MAXQDA qualitative analyses and showed that 80.5% of the local respondents don't agree that sugarcane cultivation impacts upon food quality or food access. Most respondents' arguments point out that the new areas of sugarcane cultivation substituted predominantly soybean monoculture cultivation and extensive cattle farming, bringing no impact in terms of quality or diversification of food at their tables. Since long time ago, items such as rice, beans and vegetables have come from different areas of Brazil supplementing local production. Testimonials in different regions indicated that certain edible crops had been banned from the

areas studied more than 30 years ago due to climate and market factors. Examples include rice in Minas Gerais, coffee in São Paulo state, and beans in Mato Grosso do Sul.

Another aspect mentioned indicates improvement in the access to food in some cities as a result of increased income and wealth enabling the increased presence of such food items in the local markets. These perceptions appear confirmed with studies by Escobar et al. (2009), Frate and Brannstrom (2015), Kline et al. (2017) and Rosillo-Calle (2019, 2012).

With a different view, 19.5% respondents agree with some impact on food production and the more frequent argument is the change in fruit and dairy production areas. Second, in their testimonials, the land use change of medium-sized properties to sugarcane cultivation occurs because the farm owner prefers to lease the land to a sugar mill since using their own family as workers is not so much an option anymore. Family members have increased their educational skills and have gained employment in other urban sectors and activities. There also is no longer an inexpensive workforce available for crop production as sugarcane mills have caused an increase in wages as well as better working conditions in the areas. These observations are in accordance with the findings of Novo et al. (2012) that also pointed out that Brazil's aging population is the main reason for small and medium-sized farm owners to lease their land to sugarcane producers.

Traditional communities (Frequency of agreement: 21.2%) - Communities of "quilombolas" (descendants of slaves) are not common in the researched area (three municipalities), and indigenous communities are present only in Mato Grosso do Sul state, in the cities of Caarapó and Dourados. From the interviews, the comments were of two kinds. First, those that disagreed with the negative impact (88.8%) said that there was no presence of traditional communities in their area, and in the case of Mato Grosso do Sul state, indigenous communities were included in the local society with several members working for a mill company. In addition, there is no land conflict with sugar plantations. Second, there were those that agreed with the negative impact of sugarcane cultivation, this in Mato Grosso do Sul, where only a few indigenous persons still worked for the company but they cannot meet productivity standards, and the land use change to sugarcane diminishes the opportunity for them to work on other crops, of which they were more suited (Rafael Cruz & Marques Casara, 2013).

In the other four states, negative perceptions of impact include mention involving the "colono". This is how people who work and live on the farms are called. when the land owner

leases the land to a company, the “colono” lose their work and have to move to the cities. But instead, nowadays most of them opt to work for the company – with better wages and working conditions than before and, since they begin to live in urban areas, they have better access to public education and other public services. Sometimes this change is positive, sometimes negative. In any event, the facts are that sugarcane cultivation in this context has significantly improved the lives of these workers.

Water quality (Frequency of agreement: 26.6%) - For most respondents (74.4%), there was no impact of sugarcane cultivation on water quality. Some of them claim that the better management of land by the companies helped to increase the quality of water, due to better contour lines and terraces, which avoid the silting and contamination of rivers and lakes. However, 26.6% of the respondents agree with some amount of impact; the most common explanation is the flow of chemicals through badly implemented soil preparation, as well as aerial pulverisation and some leaks or over application of vinasse on the fields.

Water availability (Frequency of agreement: 26.1%) - The availability of water is a critical issue to biofuel cultivation in many areas of the world. However, in the researched area this does not seem to be an issue for almost ¾ of the respondents. They usually justify their position using three main arguments. First, companies have been managing the water sources better than traditional farmers, taking care of land preparation in a way that conserves water. This includes avoiding planting close to rivers and lake springs, and protecting the spring areas from cattle. Second, the current water crisis in Goiás and Minas Gerais states is due to climate change and not only linked to sugarcane cultivation. This perception seems consistent with the findings of Diaz-Chavez and Vuohelainen (2014). Lastly, regarding Mato Grosso do Sul and Paraná states, these areas have a large amount of water and scarcity is not a problem at all.

For those who see some direct impact from sugarcane cultivation on water availability (26.1%), the most frequent arguments are that (a) sugarcane plantations use a lot of ground water, (b) the burning process reduces water springs, and (c) some producers are cutting trees affecting watershed areas.

Soil quality (Frequency of agreement: 30.6%) - Most respondents (69.4%) do not see negative impact from sugarcane cultivation on soil quality. Some of them argue the opposite, that the sugar mill improves the soil conditions with the fertilization process (calcarium, vinasse, phosphorus and others) in a frequent and controlled way. In addition, the construction

of contour lines and terraces to avoid erosion and the "direct planting" process (putting some straw on the soil to keep the humidity and to diminish the release of CO2) are procedures cited as examples of good practices conducted by mills. Those practices usually were not performed by the land owners before, as they are expensive tasks. In areas where the previous dominant activity was cattle raising, this argument is more frequent than areas where soybean cultivation was the prevalent activity.

However, analysis using MAXQDA shows groups that agree with some amount of negative impact. These respondents are concentrated in Paraná state, and they refer to higher ground declivity. It is because, due to the obligations of mechanised harvesting, companies had to enlarge the terraces and contour lines to enable the usage of harvesting equipment. This enlargement of terraces increases the risk of leaks in contour lines when heavy rains occur causing deep erosion. This impact is more frequent now with the mechanised harvesting than before, when manual harvesting was the standard. The consequences of harvest mechanisation on soil compaction seems to be a challenge and an important trade-off for the sector. This theme is the focus of some studies by Bordonal et al. (2018), Cortez et al. (2014), Jesus and Torquato (2014).

Violence (Frequency of agreement: 35.1%) - Respondents that agreed with the impact of sugarcane cultivation on increased rates of violence in the region used to justify their positioning by mentioning the increase of migrant workers for constructing mills and manual labour at the beginning of the mills' operation. The most common violence cited were petty theft, drug-related violence, fights, and arguments. In any event, 64.9% of respondents do not believe in any relationship between the expansion of sugarcane and violence rates since, in their viewpoint, mechanised harvesting ended the burning sugarcane process resulting in a smaller number of migrants, and those with higher skills. This analysis is aligned to the scores by state. For example, in Paraná state, the frequency of agreement with this concern is the lowest. This is perhaps due to the state's population density and available workforce, resulting in a lower number of migrants.

Health (Frequency of agreement: 35.4%) - 35.4% of respondents agree that the sugarcane arrival has brought some problems to the health system in their cities. The most common argument was the increased demand on the public health system, mostly in the beginning of the process or during mill construction, due to the sudden rise of temporary

inhabitants in the city. Even though the practice of burning sugarcane is no more in most places studied, as pointed out by respondents, a common complaint was respiratory illnesses when this process was in place. Few respondents mentioned traffic accidents caused by dust on rural roads that were used to transport sugarcane to the mills.

The 64.6% of those that did not agree with the negative impact of sugarcane arrival on the health system mentioned that some problems had occurred in the beginning of the operations but now the whole situation has improved. The main reasons for improvement that were mentioned include: the end of the sugarcane burning process, which reduced respiratory problems; health campaigns; the provision of private health insurance to employees, alleviating the demand on the public system; and, lastly, the increased number of doctors working in the city.

3.4.2.4. New issues raised by respondents

From the qualitative analysis with MAXQDA software, we can see that a new topic has emerged regarding the impact of sugarcane cultivation. During the interviews, farmers (sugarcane producers and other crop-producing types of stakeholders) mentioned concern about "bad" contract terms regarding the lease of land. Respondents mentioned concern about soil quality conditions, profit sharing, biodiversity loss, and other factors.

Since horizontal agreements seem to be the prevalent way for companies to access their main raw material, sugarcane, these agreements or contracts have a critical role in the governance and management of impact on environmental, social, and economic aspects of the business. Unfortunately, due to the lack of previous knowledge on sugarcane cultivation negotiation aspects, some contract topics were not very well clarified and defined. Land owners, however, received clarity experiencing the process. Some of the recommendations from land owners to improve contracts are: taking into account the costs associated with ceasing contracts for previous activity (cattle raising, soybean cultivation, etc.); the company's obligation to give back the land in a similar condition (fertility), payments for compulsory set aside land and legal reserves, etc. These issues require a deep and broad analysis in future research.

3.4.3.Main differences from the initial debate

By analysing the differences between concerns extracted from reports and the literature review of the 2000´s, used to set the themes of field research, and the current perceptions of local stakeholders, we could identify three main types of results:

3.4.3.1. Themes with comparatively different impact assessments

Regarding social concerns, important themes indicated by the international debate, such as worsening work conditions and food insecurity, were not confirmed. In fact, in the case of work conditions, the expansion of sugarcane cultivation is locally considered to have had among the most positive impact generated, with salary increases, formalised contracts, and access to benefits such as medical assistance and basic food provision. This positive effect has expanded beyond the sugarcane sector and spread throughout the labour market in the areas.

3.4.3.2. Themes with different meanings for local stakeholders

Some themes such as biodiversity, deforestation, and air quality were confirmed as the most common concerns of respondents. However, when examined more deeply, one can see that the understanding of the population on what each theme actually represents is different from the vision established in the international debate. Thus, for example, the matter of deforestation, identified as having major impact, is reported not as deforestation of untouched/native forests, but as the extraction of isolated trees in areas of pasture, which is the predominant type of terrain.

Also, the theme of biodiversity was prioritised by the respondents especially due to the appearance of a “stable fly” plague, which affects cattle, reducing milk production. Besides this, the impact on fauna, although undoubtedly existing, is at times expressed as a positive impact due to the larger perception of large animal species in the area, and at times is mentioned as a negative impact because of the lower frequency of certain bird species.

3.4.3.3. Themes with lower levels of expected negative impact

Most of the themes have low or almost no relevance from the point of view of local respondents. The reasons behind such analysis are: no occurrence of the specific problems in most of the researched area, such as displacement of traditional communities; and some themes had negative impact in the past but, due to changes in technology and/or process, the negative impact has ceased partially or completely, e.g., health-related concerns, levels of violence, reduced soil or water quality. From the analysis of the interviews, two main points can be extracted:

a) Most of the themes included in this research were not confirmed as having high negative impact by the stakeholders directly in touch with the effects of sugarcane cultivation expansion. In addition, even though some themes were

confirmed as having potential negative impact, their intensity is lower than initially thought.

b) From the results presented, one can say that a public policy was essential for a general positive result in the sector: the obligatory ending of the sugarcane burning process in harvesting. In fact, all of the companies had to be mobilised to adapt to the new reality, and in 2011 about 80% of all sugarcane harvested in the Centre-South region of the country was already harvested in a mechanised way, according to data in the last Varietal and Productivity Census available.11

In fact, according to the respondents' perceptions, the measure of ending sugarcane burning had positive impact concerning several topics considered relevant to international organisations and local stakeholders. In the environmental field, several interviewees link the end of the sugarcane burning process with the end of nutrient loss in the soil, the greater preservation of the local fauna (biodiversity) and the improvement of air quality (less smoke and soot). In the social field, several responses indicated that the end of sugarcane burning accelerated the process of harvest mechanisation, improving the working conditions of rural workers, improving health in surrounding communities by reducing respiratory problems related to fires, and also reduced the migratory influx for manual harvesting processes, which positively impacted the respondents' security perceptions. In the economic field, it has been said many times that although the mechanisation had reduced the numbers of jobs, the quality of jobs has increased. Moreover, new business sectors linked with the mechanised harvesting process brought more attractive jobs to the region.

3.5. Limitation

To our knowledge, the current study is the most extensive research on the local stakeholders' viewpoints regarding the social, environmental, and economic issues involving the sugarcane ethanol sector in Brazil. Due to the broad geographical area covered by the field

[11] Centro de Tecnologia Canavieira (2011).

research, and the number and diversity of types of stakeholders, the patterns identified in the field research present a meaningful overview of local communities' perception and awareness in the Centre-South region of Brazil. Even so, due to the chosen criterium to define the geographical area for interviews (regions with high rates of sugarcane plantation growth), some issues maybe have been unintentionally underappreciated.

The perceptions of local stakeholders can serve as a proxy of reality and a good tool for exploring topics of impact assessments. However, real impact should be assessed utilising complementary methodologies specific to each one of the studied issues, which were out of the scope of this research. Moreover, for other regions (e.g., Northeast of Brazil or other countries), the relevance of issues may differ due to different socioeconomic contexts. Therefore, repeating the survey shall be valuable for other regions. Additionally, due to the objective of this study of listening to local people, the expert stakeholders' survey was out of scope since they live in big centres far from producing areas. Conducting another survey of expert stakeholders would complement the different perspectives and could considerably enhance and add value to the research results.

3.6. Conclusion

The objective of this study was to identify the local perceptions and main concerns about biofuels expansion in Brazil and improve understanding about the its potential impact using the viewpoint of local stakeholders directly exposed to those impacts. To improve the robustness of this knowledge, we designed a field research that includes, at the same time, local stakeholders' perceptions and a broader geographical area (different regions and cities in five Brazilian states). This study aims to show a more representative view of different experiences and avoid the pitfalls of small samples, which may not necessarily represent the overall experience of expanded sugarcane cultivation in Brazil. To do so, the main themes and alerts / concerns put forth during initial debates and in the literature were identified, and questionnaires were formulated which served as a basis for the field research in the sugarcane expansion area.

Quantitative and qualitative analyses led to determining that the population has a generally positive view of the effects of sugarcane expansion in their region, although there is room for improvement. Some of the analysed themes have different meanings and results locally than previously put forth in academia and general civil society. There are new issues to be tackled— better and clearer contracts involving the lease of land, and the phenomenon

resulting in the burying of isolated trees to avoid the cost of legally having to plant new trees, which is an unwanted and negative consequence, but not the same thing as deforestation.

Including local viewpoints in a representative manner enabled us to better identify impact which was not foreseen. Furthermore, it contributes to our understanding about the advantages and limitations of biofuel expansion from local and global viewpoints. Future studies, however, can analyse if the different types of impact were equally distributed among regions and types of stakeholders. This research helps policymakers to develop new policies, or enhance existing ones, regarding first-generation biofuels by taking into account local stakeholders' perceptions.

Declaration of interest

None

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Chapter 4

4. Inclusion in the expansion of sugarcane in Brazil: local perceptions on how and why

A shorten version of this chapter is under revision of Journal of Cleaner Production (Elsevier) as:

Marques Postal, A., Felício,A. Asveld, A., Osseweijer, P., Da Silveira, J.M.F.J. 2020. Expansion of sugarcane in Brazil: how inclusive was its impacts from local communities´ perspectives.

Abstract

In Brazil the ethanol production cycle in the 2000s occurred within a context of intense market deregulation, international liquidity of capital and the emergence of a global call for sustainability that strengthened clean and renewable energy markets. Large investments in co-generation projects, expansion of ethanol mills and new greenfield facilities took place within this environment. However, concerns have emerged regarding the social and environmental aspects of this crop and the expansion process for biofuel production, slowing down the transition to a biobased economy. Specifically, it was unclear whether the Brazilian expansion process achieved inclusive local development in which social aspects are a key goal. Therefore, this article aims to verify the extent to which the Brazilian sugarcane expansion process achieved inclusiveness in order to form a complete understanding of the impacts of biofuels. For this analysis, we focused on four aspects of the impacts: business model to access sugarcane, land concentration, working conditions and food security. Each of these impacts are analysed comparing local stakeholders' perceptions (collected through field research) with secondary data from official databases. The results show a change in the business model of crop acquisition that implies the inclusion of farmers into the sugarcane value chain, a positive impact on working conditions due to the formalization of contracts and a positive impact on food access, one of the dimensions of food security. The conclusions highlight that the local stakeholders perceive inclusion as an outcome of this process represented by better living conditions in their communities, even though these inclusive outcomes may be not enough to guarantee long-term progressive and sustainable wellbeing

Key words

Inclusion, sugarcane expansion, local perception, food security, working conditions, land concentration

4.1. Introduction

Sugarcane plantations were one of the first economic activities developed in Brazil and have historically been linked to economic cycles and public policies that guided, boosted, or delayed the growth of the sector (Sparovek et al., 2007; Vian, 2002). Since then, cultivation has been associated with the economic strength of the sugar trade and land concentration in the hands of a few mill owners. The land concentration happened as a consequence of the plant's expansion model, based on the vertical integration of production, and ended up intensifying the concentration of income and causing even greater social inequality and exclusion (Garcia et al., 2015). Additionally, the degrading working conditions were worsened by the operational characteristics of the cultivation and harvest that involved manually cutting the cane, pre-harvest fires so that the cane could reach the mill without straw, and a seasonal activity that favoured informal labour arrangements. Cases of mistreatment, deaths from exhaustion, non-payment of labour rights, lack of personal safety equipment, and even lack of food are still happen, although with much lower frequency (Laat, 2010). As a result, the sector's image was justifiably exclusionary (Gomes et al., 2009).

This bad reputation was reflected in concerns related to the sustainability of various aspects of biofuel expansion contributing to slowing down the transition to a biobased economy. The social dimension was also questioned regarding its potential exclusionary impact on food production, expulsion from communities, bad working conditions, among others (Mol, 2007; Reeves, 2016; Ribeiro, 2013; Rutz & Janssen, 2014; Wilkinson & Herrera, 2010). Regarding the environmental side, limited reduction of CO2 emissions, impacts on soil and water quality and deforestation are among the other issues of concern (Azadi et al., 2012; R. A. Diaz-Chavez, 2011; Duarte et al., 2013; Luiz A. Martinelli & Filoso, 2008).

Despite the sector’s persistent bad reputation, some researchers argue that the expansion cycle in the 2000s may have had a positive and deep inclusive impact on the sector's dynamics. The liberalization of markets in a more globalized business context, with environmental objectives (clean and renewable energy, government mandates to produce a cleaner energy matrix) in addition to the international liquidity of capital, attracted a new profile of investors to the sector and, while it allowed for the expansion of markets, it also brought major international scrutiny of sectoral practices and hence improvements (Bunde, 2017; A. Marques Postal, 2014; Moraes & Zilberman, 2014). The result of this behavioural change in the sector

would put sugarcane as one of the best types of biofuels in terms of inclusion and poverty alleviation as well as environmental aspects of sustainability (Caldarelli et al., 2017; Coelho et al., 2006; Moraes et al., 2015; Rosillo-Calle, 2012b). Table 6 presents how the main drivers influenced the expansion process from 1998 – 2012

Table 6 - Main drivers for expansion from 1998 to 2012

Period	Main drivers	Characteristics and trends
1998 to 2003 The triple impulse	• International sugar market expanded with the end of bilateral agreements and price increases; • Opportunities for energy cogeneration from bagasse; • Launch of the flex car;	• Consolidation of the Cosan Group (national); • Brownfield[12] acquisitions; • Focus on the traditional São Paulo region;
2003 to 2008 Financial liquidity and environmental concern	• Expansion of demand through international public policies; • Emergence of the environmental issue; • International financial liquidity;	• Entry of international groups; • São Paulo brownfields and overflow to other states; • Greenfields[13] in other states;
2008 to 2012 Financial crisis and strong demand	• International financial crisis; • Continued growth in international demand sustained by public mandates for adding ethanol to gasoline in different countries; • Maturation of greenfield projects;	• Lower prices for acquisition; • Groups in debt due to expansion and crisis; • "Opportunistic" acquisitions;
2013 to 2020	• Loose of traction on the sector´s growth • Political and institutional instability impacting the long-term planning of investors; • Decrease in fossil fuels prices	• Lack of investors keep the low attractiveness of the sector; • Opportunistic acquisitions • Bankrupt companies.

Source: Adapted by the authors from Marques Postal, (2014)

To be aligned with sustainable goals of social inclusion and transition for cleaner energy sources, it is important to see how this value chain is sharing its value better than in the past or

[12] Brownfields refer to the expansion through acquisition of existing companies;

[13] Greenfields refers to expansion through new companies from scratch.

if these changes are perceived by society as generating positive results for community-wide development and not just for an elite with ownership of the sector's assets. That said, the research question is to what extent can the biofuels expansion cycle be considered inclusive? Does this expansion cycle provide elements that positively impacted inclusive local development?

In order to answer these questions it was not enough to gather information from the global debate (academic and civil society reports) since this literature contains highly aggregated data, generalized results for different crops, case studies with low representativeness and an underrepresentation of the communities involved (Jordaan, 2007; Petrini et al., 2017; Ribeiro, 2013). This underrepresentation, in fact, calls into question some of the results of the debate and indicates the need for studies where the perception of local actors is considered in an inclusive manner (Vermeulen & Cotula, 2010). To fill this gap, field research in agricultural areas of sugarcane expansion was seen as the best way to include local community perceptions in the debate. Additionally, as stated by World Bank,(2013)

> *Attitudes and perceptions matter for social inclusion because people act on the basis of how they feel. Their feelings of being included and respected are central to the opportunities they access and the ways in which they take part in society. (World Bank, 2013)*

It requires to clarify that the focus of this article is on the perception of inclusion of local stakeholders in the surrounds of sugarcane plantations, defined here as the excluded target group who were underrepresented in the debate of the last decade on sugarcane's potential impacts. We also define "inclusion" as the improvement in wellbeing and accessibility, considering a group of indicators related to the following themes: business model, land concentration, working conditions, and food security.

These four themes are frequently mentioned in national and international publications as being critical and they were chosen due to their particularly relevance in both the Brazilian and international contexts, since they stood out as structural elements of the exclusionary character of the sector. The issue of the vertical integration business model to access sugarcane (Almeida & Buainain, 2016; Lima, 2010; Picanço Filho & Marin, 2012) is considered one of the reason for land concentration since colonial times of Brazil. The consequent land concentration is typical of structural social inequality since it concentrates income and capital

(Bordonal et al., 2018; Borras et al., 2010b; Frate & Brannstrom, 2015b). The bad working conditions in the sector (Martinelli & Filoso, 2008; Moraes et al., 2015; Petrini et al., 2016) is also a reflex of the structural inequalities and, at the same time, can perpetuate the vicious cycle of bad working conditions, low expectations, bad education, bad working conditions again. The fourth theme, food security, is one of the main concerns worldwide (Benites-Lazaro et al., 2020; Escobar et al., 2009; Harvey & Pilgrim, 2011c; Luiz Antonio Martinelli & Filoso, 2009) and given the global value chain interconnection should also be analysed even though is not considered as a main topic in the Brazilian context (A. Marques Postal et al., 2020).

The article begins by presenting the methodology used and the format of the field research, which was done aligned with the institutional rules for agreed consent of interviews, and which carried out 353 interviews in five states of central-south Brazil to get a representative overview of the developments in expansion areas. In sections 3,4 and 5 the literature review, field research and secondary data results are presented for each of the proposed themes with a final remark on their inclusiveness. Section 6 discusses how inclusive the expansion process was for the selected themes, followed by the conclusions and recommendations.

4.2. Methodologies

4.2.1.Field research interviews

The dataset used for the present study partially overlaps with the data set of Marques Postal et al., (2020).

4.2.1.1. Data collection

The field research, following the ethical procedures of the university and aligned with Helsinki Declaration (1983), was carried out from April 2016 to October 2017 in 33 municipalities in which high growth rates of sugarcane planting took place after 2000 (Appendix C) and in companies that began operations after 2000. (Appendix E). The focus was placed on areas of "new expansion" to capture stakeholders' perceptions of the recent change in the local context. In each semi-structured interview, which took around 40 minutes, respondents were invited to agree or disagree with statements (Likert Scale). In order to capture a diverse range of perceptions we included stakeholders from local government, civil society

represented by community leaders, workers (sugarcane cutters, rural workers of other crops, urban worker) and experts (consultants, agricultural technicians from agricultural govern secretaries), and private sector workers (sugarcane producers, other crops and cattle producers and urban entrepreneurs). The mill representatives were not included in the research since the focus was on local community perceptions. It is understood that the mills are already well-represented through sector associations at a national and international level. Formal groups such as local government, workers unions and rural producers' unions were contacted in advance to schedule the face-to-face meetings. Informal groups such as community leaders, other crop producers and urban entrepreneurs were identified by approaching key opinion leaders who indicated other local leaders using snowball sampling (Atkinson and Flint, 2013; Biernacki and Waldorf, 1981; Browne, 2005). A range of seven interest groups were chosen in order to avoid any potential bias. A large number of respondents from different regions (353 from 5 Brazilian states) was chosen to enable statistical relevance and avoid unbalances due to strong opinions14. See Appendix F for the respondents' distribution and profile.

4.2.1.2. Data analysis

Circa two thirds of stakeholders (varying by question) also agreed to register and share their perceptions and opinions on each of the topics raised (as requested by Ethical procedures of the institution). This made it possible to better capture effects that were not portrayed by official statistics (due to a lack or granularity of data). All interview files were organized using the MAXQDA15 software version 2020.0.7. This software allows the researcher to coordinate the entire coding process and result analysis (Kuckartz & Rädiker, 2019)16 . The categorization framework proposed by (Gibbs, 2008) was used to perform the data analysis. In other words, all the topics covered in the interviews, according to each question in the interview script, were

[14] Further studies are being developed about different perceptions among regions and among types of stakeholders.

[15] www.maxqda.com

[16] (1) Table of frequency to identify repetitions and similar words,
(2) Word cloud to define the main terms;
(3) Expressions cloud to identify meaning and codes
(4) Content identification to organize the tendencies in the argumentation

grouped into categories and after the content analysis were reorganized into subcategories. Figure 1 represents the phases of coding and content analysis.

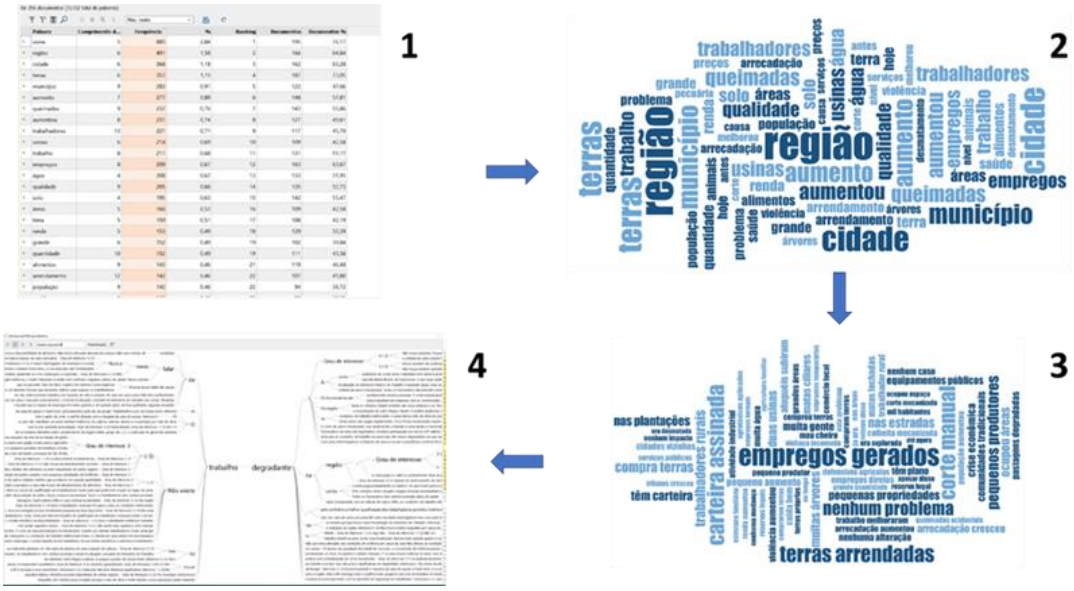


Figure 6 Phases to analyse the interviews and create code and sub-codes, after Gibbs, 2009

After this process, another content analysis was carried out to group the statements for the elaboration of the subcategories in a hierarchical structure. Finally, these hierarchical structures were presented in each thematic discussion to facilitate the understanding of how the arguments are grouped. The figures which represent the content analysis results in this article use the thickness of lines and colours to emphasize the different opinions and the frequency of each type of argument.

4.3. Business model[17] and land concentration: results and analyses[18]

The need for the mill owner to guarantee the supply of the main raw material, sugarcane, has always justified the "land concentrator character" of the sugar energy sector (Vieira, M. C. A.; Lima, J. F.; Braga, 2007) . Thus, planting was almost always on their own land and any expansion required the acquisition of more land, thus increasing concentration. This situation only changed in 1964 with the promulgation of the "Land Statute"19, which required the purchase to be made by other independent suppliers (Vian, 2002). In practice, however, such separation of roles has not occurred since the ownership of the land still largely belonged to the mill owner and his family (succession). Lima, (2010) characterizes the "traditional" format of sugar-energy expansion as that based on the acquisition of land for planting by the mill itself (vertical expansion) and, therefore, concentrations of land ownership.

A new profile of large corporations, national and international (Castillo, 2016; Figliolino, 2012), caused the traditional mode of land acquisition (capital immobilizer within the company) to give way to a model of horizontal contracts or "horizontal arrangements" (Lima, 2010) with leases lands, sharecropping and independent suppliers to access sugar cane, favouring more capital liquidity and investment in areas considered core business - the processing of cane and its products (Marques Postal, 2014) . This new investor profile was only possible because of radical changes in the international context such as sugar market trade liberalization (Pinto, 2011), international capital liquidity (Nascimento, 2011) and strong global demand for clean energy (Conejero et al., 2010). These changes in the business model impacted not only company finances, but primarily the dynamics of local development as it allowed more local actors to participate in capturing the value of this business chain (Marques Postal, 2014; Reydon,

[17] The term "Business model" here is used as the strategy to getting access to the main raw material – the sugarcane (A. Marques Postal, 2014)

[18] Due to the great interconnection between forms of access to sugarcane and the concentration of land, the two themes will be analysed together in this section.

[19] Law nº 4.504, 11/30/1964

Bastiaan; Marques Postal, 2016), and, in this sense, was more inclusive in terms of sharing the revenues generated by the sector.

However, it is necessary to understand the extent to which the “new way of accessing sugarcane” predominated in the sugarcane expansion cycle and whether or not this new business model managed to change land concentration in these regions, given its importance in the inclusion issue.

4.3.1. Local perception on business model and land concentration

Local perceptions were included in the analysis of structural changes in sugarcane expansion areas using both quantitative positioning for each theme and a content analysis of the underlying arguments.

4.3.1.1. Quantitative positioning on the business model and land concentration

The positioning analysis of the 353 respondents shows that 84.4% did not agree with the statement “The mills access sugarcane through planting their own lands (land acquisition/vertical integration). Leased lands, partnerships, and supply contracts to access sugarcane are the minority”, meaning that a large proportion of the respondents understand the "horizontal arrangements" as being the prevalent business model for expansion in the area[20]. A lower proportion of 53.3% did not agree with the increase in land concentration in their regions as can be extracted from the statement: “The arrival of sugarcane caused land concentration in the hands of a few people/companies”[21]. This demonstrates the greater uniformity of opinions on the business model theme than for land concentration and thus raises the question: why are perceptions about land concentration so divided if the perception of access to cane through contracts (and not land acquisition) is so prevalent?

4.3.1.2. Content analysis of the business model and land concentration

The study of perceptions through content analysis confirmed the prevalence of horizontal arrangements (leased land, sharecropping and types of supplier contract) as presented in Figure 7.

[20] 3.1% of respondents said they have “no opinion” on the theme of business model prevalence.
[21] 10.4% of respondents have “no opinion” on this statement about land concentration.

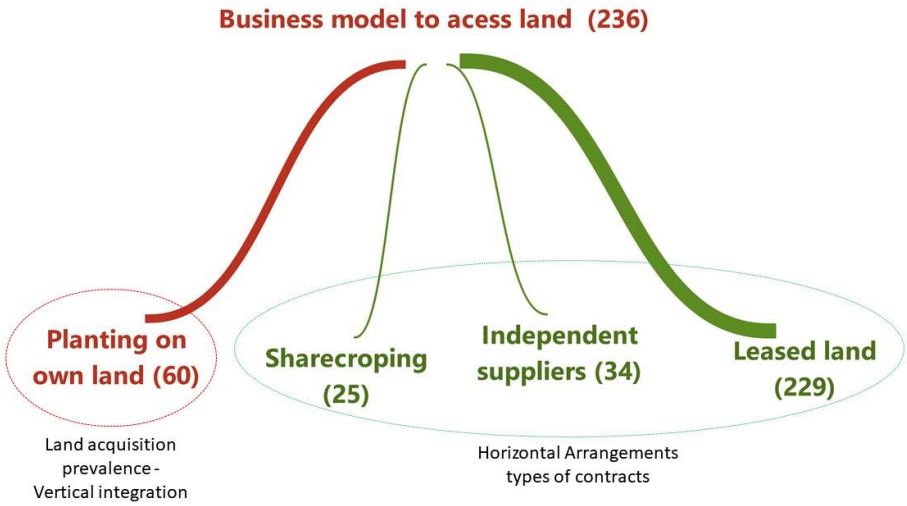


Figure 7 Business model to access sugarcane - main comments from field research

Source: Prepared by the author using Maxqda software

The strategy of leased land was mentioned 229 times by the 236 (registered) respondents and, together with sharecropping (25) and independent suppliers (34), shows the prevalence of horizontal arrangements to access sugarcane. Planting in the mill's own land as a predominant strategy was mentioned by 60 people.

Regarding the comments on land concentration, the content analysis presented a weaker (108) homogeneity among the respondents (196) as can be seen in Figure 8. The width of arrows defines the frequency of comments.

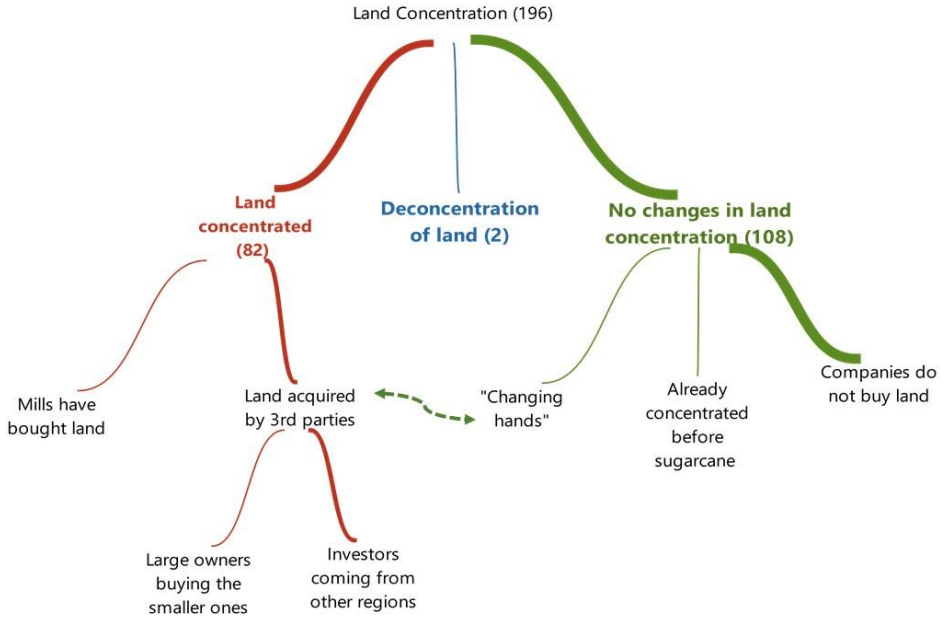


Figure 8 Land concentration main comments from field research

Prepared by the author with Maxqda software

The majority of respondents (green path) stated that there were no changes in land concentration due to the arrival of sugarcane in the region, justified by the fact that mills rarely buy land, or the land was already concentrated before the arrival of the sugarcane, or because they only perceived a “changing of hands”. 82 respondents note that there was some concentration of land. These perceptions were already expected in cities where the vertical business model predominated (for example in Turvelândia- GO, Vicentina – MS). However, this perception also occurs in other regions where leases and partnerships are the predominant ways to access sugarcane (ex. Bom Jesus de Goias – GO, Dourados – MS). How can this apparent contraction be explained?

A more detailed analysis of the answers and arguments allows us to understand that the acquisition of land to plant sugarcane by third parties (and not by the company) leads to this perception of concentration. The testimonies indicate that, although 108 respondents did not perceive a change in the size of the farms (concentration of use), 82 do mention "concentration of title" (or concentration of ownership). This was explained by the fact that even in regions where the companies rarely bought land, several investors from other (more traditional) regions of sugarcane sought out the expansion region to acquire cheap land and then lease it to the mill to capture the valorisation of the asset. This perception is also related to the "changing of hands"

justification used by those who perceived that there was no concentration (Figure 4). Therefore, the acquisition of land by investors other than sugar and ethanol companies justifies the perception of land concentration even in cities where the predominant business model to access sugarcane is the horizontal arrangement. We used secondary data to establish whether or not this perception reflects the reality.

4.3.2.Secondary data analysis

The analysed data were used to verify three issues emerging from local perceptions: a) the prevalence of a horizontal arrangement to access sugarcane; b) the concentration of land in the area; and c) the impact of changes to this business model on the land structure and inclusion.

4.3.2.1Horizontal arrangements

Table 7 shows the results of the comparison between changes in the composition of land tenure in the five states and the corresponding municipalities in the sample using data from the Agricultural Census from 2006 and 2017.

Table 7 - Variation of Legal Tenure categories - Sum of Total Area by category in ha: 2006-2017

	Goiás		**Minas Gerais**		**Mato Grosso do Sul**		**Paraná**		**São Paulo**	
Legal Conditions of the lands/ Evolution 2006/2017 (%)	Total	Sample	Total	Sample*	Total	Sample	Total	Sample	Total	Sample
Own Lands	-7	-9	8	-12	-9	-26	-14	-39	-24	-23
Leased Lands	92	56	161	202	118	116	66	213	43	40
Sharecropping	164	150	70	978	491	122	55	238	226	919
Horizontal Arrangements	98	62	143	234	148	117	64	221	90	139
Others (occupied + concessions)	51	123	67	27	74	35	9	67	88	-37
Total Agricultural Land	**1**	**4**	**15**	**5**	**1**	**-2**	**-4**	**-19**	**-3**	**-12**

Source: IBGE - Censo Agropecuário, 2006 and 2017.

* Uberaba is an outlier due to its larger and complex economy and smaller portion of agricultural areas and because of that it was not included in the sample

A reduction in the category "own lands" and the growth in the horizontal arrangements in agriculture is evident. In two states, Goiás and Mato Grosso do Sul (strongly marked by historic high levels of land concentration), the presence of horizontal arrangements grew faster than observed in the municipalities of the sample, suggesting the adoption of these arrangements for other crops, such as soybean and corn.

The substitution of pastures for sugarcane and other crops in some regions of Mato Grosso do Sul has contributed to the growth of these forms of land tenure that separate exploitation and

property of land. In the states of Minas Gerais, Paraná, and São Paulo, the preference for any of the two types of horizontal arrangements has resulted in faster growth than in the other states in the sample. In sum, horizontal arrangements in regions with increased agricultural exploitation of the land are observed, and particularly prominent in municipalities dedicated to sugarcane plantations.

This means more opportunities for local farmers to participate in the sugarcane chain, thus sharing value with local farmers and bringing development to the local community. The increased chances to capture value from the sector could also result in greater inclusiveness. In the past the strategy of vertical integration was responsible for dislodging several local farmers to urban areas and for the loss of agricultural knowledge. Using the new model, it is possible that local farmers maintained their traditional crops in part of their land while receiving some income from contracts with sugarcane mills. Such arguments for using the horizontal arrangements were mentioned by some respondents who comment that:

> *"Contracts with sugarcane was salvation from the financial crisis caused by "Asian soybean rust" (Phakopsora pachyrhizi)". (Goiás)*

> *"A sugarcane contract means an income opportunity, an opportunity to live in a dignified manner since the farmers are now older and do not have the workforce to manage their lands". (São Paulo)*

> *"The leased land was good for farmers. Many did not have the capital to invest in production, pastures and other activities and through the lease for sugarcane they received revenues that would allow technological improvement in other activities of their land". (Minas Gerais)*

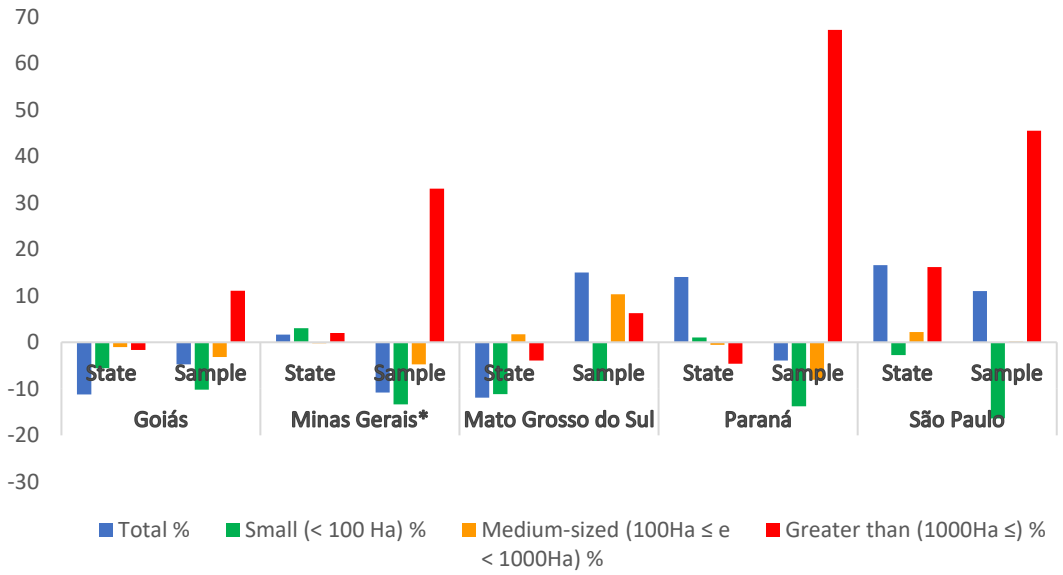
This evidence leads us to believe that the changes in the ways to access sugarcane have created a more inclusive business model helping to distribute income and wealth. Furthermore, given the prevalence of a horizontal arrangement business model, it is possible to assume that either no or small changes took place in land concentration.

4.3.2.2. Land concentration

The analysis of land concentration can be approached in two ways. Firstly, the concentration of land ownership helps us understand the movement, described in interviews, of outside investors buying land in the region (concentrations of ownership) and leasing the land to sugar mills (horizontal arrangements). Unfortunately, this approach requires data on the land´s title ownership, which, according to Brazilian law, is not available to the public.

The second approach analyses the changes in rural property sizes (concentration of use) and requires the analysis of official data related to the size of rural agricultural organizations in each municipality of researched area. For this we grouped the properties into 3 main groups: small (less than 100 hectares), medium (between 101 and 1000 hectares) and large properties (more than 1001 hectares). The variation of the average size of each group of properties by state and by the researched area is presented in Graph 2. The negative variation means a decrease in the average area of properties.

Graph 2 Variation of Average Area of Agricultural Establishments by hectare (%) 2006-2017



Source: IBGE - Agricultural Census, 2006 and 2017.

* Uberaba is an outlier and was not included in the sample

The set of establishments with a size equal to or more than 1000ha (large-sized) showed a positive variation (increase in average area) stronger in sample areas than the average in each state. The establishments considered as small (<100ha) had decrease in average size) in all regions analysed by the

sample. The medium-sized establishments (100ha≤ and <1000ha) showed low expressiveness in the variation (SP and MS displayed positive variation, and PR, MG and GO had negative variation). The results show a higher land concentration in the samples of our research in comparison to the states in which these samples were taken.

In contrast to the majority of stakeholders saying that the concentration of land did not increase, when the evolution of the average size of properties was evaluated, secondary data indicate that such phenomenon did occur, albeit only slightly. However, it was not possible to analyse the data using the land title (to confirm the concentration by ownership and the acquisitions of land by investors from other Brazilian states) since Brazilian law prevents access to official data due to privacy issues. Therefore, we used the primary perceptions of local stakeholders, together with other contextual evidence as a proxy for reality, that there is “some” land concentration with the arrival of sugarcane.

Interestingly, the land concentration was not driven by the companies, which in general prefer not to acquire land and have a prevalence for horizontal arrangements, but indirectly by third-party investors who came from other areas in order to capture value from the “promising sector" at the time. So, despite the confirmation of horizontal arrangements as the prevalent business model, some land concentration was not prevented, once it was driven by market forces, usually executed by other investors outside the region.

In sum, a degree of inclusion for local farmers was achieved through better opportunities for participating and capturing value resulting from the prevalence of the horizontal arrangements, but those effects were reduced by the indirect concentration of land caused by land acquisition by outside investors (concentration by ownership). Gini index analysis showed a decrease in land inequality in the majority of the sample area (19 of 34 cities). However, in order for this conclusion to be interpreted as an inclusive effect from the positive impacts in sugar cane expansion further research is needed to better understand the extent of land concentration and how this relates to inclusion and exclusion.

4.4. Working conditions

The manual cutting of sugarcane, process which requires the largest number of workers in the value chain, leads to many complaints from humanitarian NGOs, academia, and different

stakeholders in Brazilian society and abroad. This issue has been identified in several academic studies (Actionaid, 2010; Cordeiro & Boas, 2008; Dahlbeck, 2004; Marshall, 2009; Ribeiro, 2013; Rutz & Janssen, 2014; Szmrecsanyi, 2008; Wilkinson & Herrera, 2010).

As cane cutting is a seasonal and intensive activity, thousands of the workers used to come from other regions of the country for the "harvest season". With precarious housing conditions, these workers were known as "boias frias" (cold meal) to indicate that they were eating their lunch cold since there was nowhere in the field to warm up the food brought from home. As they were coming from distant areas, many workers were exploited by contractors in terms of low and irregular payment, informal contracts and no additional benefits. With very low wages defined by productivity, they had to work very hard to receive enough to cover their basic needs, and as a result many of them developed health issues. A series of strikes in 1984 began to expose this issue (Veronezzi, 2015) and the social situation of sugarcane workers became a society-wide concern.

With increased social exposition of the inequalities, the sector became the focus of several public policies aiming for better working conditions. This, together with international scrutiny of environmental issues and evolution of the harvest technology promoted better conditions for the whole industry. Some authors advocate that changes in the value chain transformed it from a sector rife with inequality to one that promotes poverty alleviation (Bacchi & Caldarelli, 2015b; M. Brinkman, 2018; Gilio et al., 2016; Souza et al., 2015; Wilkinson & Herrera, 2010).

Although some studies analysed aspects related to increased jobs and income, fewer studies focused on the quality of working conditions from the perspective of local stakeholders. Improvements were expected due to harvest mechanizations and human rights issues under scrutiny from national and international organizations, but to what extend were these elements perceived by the local community? Which elements represent the improvement and inclusiveness of working conditions?

4.4.1.Local perception of working conditions

4.4.1.1. Quantitative positioning

When faced with the statement: "The arrival of sugarcane in the region increased the frequency of workers in degrading conditions" the answers showed that 83.9% of respondents did not agree that working conditions worsened as a result of the arrival of sugarcane. The

several examples of positive impacts commented by respondents show that quite the opposite was perceived.

4.4.1.2. Content analyses of interviews

After the first exploratory analysis of the consented 222 interviews on this theme, the results are presented in Figure 4.

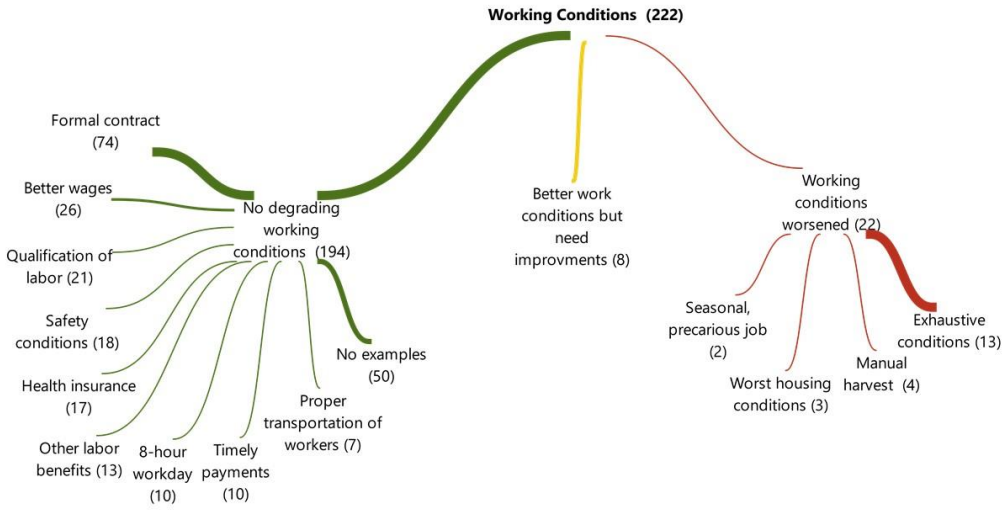


Figure 9 Working conditions - main comments from field research

Source: Prepared by the author using Masxqda software

Figures = number of comments under this code/theme

The three main sub-themes extracted from the analysis were a) those who disagreed with the presence of bad working conditions in the region (87.4%), b) those who agreed that the working conditions deteriorated (9.9%) and c) those who agreed that the conditions improved, but feel there is still the need for improvement (3.6%). Among those who agreed that conditions had worsened, 13 did not give specific reasons, 4 mentioned the manual cutting process and the others referred to the seasonal, precarious nature of the job and bad housing conditions. The stakeholders who perceived better working conditions but still see room for improvement also mention the exhausting routine (7), the irregular payments (4), inadequate housing conditions (3) and the practice of many layoffs every year (3).

However, the majority of respondents (194) believe that working conditions did not worsen due to the arrival of sugarcane to the region and offered several examples of benefits

and improvements in labour practices. The most cited was the formalization of contracts (74) followed by better wages (26), training and qualifications of labour (21), safety conditions (18), health insurance (17), 8-hour workdays (10), timely payments (10) and proper transportation for workers (7). Other benefits were grouped together as they received less than 5 mentions (food stamps, overtime, basic goods package, profit sharing, discounts on medication, career plan, paid vacations and dental plan).

Figure 10 below shows the content analyses with systematized stakeholders' comments about the possible causes for working conditions changes.

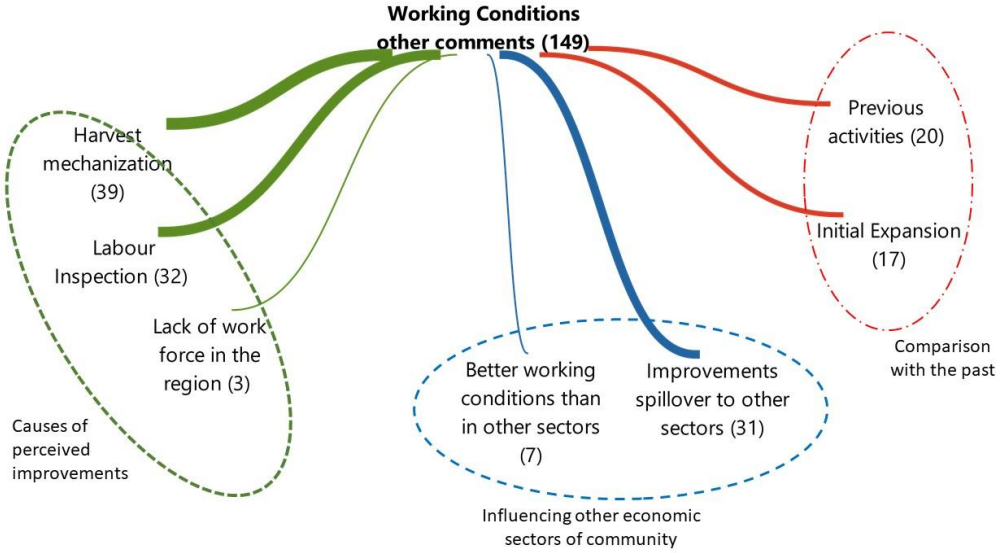


Figure 10 Additional comments about working conditions in sugarcane expansion

Source: Prepared by the author using Maxqda software

The positive perceptions of most of the local stakeholders can be grouped into 3 aspects: reasons for improvements, comparisons to the past and impact on other economic sectors. Comparisons to the past referred to changes in the process since its initial phase (usually going from a manual cutting to a mechanized harvest process) or to explain how the lives of citizens had changed:

> *"In the beginning, with manual cutting, there were workers in degrading conditions. But the legislation was being modernized. The cane harvest was mechanized and many cutters were requalified for other functions. (134)." (worker in MG)*

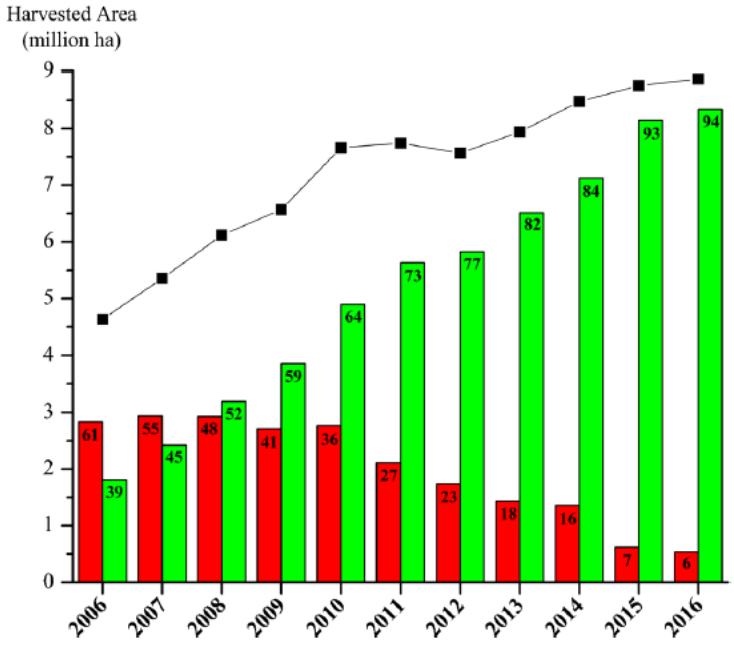
The second group commented on how other sectors of the local economy seemed to be influenced by the arrival of sugarcane. Respondents mentioned how working conditions were better in sugarcane than other agricultural activities such as orange, cotton and cattle where the labour rights are not respected accompanied with much lesser attention from the labour inspection authorities. Other comments referred to how the presence of the mill in the region had "raised the bar" for all sectors in terms of labour rights since the regions have low-density populations and the struggle to maintain workers was crucial. In this sense it was commonly perceived that even for urban activities with no direct link to the mill, the working conditions improved since the employers were forced to promote better conditions for their employees in order to keep them. This spill over effect was also referred to by M. L. J. Brinkman et al., (2018) and can be represented by one testimonial:

> *"Competition for labour between plants and farms forced the regularization of many agricultural workers who worked without formal contracts (on farms). This competition also caused a general increase in wages. Farms had to raise wages to keep workers." Producer of other crops - MG*

This third group of comments seems to point out two main reasons why this improvement took place. The intensification of labour inspections is perceived as a natural consequence of the sector's bad reputation but is also a reflection of operational ease in inspecting an activity that has a large company as the anchor. The work of inspectors is quite different when the targets of their inspections are farmers spread across the territories with small numbers of employees. The presence of employee unions also caused a rise in the number of inspections.

The positive impact of harvest mechanization was the most frequently cited reason to justify the improvements in working and living conditions, reflecting on the whole community in the five researched regions. This crucial change impacted working conditions, training and employee qualification, in addition to the health of employees and the greater community given that it was no longer necessary to take part in pre-harvest burning. Graph 3 shows the changing pace of the introduction of mechanization.

Graph 3 Total harvest area (black line) in south-central Brazil and evolution (in %) of the type of harvesting during 2006-2016 manually burned (red bars) versus mechanized (green bars).



Source: Bordonal et al., 2018.

The evolution of the harvest mechanization and its benefits to living conditions were mentioned by the community and are aligned with the findings of (Bordonal et al., 2018; Cardoso et al., 2019). Technological improvements, increased governance for environmental issues, and labour shortages for manual cane cutting led to the effective implementation of legislation that replaced manual cutting with mechanization for harvesting cane which immensely transformed working conditions in the sector.

4.4.2. Secondary data analyses on working conditions

In order to verify whether the local perceptions were reflected in secondary data, indicators related to two main benefits mentioned by the respondents were analysed: the formalization of contracts and better wages. Table 8 presents the average evolution of contract formalization in each municipality of the sample in the period 2000 – 2010.

Table 8 - Evolution of total labour contracts formalization

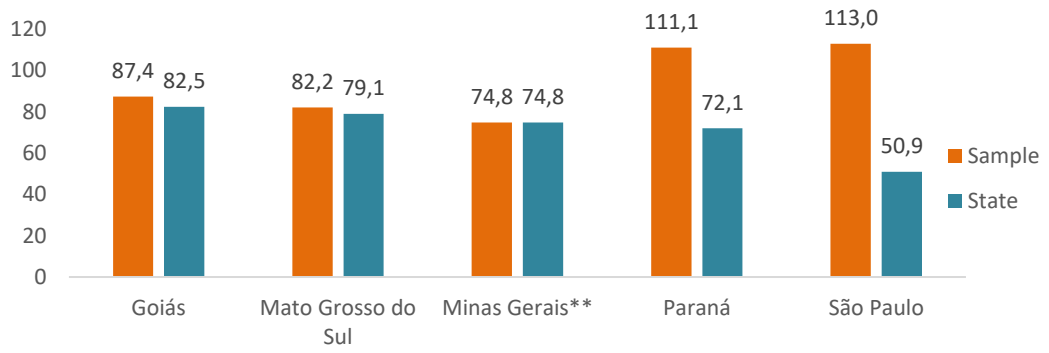
Areas	2.000	2.010	%
Goiás Total	**662.831**	**1.254.861**	**89,3%**
GO Sample	**38.711**	**91.543**	**136,5%**
Bom Jesus de Goiás	2.139	4.978	**132,7%**
Caçu	895	2.853	**218,8%**
Goiatuba	3.787	5.926	**56,5%**
Jataí	10.958	19.548	**78,4%**
Porteirão	413	958	**132,0%**
Quirinópolis	3.387	10.144	**199,5%**
Rio Verde	16.674	46.269	**177,5%**
Turvelândia	458	867	**89,3%**
Minas Gerais Total	**2.685.802**	**4.294.049**	**59,9%**
MG Sample *	**29.098**	**52.555**	**80,6%**
Carneirinho	1.047	2.322	**121,8%**
Comendador Gomes	504	577	**14,5%**
Frutal	7.111	13.465	**89,4%**
Gurinhatã	604	740	**22,5%**
Itapagipe	865	2.574	**197,6%**
Ituiutaba	13.875	23.666	**70,6%**
Limeira do Oeste	482	1.545	**220,5%**
Santa Vitória	1.786	3.631	**103,3%**
Tupaciguara	2.824	4.035	**42,9%**
Uberaba	57.862	86.127	**48,8%**
Mato Grosso do Sul Total	**278.714**	**501.030**	**79,8%**
MS Sample	**32.673**	**64.226**	**96,6%**
Caarapó	2.251	4.633	**105,8%**
Dourados	25.532	48.414	**89,6%**
Fátima do Sul	1.515	2.840	**87,5%**
Rio Brilhante	3.185	7.605	**138,8%**
Vicentina	190	734	**286,3%**
Paraná Total	**1.643.598**	**2.653.498**	**61,4%**
PR Sample	**23.213**	**38.238**	**64,7%**
Astorga	4.435	6.530	**47,2%**
Nova Londrina	2.350	2.967	**26,3%**
Santo Inácio	752	1.202	**59,8%**
Umuarama	15.676	27.539	**75,7%**
São Paulo Total	**7.448.207**	**11.780.154**	**58,2%**
SP Sample	**3.933**	**8.575**	**118,0%**
Gastão Vidigal	475	1.349	**184,0%**
Luiziânia	724	1.434	**98,1%**
Meridiano	520	937	**80,2%**
Mirantedo aranapanema	1.141	2.716	**138,0%**
Monções	227	400	**76,2%**
Nova Independência	364	923	**153,6%**
Queiroz	482	816	**69,3%**

Source: IBGE – Brazilian Demographic Census

*Excluding Uberaba which has a different economic dynamic based on the industrial and services sectors.

In order to verify the perception of the improvement in "better wages", we analysed the evolution of income in the researched regions as presented in Graph 4.

*Graph 4 - Variation of income 2000-2010*in all sectors*



Source: IBGE Demographic Census 2000-2010

* deflated values

** Uberaba (MG) was excluded due to a potential bias given that it is a large city with an economy influenced by the industrial and services sector.

In all areas the increase in income was higher than 70% in real terms (corrected for inflation). In Paraná and São Paulo where economic dynamism is higher, the competition for workers was much greater than in the other states. In sample areas in the Goiás and Minas Gerais states the sugarcane arrival helped to increase or at least keep the level of jobs and income in the time that those regions were suffering decreased activities in dairy and beef cattle and economically suffered from the soybean plague "Asian soybean rust" (A. Marques Postal, 2014; Souza Júnior & Santos, 2014). In Mato Grosso do Sul the importance of sugarcane for income is also referred in (Defante et al., 2020).

The stakeholder's perceptions (positioning and qualitative data) were aligned with secondary data which presented an increase in formal jobs and income and were confirmed by the literature review. These results seem to explain the positive perception surrounding the impacts of the arrival of sugarcane to the region and, in addition, a type of formal job which was previously uncommon. In the small cities in the Brazilian countryside, the presence of large companies and formal jobs is rare. The impacts of the formal job availability, together with many other benefits, include 1) the potential to purchase from local commerce using credit

loans (given the possibility of a higher salary with a formal job), 2) a fall in the use of the local public health system provided by worker access to private health care, 3) improved working conditions since the companies tend to have rigid safety systems in place. All of these elements were referred to in the interviews.

It can therefore be assumed that the working conditions of local stakeholders did improve and these improvements spilled over onto other parts of the community. The improvements were also reflected in the reduction of inequality according to the Gini index of income and so can be considered as an element of inclusiveness as an outcome of the expansion process.

4.5. Food Security

As previously mentioned, food security was chosen as one of the topics to be analysed, as it is commonly considered one of the main negative impacts of expansion of biofuels in the world (R. Bailey, 2008; Cordeiro & Boas, 2008; Gomes et al., 2009; Harvey & Pilgrim, 2011b; Marcatto et al., 2010; Mol, 2007; Searchinger & Heimlich, 2015) (Bailey, 2008; Cordeiro & Boas, 2008; FGV, 2008; Gomes et al., 2011; Marcatto et al., 2010; Mol, 2007; Schlesinger, 2014). This debate was marked by a major popular appeal known as “food versus fuel” which questioned the use of agricultural land for “planting” fuel instead of food, while hunger is still a serious issue in the world (Schlesinger, 2014). However, numerous studies point to methodological flaws in the argumentation and analysis. The basic assumption behind the statement that land should not be used for non-food crops is the lack of land for a growing world population, which is questioned by several scholars (Kline et al., 2017b). Others include generalizations about the impact without distinction of specificities related to the type of raw material (crop) or to the agricultural and social context of the country in question (Frate & Brannstrom, 2015a; A. Marques Postal et al., 2020) and often overlook a distinction of the full criteria of food security (Kline et al., 2016; Osseweijer, P., Watson, H.K., Johnson, F.X., Batistella, M., Cortez, L.A.B., Lynd, L.R., Kaffka, S.R., Long, van Meijl, J.C.M., Nassar, A.M., and Woods, 2015).

In the Brazilian case, the situation is quite different from other countries due to three factors: a) the type of raw material – sugar from sugarcane - is not considered an essential raw material in Brazil since its main destination - sugar, has negative health effects when consumed

in excess (Louzada et al., 2015); b) the vast territorial extension of the country with a competitive agricultural sector makes abundant food production possible (Brazil exports almost 50% of its food production) even with the presence and expansion of biofuels (Bordonal et al., 2018), and finally c) Brazilian society is already used to buying food from other regions of the country (A. H. Nogueira & Silva Capaz, 2013) and the concept of "local production", although often claimed as desirable in terms of sustainable economy, has a different meaning for this large country and is not a priority for the local population. But are these factors really valid?

These arguments, together with the absence of the voice of local communities in the academic literature, led us to ask: how does the local community perceive this issue? How do local communities perceive the impact of sugarcane expansion on the issue of production and access to food? How has the expansion of the biofuel sector in the region impacted access to or production of food and, in this sense, reflects the well-being and inclusion of the most vulnerable strata of the local population?

4.5.1.Local perception on food security

To answer these questions, the field research used the concept of Brazilian legislation that states: "We defined food security and safety as regular and permanent access to quality food in sufficient quantity without compromising access to other essential needs[22]. This concept is aligned with the four dimensions of the food security: availability, accessibility, stability and utilization as defined by the (FAO, 1998). Analysis of the Brazilian case focuses on "availability" and "accessibility". This is because the utilization dimension, related to the quality of diet and nutrient retention, is considered satisfactory in Brazil, when excessive sugar consumption is avoided, and the question of stability, related to drastic interruptions in food production (by wars or extreme weather events) is unrelated to the expansion of sugarcane in Brazil. Thus, the statement presented to respondents during field research was: "The arrival of sugarcane diminished food availability and /or food accessibility to the point of causing hunger."

[22] (Brazil, Law 11.346 /2006).

4.5.1.1. Quantitative results of positioning

The quantitative results of respondents positioning expressed 79% of total or partial disagreement (1&2) to the question: "The arrival of sugarcane to the region has diminished the availability of food and/or increased the price of food, impacting food security." Only 1.5% of the 353 respondents have “no opinion” on this theme.

As the literature review highlighted concerns on food security as fundamental, why then did most of the respondents disagree with the statement on negative impacts? To understand this question, we analysed 205 authorized registered interviews carried out during the field research.

4.5.1.2. Qualitative field research analyses

The 205 registered comments on food security were analysed to group the answers into subcodes as presented in Figure 11 below.

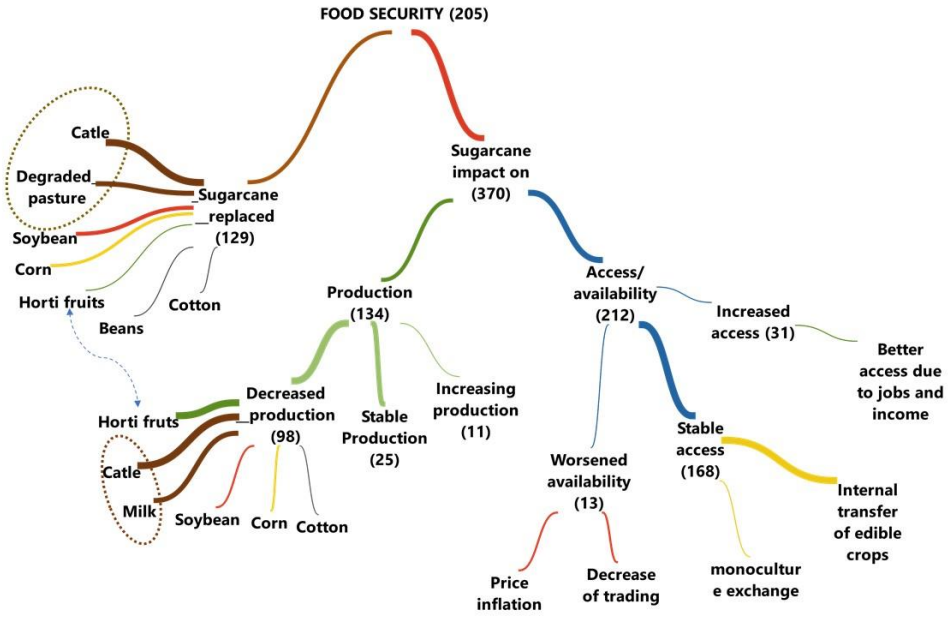


Figure 11 – Food Security - main comments from field research

Source: Prepared by the author using Maxqda software

The frequency of comments is demonstrated through the width of the lines. The comments were grouped into two main codes – a) what type of activity was replaced by sugarcane plantation and b) the impact of sugarcane on food security. Comments of the first group frequently supported the arguments of the main theme (impact on food security). It was

clearly perceived and in alignment with the literature review that cattle farming was the most replaced rural activity, here referred to both as cattle or degraded pasture area, followed by soybean and corn (Adami et al., 2012; Goldemberg et al., 2008; Novo et al., 2012; Osseweijer, P., Watson, H.K., Johnson, F.X., Batistella, M., Cortez, L.A.B., Lynd, L.R., Kaffka, S.R., Long, van Meijl, J.C.M., Nassar, A.M., and Woods, 2015; Rudorff et al., 2010). Fruit & vegetables and beans were referred to by 11 and 3 respondents, respectively.

Respondents mentioned two FAO (1998) dimensions – food availability (linked with production) and food access, the latter at a higher frequency. This can indicate that the question of food access is of relatively greater importance in the minds and perceptions of local communities.

On the production side, most of the perceptions (98) point to a decrease in production of cattle, fruit & vegetables and soy. It is interesting to note the frequency with which fruit & vegetables were mentioned when speaking about decreasing food production while such replacement was on a low 4th place in areas replaced by sugarcane. Some respondents mentioned the inaccurate aerial spraying of pesticides on soybean and sugarcane as a reason for the decrease in fruit & vegetables productivity. The arguments used by those who perceived a stable and increased production (36) usually regard the technical improvements on cattle and other crops made possible by the extra income from sugarcane. These perceptions are aligned with the literature review (Campbell et al., 2018; Novo et al., 2012) and can be exemplified in the testimonial:

“There was no loss of food. In fact, dairy farming increased with investments in productivity that farmers were able to make with the income of leasing land for sugarcane. Farmer X says that today he produces more milk than previously thanks to sugarcane”. (351)

In the “food access” dimension, the most frequent response was about stable access to food (168) due to the custom that was already in place of buying food from other more specialized areas of the country. Several respondents mentioned that the region was already dominated by other non-edible monocultures (soybean, cotton) or extensive cattle farming which forced purchasing of edible crops from other specialized regions of Brazil. Some respondents from Goiás, São Paulo and Minas Gerais samples mentioned that other crops previously cultivated in the area had been replaced by soybean, corn, cotton and cattle more than 20 years before for a number of reasons, including climate change and diseases. In reality,

the largest areas of rice and bean cultivation, staples of the Brazilian diet, are Rio Grande do Sul and Bahia respectively (Louzada et al., 2015). Some comments which illustrate this:

> "The region no longer had a diversity of cultures and was not a food producer. Cotton and coffee were planted. The arrival of sugarcane only caused an exchange of monocultures. Availability did not fall because the region has always bought food from other regions of the country". (105, PR)

> "In the past, the region used to produce corn and cotton, which have been replaced by livestock. Sugarcane replaced pasture. Day-to-day foods (rice, beans) were always purchased from other regions of the country." (242 SP)

Finally, 31 of the 205 respondents noted better access to food related to the region's improvements in working conditions, jobs and income. These perceived spill over effects of sugarcane expansion to other sectors of the region are well-recognized in the literature (Bacchi & Caldarelli, 2015b; M. L. J. Brinkman et al., 2018; Caldarelli & Perdigão, 2018) and are also reflected in some respondents comments:

> *"Food access increased because the higher income brought even more trade to the region, diversifying the food." (273)*

> *"...on the contrary, it even increased due to income generation in the region". (339)*

> *"There is a greater benefit from the jobs generated and the quality of jobs has allowed a higher permanent income for families. Food access has improved for that reason." (299*)

4.5.2.Secondary data analyses on food security

Statistical data on the topic are concentrated on the production of food and access to / purchase of these foods.

4.5.2.1. Food production - PAM

Respondents noted a decrease in the production of local agricultural and cattle products. In order to compare this with official data we analysed the evolution of the main items

mentioned by local stakeholders. The indicator of production evolution in the selected municipalities was captured from the IBGE - PAM23. The results are presented in Table 9.

Table 9 - Evolution of main activities production replaced by sugarcane, 2000-2016 (%) [1]

Rural production replaced[1]	Goiás		Minas Gerais		Mato Grosso do Sul		Parana		São Paulo	
	Sample	State	Sample	State	Sample	State	Sample	State	Sample	State
Sugarcane	1088.6	599.2	1752.6	273.9	1223.5	789.6	481.1	104.8	3351.0	134.0
Soy	83.2	150.2	72.8	230.0	172.2	197.2	55.0	138.2	811.8	134.7
Cattle[2]	-16.1	24.6	0.2	18.3	-49.4	-1.8	-20.9	-1.6	-21.1	-15.7
Rice	-98.3	-63.3	-96.8	-94.2	-77.7	-66.5	-100.0	-33.7	-100.0	-46.4
Bean	304.9	64.8	314.9	28.3	8.9	64.1	-89.7	20.3	-100.0	29.5
Cassava	-49.1	-15.6	-70.5	-6.4	10.9	25.0	134.4	2.9	63.1	50.7
Corn	129.7	58.6	-37.2	38.1	280.8	463.8	240.4	89.4	-43.3	50.1

Source: Elaborated by the author using IBGE Data (PAM and PPM)

1- Values are percentages in change either increasing or decreasing (-).

2- Cattle = number of heads; other crops = thousands of tonnes;

Soybean production increased in all regions, contrary to the perceptions of local residents. The same was true for corn, with the exception of São Paulo and Minas Gerais. The production of beans, a basic edible crop in the Brazilian diet, increased in three states and decreased in São Paulo and Paraná. Other edible crops, such as rice and cassava, suffered a significant percentage drop, although these crops were no longer relevant in terms of production and planted area even before the arrival of sugarcane. Coinciding with local perceptions, a significant decrease in cattle farming was noted, with the exception of Minas Gerais where production remained stable over the years. This exception is aligned with some comments on the intensification of cattle production (more heads by km2), made possible due to the income provided by the sugarcane sector (Campbell et al., 2018).

[23] PAM – Produção Agrícola Municipal – Official data for municipal agricultural production provided by statistical data on municipalities in Brazil

PPM – Produção Pecuária Municipal – Official data for municipal cattle production provided by statistical data on municipalities in Brazil

The decreases in the production of edible crops such as rice, cassava, and beans were not perceived as critical by respondents since internal transfers of foods in a large country like Brazil are quite common for some time. However, this diversity loss in local crop production could pose a future threat to farms and local residents.

4.5.2.2. Food access – secondary data

According to FAO, the main determinant of access to food is income. We therefore considered the results of 4.2 in our analysis. Since the results show better jobs, income and therefore better "purchasing power" of workers, we can conclude that food access is increased.

In sum, the analysis of issues surrounding food security clarifies why this is not a "hot topic" in Brazil, different to the global debate. It is clear that some edible crops were replaced by sugarcane and soy but it is also observed that traditionally the case study areas already obtained their food crops from other more specialized areas. The better (compared to their past) jobs, wages, and income resulting from the expansion of sugarcane also contributes to the perception of better food access. We can therefore conclude that this expansion process appears to be inclusive as an outcome in terms of food security in the context studied. A further question is: is this inclusion long term? How sustainable is the mechanism of internal trade for these edible crops? Does the lack of diversification of production jeopardize food security in the long term? Are relevant public policies in place to deal with the issue? These questions should be studied in future research.

4.6. Inclusion as a key aspect of economic development

"A sustainable path toward ending extreme poverty and promoting shared prosperity would also involve creating an inclusive society, not only in terms of economic welfare but also in terms of the voice and empowerment of all groups. An inclusive society must have the institutions, structures, and processes that empower local communities, so they can hold their governments accountable." (WBG, 2013)

The World Bank (World Bank, 2013) considers inclusion a key element of shared prosperity that promotes all aspects of economic and social development. Because of this, the term inclusion is widely used in various conceptions of public policies, generating, however, some misunderstanding as to its meaning. According to some authors (George et al., 2012; R

Heeks et al., 2013) inclusion can be seen as a dimension of the development process and/or as a dimension of the result of an action.

When discussing inclusion as an outcome, the focus should be on the "excluded" group (Heeks et al., 2013), here defined as the local community directly impacted by sugarcane expansion and underrepresented in the global debate. Four impacts have been discussed through the lens of local perception and complemented with the literature review and secondary data where possible. The analysis of how inclusive the expansion process was for the selected themes is summarized in Table 5 below:

Table 10 Inclusive aspects of sugarcane expansion

Themes	Inclusive?		Main outcomes	Reasons	Main driver
	Result from local perceptions	Result from secondary data			
Business Model	YES	YES	Allows local farmers to capture value from this business sector through horizontal arrangements	A new generation of investors who prefer the liquidity of capital to land asset valorization	Private sectors (mill and biorefinery owners)
Land Concentration	NEUTRAL	NO	Investors from other traditional sugar cane areas have bought land to lease it to the mill.	The market forces act to capture land valorization and caused some land concentration	Private sector (Farmers and land owners)
Working Conditions	YES	YES	Improvements in contract formalization, better wages and other benefits	Harvest Mechanization and increased inspection of labor rights	State – policy makers and labor inspections
Food Security	YES	NEUTRAL	Slight Decrease in production of some edible crops but increase in food access	Sugarcane condensed and/or replaced cattle areas but also some marginal edible crop areas	Private sector – local farmers

Source: created by the authors based on field research and secondary data.

The prevalence of horizontal arrangements as a business model is perceived as more inclusive than the previous expansion cycles since it allows local farmers to capture value from the sector. The secondary data on the types of legal tenure categories also show this. It is possible that the strong agreement about the benefits of horizontal arrangements induced the initial perception about the neutral impact on land concentration inclusiveness. However, secondary data indicates that this business model was unable to prevent "market forces" or other

private sector investments from causing some land concentration while trying to capture the valorisation of the "land" in the areas surrounding the ethanol mills. Working conditions, the third theme analysed, have improved greatly with the rise in formal contracts, benefits and better wages and income. These improvements spilled over onto other sectors and counties in the surrounding areas helping to develop the local economy and therefore can be considered inclusive by perception as well as in reality, as confirmed by secondary data. Regarding food security, it was clear that the continental dimensions of Brazil and historical internal trade practices minimized the risks of scarcity or unavailability of basic products. Moreover, the rise in average income and jobs has amplified the purchasing power for food, despite the flagrant reduction in cattle and some food crops. These aspects together warranted the positive/inclusive perception from local stakeholders while the secondary data provide evidence in both directions - in balancing the increased access and decreased edible crop area - thus indicating a neutral result of the factual data.

It is therefore possible to conclude that the sugarcane expansion that took place in the 2000s resulted in more inclusive outcomes than in the past. It is questionable, however, how sustainable these results are in the long term or how they can be leveraged to a higher level of inclusive development as preconized by the World Bank in 2013.

Hence, in order to encompass a broader and more sustainable level of inclusive development, which entails community wellbeing, empowerment and environmental sustainability (Ros-Tonen et al., 2019), it is necessary to create institutional coordination to arbitrate power imbalance and to promote inclusion (World Bank, 2013). Only with such coordination, the local community can develop skills (Luiz A. Martinelli et al., 2010; Sen, 1999) and become empowered and capable of identifying structural constraints, providing input on needs and concerns which can be incorporated into long-term planning. This can take the inclusive process to an even higher and more sustainable and desirable level of structural inclusion (R Heeks et al., 2013).

4.7. Limitations

To our knowledge, the current study is the most extensive research on the local stakeholders' opinion regarding the themes for the sugarcane ethanol sector in Brazil. Due to

the broad geographic area covered by the field research, and the number and diversity of types of stakeholders, the patterns identified in the field research presented a meaningful overview of local communities' perception and awareness in the Centre-south region of Brazil. Even so, due to the chosen criterium to define the geographic area for interviews (regions with high rates of sugarcane plantations growth) some issues may have been unintentionally neglected as the impact over traditional communities of "quilombolas"24 or indigenous people.

The perceptions of local stakeholders present a good tool for exploring topics of impact assessments related to wellbeing. However, for other regions (e.g., Northeast of Brazil or other countries), the relevance of issues may differ due to different socioeconomic contexts. Therefore, repeating the survey shall be valuable for other regions. Additionally, due to the objectives of this study of listening to the local impact perceived by local people, an expert stakeholders' survey was out of scope since they often live in big centres far from producing areas. Conducting another survey for expert stakeholders, would complement the different perspectives and add value to the research results.

4.8. Conclusion

Field research was carried out in areas of sugarcane expansion in 5 states of Brazil in order to investigate whether or not local stakeholders perceived as inclusive the impacts of four structural aspects connected with the exclusionary character of the sector history in Brazil. The results of interviews were analysed and complemented with academic literature and secondary data.

It can be concluded that inclusive impacts, as defined in this article as 'the improvement in wellbeing and accessibility', were clearly perceived by local stakeholders in two themes: 1) the business model with farmers participating in the value chain and helping to develop local business services for the sector; and 2) in working conditions, with benefits arising from the formalization of work and spill over into other sectors in the region. The results on food security

[24] Quilombolas are the descendants from slaveries

are considered neutral since they pointed to a slight decrease in local food production even though an increase in food access. This apparent contradiction is explained by the well-established inland trade that supports well the increase in access to food due to better wages in the regions of expansion of sugarcane. The theme of land concentration showed a slight negative impact since the predominant business model at the time was unable to prevent some level of concentration which was driven to a great extent by market forces other than the mills.

In sum, the local stakeholders did perceive more inclusive outcomes than negative impact on these themes and their arguments and points of view illustrate well these perceptions.

However, even though there are more inclusive aspects here, the question arises as to whether there are also long-term positive impacts for the local community since most of the observed positive aspects are driven by contextual private sector interests rather than systematized institutional coordination. In other words, the results of the themes studied did represent inclusion as an outcome of sugarcane expansion. This is an important and verified result, which should be taken into considerations in the global debate since it contributes to empowering and building the skills of the local community.

However, as an additional result from the research, we realize that these inclusive outcomes may be not enough to guarantee the long-term progressive and sustainable wellbeing for the local community. Higher levels of inclusion (with a focus on an inclusive process and structural inclusion) should be pursued through the coordination of institutions that are able to act as deliberative forums and mediators of the interests of different types of stakeholders. Future studies should be carried out in order to verify the impact of sugarcane expansion under such institutional coordination and establish whether this is able to create a long-term inclusive process of participation of different stakeholders and whether it can leverage the positive outcomes.

Declaration of interest

No potential conflict of interest was reported by the authors.

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Chapter 5

5. Discussion and Final Remarks

5.1. Introduction

Stakeholder perceptions and the context of production of biofuels have been investigated through extensive field research interviews in five states in the centre-south region of Brazil. The aim was to analyse to what extent the biofuels' expansion of the 2000s was understood as inclusive through the perceptions of local stakeholders. In this chapter, we will articulate a newly developed theoretical scheme (Fig 12 section 5.5) that represents the conclusions derived from this research by combining existing insights on different levels of inclusion and various kinds of impacts. With a better understanding of the elements contributing to inclusion, we can get closer to answering the second overall question: How can we design inclusive biofuels value chains to improve sustainable development?

5.2. RQ1 - What is a responsible process?

What is a responsible innovation? The one developed and implemented through a participative process (with effective participation of a broad range of stakeholders and interests), or one whose impacts or results help achieve the society´s needs? Most of the literature on Responsible Research and Innovation (RRI) frameworks seems to argue that both options are intrinsically connected and all participative processes of innovation will achieve results with inclusive impacts, and consequently refer to this innovation as responsible. However, we conclude that this is not always true, because the effectiveness of the process to achieve a responsible process depends on a set of cultural and contextual variables that may be not in place in most of the cases. We also observe authors who do not have a clear separation of these two dimensions of the research subject (process and impacts) and who make judgements about the character of the innovation (responsible or not) focusing only on the process of implementing the innovation in places where the processual side cannot be carried out according to the criteria of RRI framework.

During the first phase of the work, we became to understand that a ‘responsible’ innovation process according to RRI theory is one with effective participation, or substantive inclusion (Bronson, 2020) by a wide range of stakeholders. It was noticed that the term ‘inclusion’ used in this framework places more emphasis on inclusion as an engagement process (Gremmen et al., 2019; Schomberg & Hankins, 2019; van de Poel & Robaey, 2017), and not inclusion as a direct impact of innovation--for example, greater access to goods and services for all, especially for those previously excluded minorities (R Heeks et al., 2013). Due to the

contextual character of inclusion of process, which is dependent on the local values and culture that shape ways of interaction and participation, the use of the RRI framework in locations with high levels of social inequality requires a careful analysis of local institutions. These institutions must be able to organise participation through dealing with traditions, power balance, gender issues and forms of interaction; simultaneously, these institutions must work as a 'locus arena' where the engagement process takes shape and enforcement is achieved. The non-observance of institutional capacities to coordinate such an engagement process limits the effective participation of stakeholders and (as a result) raises questions about the effectiveness of applying the framework for the analysis of the responsible character of the innovation outcome.

Since the goal is not to comply with all dimensions of RRI principles but rather to analyse the inclusive character of biofuels expansion, a field research was carried out to in order to understand whether this innovation can be considered inclusive when inclusion as a process is not fully possible. Or, whether it is possible to achieve inclusive development as an outcome of a biofuel's implementation project without proper participation (inclusion of process) in the innovation process.

5.3. RQ 2 – What are the local perceptions and main concerns about biofuels expansion in Brazil?

The objective of this study was to improve understanding about the potential impact of biofuels expansion in Brazil from the viewpoint of local stakeholders directly exposed to those impacts. To improve the robustness of this analysis and the inclusion of as many local voices as possible in the debate, we designed a field research that heard local stakeholders' perceptions in a broader geographical area that encompassed 5 Brazilian states, 33 cities and 353 respondents in semi-structured interviews. The more representative view of different experiences helped in avoiding the pitfalls of small samples.

Listening to local viewpoints in a representative manner enabled us to better identify impacts which were not foreseen and to reveal the main issues, arguments and storytelling in the heads of local stakeholders. We could also identify the slight variation of perceptions, by

region or by type of stakeholder, about the seventeen selected themes25. In fact, the small differences in perceptions were mostly related to differences in previous economic conditions and to the geomorphological profile of each region26. These differences, however, were not significant for the general perceptions about the sugarcane expansion in the area. Some of the themes analysed appeared to have different meanings and results locally than previously put forth in academia and general civil society. The results pointed to a generally positive view of the impacts of sugarcane expansion, although there is room for improvement.

However, the understanding of inclusion in those processes needed a deeper analysis into some key aspects that were always linked with the historic exclusionary character of the biofuels sector in Brazil. These aspects need to be better scrutinised, since they are the source of inequalities that should be avoided when we wish to establish responsible developments resulting from innovative biofuels in a transition for a bio-based society.

5.4. RQ 3 - How inclusive was the last biofuels expansion cycle in order to counterbalance the negative side-effects of this expansion process? Does this expansion cycle provide elements that positively impacted the search for an inclusive local development?

We conducted a quantitative and qualitative analysis of registered and authorised interviews in order to investigate the feeling of inclusion presented in the local stakeholders' perceptions. The four themes analysed were defined as important due to their structural exclusionary character in the past (business model, land concentration, working conditions) and its importance for the international debate around biofuels expansion (food security).

It was concluded that inclusive impacts, defined as 'the improvement in well-being and access to services and resources', were clearly identified in three themes: 1) the business model with farmers participating in the value chain and helping to develop local business services for the sector; 2) in working conditions, with benefits arising from the formalisation of work and spill over into other sectors in the region; 3) in food access, improved through the better wages and jobs that sugarcane expansion implied, although perceptions point to a slight drop in the

[25] See the full set of seventeen selected themes in Chapter 3, Annex A

[26] Further studies are being carried out to further analyse in depth the differences of perceptions among stakeholders and regions.

already small local food production. The tradition of well-established inland trade helped explain why food security is not an issue for local communities. Regarding land concentration, this theme showed a negative impact because the predominant business model of horizontal arrangements was unable to prevent some level of concentration which was driven to a great extent by market forces other than the mills directly.

Overall, the results of the themes studied did represent inclusion as an outcome of sugarcane expansion. This is an important and verified result which should be taken into consideration in the global debate, especially as the results also contribute to empowerment and building skills within the local community.

However, although there is certainly a perception of inclusion derived from greater access to better working conditions, better access to food and more opportunity to participate in the sugar-ethanol value chain, the question arises as to how durable these positive impacts are for the local community, since most of the observed positive aspects are driven by contextual private sector interests rather than systematised institutional coordination.

Therefore, we realise that these inclusive outcomes, although crucial to fulfilling basic needs and creating capabilities for deeper engagement, may not be enough to guarantee long-term progressive and sustainable well-being for the local community. Higher levels of the inclusion ladder (Richard Heeks et al., 2014) with a focus on an inclusive process and structural inclusion should be pursued through the coordination of institutions that should be able to act as deliberative forums and mediators of the interests of different types of stakeholders.

5.5. Types of inclusion and research findings

What type of inclusion should be pursued in the design of inclusive biofuels value chain in order to contribute to society's development? This question emerged during the research process when we were faced with the conceptual differences between ‘inclusion’ as perceived by the schemes that try to shape the transformation of society towards sustainable development (RRI among them) and the ‘inclusion’ actually verified in the expansion of sugar cane biofuel in Brazil. The first is the inclusion in the process of implementation of innovation, and in this sense, it seeks an effective participation of representative stakeholders capable of influencing the process. Effective participation or substantive inclusion are other names assigned to this inclusion as a process. The second, verified through content analysis of field research, deals

with material inclusion or inclusion as a means of accessing goods and services that were previously out of reach for the research target populations. Such conceptual differences are frequent in the literature and in business tools that address corporate social responsibility (for example).

One possible approach about the different types of inclusion is proposed by Ros-Tonen et al., (2019) and emphasises the extension or scope of the inclusive impacts. This author systematises three bodies of literature that link the scope of impacts with the idea of inclusiveness: inclusive business, inclusive value chain and inclusive development. Using the Ros-Tonen lens, it is possible to understand that the scope of inclusive impacts is related to the type of agent that guides the process of implementing the innovation. These could be verified in the present research since food security, for example, which is one of the themes perceived as inclusive by local stakeholders' perceptions, was directly driven by the private sector without any coordination or intention of being inclusive. The theme of the business model did engage a higher number of actors and impacted the sugarcane value chain. Finally, the theme of improved working conditions could be seen as an example of inclusion achieved through societal institutional development since their effects and impacts spilled over to other sectors of the regions.

It is important to explain each theme. In food security, stable food production and improvement in food access were related to the decisions of the private sector, the mill's shareholder and governance. These private sector interests and mindsets decided to grow sugar cane in areas which previously held (preferably) cattle, soybean and corn. These decisions 'preserved' food crops in the marginal agricultural area in those regions since these types of edible crops usually are produced in small farms which did not have the scale to enter in the sugarcane value chain. Additionally, the increased number of jobs and better wages in the regions, other examples of internal decisions of the companies, created better access to food consumption in the well-established inland food market of Brazil.

The theme of the business model, here focused on the strategy to getting access to the main raw material – the sugarcane, represents a complex organisation since it involves the contractual arrangements between biofuel-producing companies and local farmers (horizontal arrangements of lease land and sharecropping). These contracts, usually six or twelve years long, are longer than the common annual risk-taker mindset of farmers and imply deeper

consequences for the value chain. This longer commitment between the parties on one hand restricts the flexibility of the farmers, while on the other hand gives the opportunity for the local farmers to capture value from the sugar-energy value chain even with small or no initial know-how on planting this crop. Again, what did drive this business model of accessing sugarcane (horizontal arrangements instead of the vertical integration observed in the former's cycles of expansion) were contextual elements of the private sector mindset and interests as, for example, the new profile of the shareholders or the preference for the liquidity of assets instead of the immobilisation of capital in the company's balance sheets, and not a coordinated public policy.

Conversely, the theme of working conditions, which achieved the most improved impacts among the selected themes, was largely driven by public policies aiming to protect the rights and well-being of workers, and in this manner, they contribute to social development. It is not without reason that the most frequent argument used by local stakeholders to justify the improvements in this area was the intensification of labour inspections (carried out by state authorities of the Ministry of Labour) and harvest mechanisation, both good examples of policy coordination to improve environmental and social conditions27. Both drivers are examples of institutional coordination whose impacts go beyond the walls of each company and value chain. In fact, several testimonials mentioned a positive influence of the sugarcane arrival in that region as a reason for the contract formalisation in other sectors in the community, such as other crops sectors, the trade sector of the cities and other rural activities. Additionally, it is reasonable to think that these kinds of effects usually keep for the long term since they are rights and procedures organised inside the legal framework.

More than the extension of impact of each type of inclusion, the analysis showed us that the resulting inclusiveness based just on private sector mindset and economic context (shareholder profiles, international markets, contextual prices, high standards from the demand side), is volatile and unstable. Two of the positive outcomes in terms of inclusion identified in Chapter 4 (food security and business model) were largely dependent on the quality and intentions of each company's governance or the quality of this business network, as typical of

[27] Law 11241/02 Lei n.º 11.241, de 19/09/2002

the ‘inclusive business’ and ‘inclusive value chain’ respectively, as referred to by Ros-Tonen et al. (2019). However, the impacts linked with the improvements in working conditions are mostly driven by institutional processes that tend to remain in the long run and imply an inclusive development.

Another possible approach to analysing the different types of inclusion is the ‘Ladder of Inclusion’ proposed by Heeks et al., (2013) which seeks to organise different degrees of engagement by making explicit the gradual greater complexity of each of the inclusion stages. Analysing the six levels of inclusion explored by the referred author, we can group the initial three steps as types of inclusion of outcomes since all of them make possible a better access to goods and services (the outcomes of the inclusion). The other three higher degrees (inclusion of process, structure and post-structure), can be grouped as inclusion of process, since they tackle the necessary right of effective participations which in last instance can draw the mechanisms which will sustain the gain and interests of all represented groups for the long term.

Observing the field research results and secondary data through the lens of the Ladder of Inclusion (R Heeks et al., 2013)28 we concluded that two of the themes studied (food security and business model) can be classified as resulting in the inclusion of impacts of the sugarcane expansion process. In contrast, the theme of working conditions represents an example of the inclusion of process, since its effects are fruits of institutional actions embedded, in their earlier stages, in civil society participation in the formation of that set of labour rules and the law of prohibition of the burning of sugarcane (which, in the end, promoted the harvest mechanisation).

It is important to mention that, although the types of inclusion as a process (process, structural and post-structural) are considered more complex and necessary for the quality, consistency, durability of the social development demanded, the types of inclusion as outcomes (or impacts) are equally important to prepare for these more elaborate and complex forms of

[28] Also explained in Chapter 2 and 4

processual inclusion. Even though they are not enough to guarantee well-being for the long term, it is important to satisfy the basic needs of individuals and then, given space or agenda, for building capabilities, thinking about cooperation, participation, claiming rights and other forms of emancipation from the community itself. The previous fulfilment of basic needs would increase the aspiration for a higher level of participation and inclusion in the decision-making process. In the example explored by Zapata, Brust-Vazquez & Plaza-Ubeda (2010), small farmers of the biodiesel value chain in Brazil were reticent to fully engage in projects when some basic needs as income generation and social inclusion were not met. The design of institutional incentives in that case failed, since the process was not preceded by meeting the basic needs of the community members and the level of engagement decreased over time, as people prioritised their survival and short-term needs rather than collective desires or plans. In other words, inclusive outcomes are important steps to further achieve in the inclusive process, as they will convert acquired rights from the first steps of the inclusion ladder into permanent rights.

Organising for the first time these two sets of theory in axes (Heek's Ladder of Inclusion in axis Y and Ros-Tonen's Extension of Inclusiveness in axis x), we can represent the results of research on local stakeholder perceptions as filled in the central area of Figure 12.

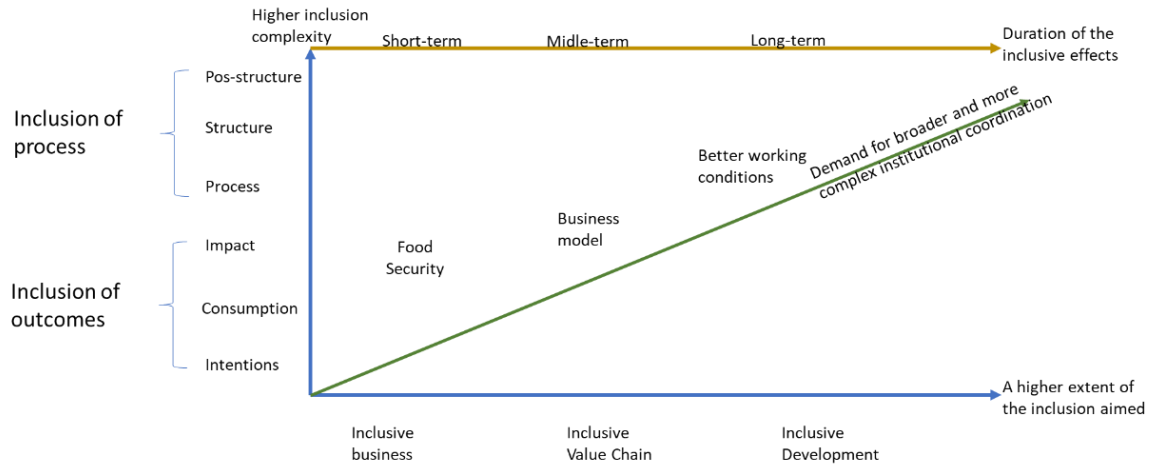


Figure 12 Inclusion for development, adapted to Heeks, Ros-Tonen, Ostrom.

The position of each theme is based on the type of inclusion as perceived in the field research (y) and the extension of this impact in the region (x). When analysed together, we can conclude that the more complex and shared the inclusiveness (inclusive development), the higher the levels of inclusion of process that are required in order to develop agreements, procedures and laws agreed upon by society's stakeholders. In other words, the broader the

aimed scope of inclusion (inclusive development, axis x), the higher the processual inclusion required (post-structure inclusion, axis y) and the higher the demand for an institution to coordinate the process of effective participation through common shared values, aims, arbitration of power imbalance and enforcement for decisions made during the negotiations process. Additionally, since the higher level of inclusion requires a higher participation of stakeholders and a more legitimised process, the results of these kind of processes tend to be more stable and fit for the long term.

The importance of the institutional coordination grows when the aimed inclusion is for everyone to achieve societal development. The need of an organisation that can plan, invite, mediate and arbitrate natural conflicts of interest among participants is naturally higher when we look for a broader scope of inclusion. This ideal context is partially achieved in the selected themes29 of the sugarcane expansion study. As we can see in Table 11, although the three aspects can be considered as inclusive outcomes of the sugarcane expansion process, the working conditions improvement was achieved through institutional coordination of the public sector authorities that consolidate this inclusive process for the long term for the whole community.

Table 11 Sugarcane expansion: Types of inclusion and the main drivers of the process

Theme	**Ladder of Inclusion**	**Scope of Inclusion**	**Likely Duration**	**Who Drove the Process**
Food security	Inclusion of impact	Business	Short term	Private sector
Business model	Inclusion of impact	Value chain	Medium term	Private sector
Working conditions	Inclusion of process	Social development	Long term	Public sector

In the themes explored, the contextual business and economic circumstances (favourable in this case) drove the business entrepreneurs of the sector (mill owners and

[29] The field research encompassed seventeen themes in social, environmental and economic dimensions. Those themes and results are better explored in Chapter 3. However, for the purpose of (and due to the size limit of) this dissertation, the deeper analysis relied on the four themes considered structural for the inclusiveness debate. See more on Chapter 4.

shareholders) in the direction of inclusive outcomes of the business and value chain. This result was not due to public policies created and coordinated by national, state or local institutions. These are the case of the food security and business model themes in this research30. These inclusive outcomes were guided basically by the private sector (typically business-oriented mindsets) and did not take into consideration concerns regarding the social function of the land, shared value in the sector or long-term food security. The community-wide spread of these positive impacts was rarely perceived beyond the surroundings of the company, even when there were impacts on the value chain, such as the increased average wage, which spilled over to other sectors in the community. But, what does the future look like without coordinated action by public policymakers in areas such as food security and land concentration? The consequence of this lack of coordination is that the effects of isolated decisions and programmes, although important for the short-term fulfilment of basic individual needs, are not able to create structures and official mechanisms that maintain those impacts for the long term. For example, in the case of an economic crises with lots of dismissals resulting in higher levels of unemployment, what would happen with that better food access?

5.6. The possible inclusion and the role of the business sector in a 'weak institutional context'

What does happen when there is weak or no institutional coordination in place? Is it then possible to achieve a responsible innovation process and (consequently) social development for all? What should a responsible company do in countries with a lack of strong institutions? These questions are important in a globalised world where trading exchanges, innovation and humanitarian issues often cross the borders of states and demand interaction between nations that are not at the same level of institutional development. In these contexts,

[30] The land concentration, another theme driven mostly by the private sector, did not reach the same positive (inclusive) outcome, and because of that it is not used in the scheme that follows.

we were challenged to analyse the role of private institutions and civil society where the formal state institutions are not capable or credible enough to coordinate such kinds of societal processes towards an inclusive social development.

From our observations of field research in Brazil, we can extrapolate that, when institutions are not in place or not capable enough to coordinate such 'inclusive' programmes, some schemes from the private sector and/or civil societies may work as forces that influence and guide private sector behaviours through the establishment of globally recognised standards designed to better achieve sustainable development. This can explain (at least in part) why some improvements in outcomes and process of inclusion are achieved even in regions where the institutions are not able to coordinate such a complex myriad of interests and aims.

Such kinds of certification schemes or patterns can be categorised secondary to the aimed extension of its impacts, as proposed by Ros-Tonen et al. (2019). For example, companies' codes of conducts or voluntary sectoral agreement schemes usually focus on the improvement of company practices in the respective subject. Other initiatives, such as ISO 14000 or OSHAS 18000, SA 8000, IFC and GRI Standards, even though also operationalised within the company, often try to influence their suppliers and the whole value chain. Sustainable Development Goals (SDG) and the Universal Declaration Human Rights are examples of standards that focus their goals not on a specific company or sector or region but for the whole global society.

At the same time, the type of inclusion required by any of these standards may vary. Some standards as with Bonsucro31 are called 'performance standards' because they focus on the achievement of specific indicators in several areas (human rights, CO2 emissions, respect for the law, biodiversity and others). Other standards are called 'process standards', since their indicators focus on how the processes are executed in an organised way (ISO 18000). In both cases, inclusion can appear as merely an indirect effect from the achievement of performance indicators or as a requirement to guarantee the legitimacy of the process. Because of the inherent difficulties in measuring the concrete inclusiveness of any project or action, it is difficult to

[31] https://www.bonsucro.com/

identify any schemes or standards with such a concrete and direct goal, although most of them have inclusion as an ultimate goal or principle.

In any of these multi-stakeholder initiatives, the credibility of members is a critical point. The presence or weight of the private sector may vary among them. Some authors see the strong presence of the private sector as an important contribution to advance in places where institutions are not able to coordinate the process (Mena & Palazzo, 2012; Scherer & Palazzo, 2011). However, other authors criticise the supervising role attributed to the private sector, arguing that the companies should be removed from their policymaking role and suggesting that these tasks be given instead to NGOs and other less-biased stakeholders (Hussain & Moriarty, 2018).

However, in a pragmatic way, it is important that a responsible company interested in investing in a region or country with lack of strong institutions maintains its path to investment and modifies its narrow area of influence. To do so, it is important to use recognised standards that, while bringing them closer to consumer markets, are also useful to include and develop within a direct sphere of operation. With exemplary effects in the short term, it is possible that these companies could influence their peers and impact their whole value chain in the medium term. The joint action of the value chain, together with the critical volume of changes in society, make it possible for sustainable development to be achieved in the long term.

5.7. Conclusion

The overall research process was designed to provide insight on to what extent the biofuel expansion in Brazil in the 2000s was considered inclusive from the perspective of local stakeholders. At this point, we can conclude that yes, this expansion process was considered as having inclusive outcomes through the lens of local stakeholders who were directly impacted by the expansion process. However, in order to answer the second part of the mains research question, i.e., to design inclusive value chains to improve sustainable development, it is important to go beyond the inclusion of outcomes to guarantee the long-term achievements and improvement in the well-being for the whole community.

For the long-term achievement and benefits for the whole community it is necessary, to pursue the inclusion in the planning process of the expansion through effective participation of local voices coordinated by publicly recognised institutions, in order to make potential acquired

rights in the short term sustainable in the long term. If the community, country or society does not have institutions which are able to support or coordinate the inclusion process, companies can then use some recognised public standards to guide them in this process

In the global debate, these distinctions and effects need to be recognised to reflect a more precise picture on the real impacts of each crop and region. The debaters need to increase the importance of local voices and consider the inclusive impacts of biofuels as an important achievement of sugarcane ethanol.

At this point, new pathways of investigations lay before us which could confirm, complement and/or further the directions to achieve a biobased transition.

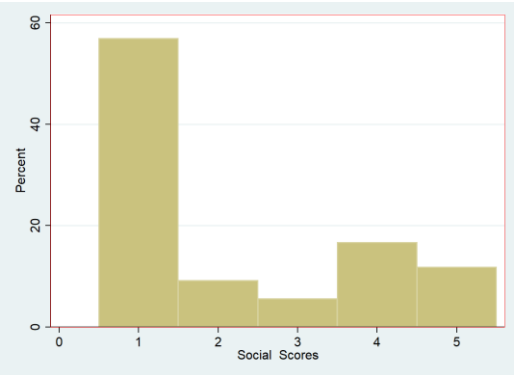
Regarding the role of institutions in coordinating the participatory process of inclusive innovation, we need to define the minimum requirements for such an institution to be considered capable enough to coordinate such a process? Furthermore, we need to investigate whether it would be possible to define a global set of characteristics that can be applied in any culture or context. For the different types of inclusion, it is important that institutions focus on a post-structural type of inclusion and we need to investigate how institutions can achieve such a higher level of inclusion. Or can one achieve a responsible innovation without inclusion? Or otherwise, can one reach a non-responsible outcome when inclusion is addressed?? If a non-inclusive process achieves inclusive innovation, what are the elements of the process are relevant for this outcome? On the topic of biofuels in Brazil, what is the importance of biofuel company's management to improve the whole sector? And what are the roles of academia, civil society and the private sector in including local voices to complement data and perceptions? How to build a joint pathway towards an inclusive decision-making process in the present an unequal world?

Science and public policy have to improve their efforts in engaging with local stakeholders. A narrow relationship between academia and policymakers can receive the correct inputs for inclusive decisions and with the recognition of the role of science and good governance, society can overcome the difficulties and advance firmly to a biobased society.

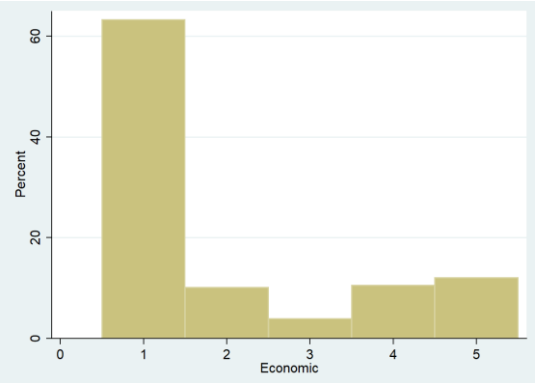
Appendices

A – Distribution of answers in each thematic dimensions N=353

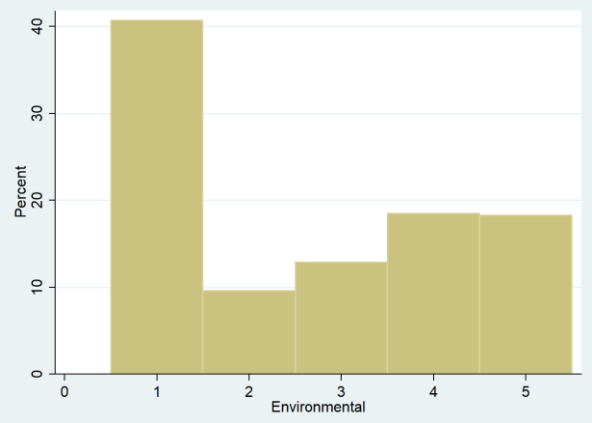
6 social themes



5 economic themes



6 Environmental themes



Source: research data

Legend of scores

1- Completely disagree with the statement
2- Partially Disagree with the statement
3- No opinion/don´t know
4- Partially Agree with the statement
5- Completely disagree with the statement

B - Field Research Questionnaire

Section A: Contact data

Last name: .....

First name: .....

Organization.....

Email:.....

Phone:.....

City:.....

State: .....

Section B: Respondent Profile

What type of stakeholder:

(_) Govern Representative (_) Expert/Academics (_) Urban Entrepreneur
(_) Sugarcane Producer
(_)Other Crops Producers (_) Workers (_) Community Leader

Age of the respondent

(_) 20 - 30 y/old (_) 31 - 60 y/old (_) above 60 y/old

Level of Income

(_) < 2 mw (_) 2 - 5 mw (_) 6 - 10 mw (_) 10 > mw

Level of Education

(_) Elementary School (_) High school (_) Higher Education/above

Length of dwelling

(_) Less than 5 years (_) From 6 to 10 years (_) From 11 to 20 years (_) More than 20 years

Local of Residence

(_) Urban Area (_)Rural Area

Section C: Thematic Questionnaire

Express your level of agreement for each one of the following statements. Please score each phrase from 1 to 5 (i.e., 1, 2, 3, 4, 5), being (1: completely disagree and 5: completely agree).

Completely Disagree -	Disagrees with the phrase and gives elements to justify their position;
Partially Disagree -	Disagrees with parts of the phrase or minimizes the importance of the evidences;
No opinion about -	Does not have information about the topic;
Partially Agree -	Agrees with some parts of the phrase but points this is not always or everyplace;
Completely Agree -	Agrees with the phrase and gives elements to justify their position.

Social Themes	Completely Disagree -1	Partially Disagree- 2	No opinion about - 3	Partially Agree - 4	Completely Agree 5
Food Security The arrival of sugarcane in the region has diminished the availability of food and/or increased a lot the price of food, impacting the food security.					
Working conditions The arrival of sugarcane in the region brought/increased the frequency of workers in degrading conditions.					
Violence The arrival of sugarcane brought violence and disturbances to the region.					
Health The planting of sugar cane brought diseases, work accidents, overloading health posts, affecting the health of the entire community.					
Traditional Communities The planting of sugar cane forces traditional communities to abandon their areas of origin.					
Land Concentration There was concentration of lands in the hands of few people / companies with the arrival of sugarcane in the region.					

Environmental Themes	Completely Disagree -1	Partially Disagree- 2	No opinion about - 3	Partially Agree - 4	Completely Agree 5
Water Quality Water quality in rivers and lakes in the region worsened due to sugarcane.					
Water Availability The cultivation of sugar cane demands an excessive amount of water, impacting the availability for other uses.					
Air Quality The arrival of sugarcane worsened the air quality in the region.					
Soil Quality The arrival of sugarcane in the region had a negative impact on the soil quality.					
Deforestation The expansion of sugarcane in this region caused deforestation of native forest.					
Biodiversity There was loss of biodiversity caused by sugarcane expansion (less plant variety and/or animal species).					

Economic Themes	Completely Disagree -1	Partially Disagree- 2	No opinion about - 3	Partially Agree - 4	Completely Agree 5
Jobs creation The quantity and quality of jobs created in the sugar value chain WERE NOT relevant to the region.					
Income Generation The arrival of the sugar-energy sector in the region HAS NOT ALTERED THE INCOME LEVEL of the community.					
Tax collection The collection of municipal taxes did not increase due to sugarcane-related activities					
Increase of Prices The arrival of sugarcane brought significantly increased prices of goods and services (except food)					
Land Business Model The mills access sugarcane through planting their own lands (land acquisition/vertical integration). Leases, partnerships and supply contracts to access sugarcane are a minority.					

C – Sugarcane Planted Area (hectares)

States/year	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2016/2006
Espírito Santo	64.042	68.816	78.249	80.162	81.393	76.488	73.459	75.821	77.937	76.683	71.733	12%
Goiás	**237.547**	**278.000**	**416.137**	**524.194**	**578.666**	**697.541**	**732.870**	**860.482**	**1.018.281**	**930.052**	**931.342**	**292%**
Mato Grosso	202.182	219.217	218.873	241.668	212.498	226.993	246.298	282.741	289.673	291.100	280.191	39%
Mato Grosso do Sul	**152.747**	**191.577**	**252.544**	**285.993**	**399.408**	**495.821**	**558.664**	**642.686**	**639.899**	**546.099**	**658.282**	**331%**
Minas Gerais	**431.338**	**496.933**	**610.456**	**715.628**	**746.527**	**831.329**	**882.624**	**896.582**	**1.090.977**	**917.878**	**911.614**	**111%**
Paraná	**432.815**	**538.931**	**594.585**	**595.371**	**625.885**	**641.765**	**655.509**	**645.280**	**667.297**	**626.375**	**656.429**	**52%**
Rio de Janeiro	164.290	132.504	137.407	135.130	133.286	105.091	117.892	108.144	95.393	79.388	56.770	-65%
Rio Grande do Sul	33.277	35.767	36.779	36.688	35.970	32.694	30.760	27.670	24.606	19.508	17.828	-46%
São Paulo	**3.498.265**	**3.890.414**	**4.541.509**	**4.977.077**	**5.071.205**	**5.216.491**	**5.172.611**	**5.415.013**	**5.417.391**	**5.576.838**	**5.590.586**	**60%**
Santa Catarina	17.154	17.740	18.084	17.646	9.528	11.129	10.845	10.581	-	8.030	7.628	-56%
South-central region	5.234.211	5.870.467	6.905.380	7.610.340	7.895.289	8.336.225	8.482.249	8.965.450	9.321.454	9.072.407	9.182.699	75%
North-Northeast region	1.158.635	1.216.384	1.305.497	1.235.493	1.269.467	1.280.390	1.270.079	1.257.593	1.324.204	1.107.420	1.062.403	-8%
Brazil	6.392.846	7.086.851	8.210.877	8.845.833	9.164.756	9.616.615	9.752.328	10.223.043	10.645.658	10.179.827	10.245.102	60%

Source: Elaborated by UNICA with information from IBGE (Instituto Brasileiro de Geografia e Estatistica)

D - Sugarcane Planted Area related to the total agricultural area of the cities visited

State	Municipality	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
GO	Bom Jesus de Goiás	7,51	9,2	15,06	25,48	24,67	29,45	27,17	28,59	30,64	28,59	27,25	23,38
GO	Cachoeira Alta			51,72	65,96	64,1	83,61	84,88	92,86	91,65	97,61	99,56	99,49
GO	Caçu		12,7	74,43	78,03	83,11	82,19	83,63	92,73	93,68	91,46	91,4	89,99
GO	Goiatuba	14,3	15,07	22,08	23,82	21,54	21,71	29,14	29,17	31,57	35,04	31,55	31,42
GO	Jataí	0,03	0,03	0,28	1,94	4,86	3,98	2,16	6,85	4,72	3,45	4,3	4,29
GO	Porteirão	39,37	51,68	58,38	58,36	60,98	66,51	59,6	64,36	54,61	56,25	48,16	51,12
GO	Quirinópolis	11,9	31,85	46,53	57,19	63,25	65,22	64,1	68,85	68,47	68,73	66,93	65,91
GO	Rio Verde	0,84	0,95	1,81	2,25	2,49	3,24	4,26	5,37	5,81	5,3	5,76	3,71
GO	São Simão		0	77,67	83,51	85,43	89,39	94,7	95,16	95,26	94,96	95,55	95,55
GO	Turvelândia	36,27	41,57	32,72	39,38	36,42	32,08	32,23	27,12	31,54	35,19	37,79	44,11
MG	Carneirinho	12,55	88,07	85,9	91,15	91,15	91,15	92,29	92,29	96,18	95,98	95,98	94,49
MG	Comendador Gomes	15,73	12,51	13,99	30,43	29,71	24,99	57,71	60,61	61,84	71,6	62,9	60,59
MG	Frutal	20,78	20,8	63,87	66,47	67,54	67,76	71,95	70,19	73,03	76,39	76,44	65,07
MG	Gurinhatã	0,8	1,67	1,66	55,06	57,8	58,36	62,07	62,06	91,02	93,39	94,56	94,88

MG	*Itapagipe*	*9,66*	*8,87*	*8,55*	*65,6*	*64,19*	*86,42*	*86,42*	*84,75*	*88,13*	*85,94*	*87,69*	*88,79*
MG	*Ituiutaba*	*30,87*	*34,18*	*56,54*	*64,5*	*62,71*	*65,05*	*58,39*	*49,86*	*53,96*	*49,59*	*46,77*	*43,64*
MG	*Limeira do Oeste*	*86,28*	*92,47*	*95,69*	*97,03*	*97,03*	*97,03*	*95,47*	*95,51*	*96,76*	*96,43*	*93,93*	*97,85*
MG	*Santa Vitória*	*0,14*	*37,45*	*86,04*	*94,98*	*98,04*	*96,59*	*93,48*	*91,17*	*90,95*	*91,17*	*94,9*	*94,42*
MG	*Tupaciguara*	*8,59*	*9,85*	*9,08*	*11,71*	*10,12*	*18,97*	*24,32*	*18,74*	*30,63*	*20,96*	*19,7*	*93,94*
MG	*Uberaba*	*18,27*	*19,78*	*27,36*	*22,96*	*25,36*	*25,65*	*29,29*	*29,01*	*34,55*	*33,33*	*26,07*	*29,76*
MS	*Caarapó*				*0,61*	*6,05*	*12,16*	*13*	*13,86*	*13,85*	*9,2*	*10,94*	*8,99*
MS	*Dourados*		*2,99*	*1,36*	*4,36*	*6,95*	*11,26*	*13,29*	*14,87*	*14,31*	*8,79*	*10,11*	*8,23*
MS	*Fátima do Sul*		*0,33*		*2,03*	*2,51*	*4,83*	*4,98*	*5,97*	*9,08*	*7,06*	*7,03*	*7,62*
MS	*Rio Brilhante*	*8,93*	*13,43*	*24,97*	*28,09*	*29,75*	*30,42*	*29,76*	*29,63*	*29,01*	*26,32*	*31,3*	*30,38*
MS	*Vicentina*		*8,13*	*10,89*	*18,74*	*22,54*	*25,77*	*29,75*	*35,08*	*34,74*	*38,27*	*38,6*	*29,93*
PR	*Astorga*	*10,62*	*9,05*	*8,59*	*8,73*	*10,71*	*9,7*	*11,39*	*9,74*	*6,48*	*5,24*	*4,49*	*6,16*
PR	*Nova Londrina*	*66,43*	*85,06*	*79,7*	*78,09*	*80,25*	*77,9*	*77,81*	*80,23*	*77,03*	*76,47*	*74,5*	*74,78*
PR	*Santo Inácio*	*40,51*	*67,96*	*81,66*	*88,65*	*89,76*	*86,57*	*83,18*	*75,51*	*70,93*	*68,76*	*68,52*	*65,08*
PR	*Umuarama*	*11,66*	*39,58*	*65,99*	*69,42*	*71,4*	*81,98*	*82,24*	*82,09*	*83,81*	*85,11*	*82,82*	*76,41*
SP	*Castilho*	*58,67*	*83,5*	*89,69*	*95,59*	*97,2*	*96,56*	*97,19*	*87,38*	*86,63*	*88,23*	*90,97*	*91,23*
SP	*Gastão Vidigal*	*27,47*	*78,75*	*68,12*	*81,05*	*93,07*	*88,51*	*96,07*	*95,49*	*94,35*	*95,1*	*92,08*	*93,41*

SP	*Luiziânia*	*55,73*	*80,71*	*72,03*	*98,81*	*94,96*	*95,29*	*91,57*	*92,98*	*87,12*	*86,81*	*88,64*	*88,31*
SP	*Meridiano*	*35,46*	*89,61*	*90,25*	*99,34*	*99,15*	*94,52*	*92,15*	*93,96*	*95,85*	*100*	*93,17*	*90,41*
SP	*Mirante do Paranapanema*	*29,69*	*31,16*	*43,46*	*84,74*	*79,39*	*86,57*	*88,12*	*90,76*	*91,25*	*89,39*	*93,34*	*89,47*
SP	*Monções*	*86,9*	*92,19*	*94,4*	*98,5*	*99,3*	*97,44*	*97,05*	*78,16*	*89,9*	*99,49*	*97,53*	*81,29*
SP	*Nova Independência*	*42,24*	*49,14*	*48,57*	*93,39*	*93,39*	*98,78*	*98,87*	*98,58*	*99,53*	*99,69*	*100*	*99,69*
SP	*Queiroz*	*53,21*	*42,62*	*86,97*	*82,96*	*92,71*	*92,73*	*91,61*	*91,62*	*93,56*	*92,91*	*91,5*	*98,2*
SP	*Sebastianópolis do Sul*	*75,44*	*85,07*	*86,96*	*98,36*	*98,36*	*98,46*	*95,8*	*93,53*	*92,26*	*94,04*	*94,87*	*93,51*
SP	*Votuporanga*	*61,82*	*84,34*	*62,27*	*90,21*	*85,13*	*16,21*	*86,11*	*83,72*	*89,16*	*91,64*	*92,26*	*88,2*

Source: Prepared by the author based on IBGE data

E - Visited cities and reference plants in the region

State	City	Company Name	Opening
GO	Bom Jesus de Goiás	None	
GO	Caçu	Usina Rio Claro (Oderbrecht)	2009
GO	Goiatuba	None	
GO	Jataí	Raízen	2009
GO	Porteirão	None	
GO	Quirinópolis	1) Usina Boa Vista (Grupo São Martinho) 2) Usina São Francisco (USJ)	2006 2007
GO	Rio Verde	Rio Verde Decal	2004
GO	Turvelândia	Vale do Verdão	2006
MG	Carneirinho	Usina Coruripe - Grupo Tercio Wanderley	2008
MG	Comendador Gomes	None	
MG	Frutal	None	
MG	Gurinhatã	CNAA/BP	2008
MG	Itapagipe	Bunge	2006
MG	Ituiutaba	CNAA/BP	2008
MG	Limeira do Oeste	Cabrera Energética	2009
MG	Santa Vitória	1) Mitsui/DOW; 2)Vale do São Simão (Grupo Andrade)	2014 2010
MG	Tupaciguara	None	
MG	Uberaba	None	
MS	Caarapó	Raízen Energia	2010
MS	Dourados	São Fernando Açúcar e Álcool Ltda	2009
MS	Fátima do Sul	Fátima do Sul Agroenergética S.A.	2010
MS	Rio Brilhante	1)Biosev 2) Biosev 3) Odebrecht Industrial	2008 2013 2008
MS	Vicentina	None	
PR	Astorga	Nova Produtiva	1999
PR	Nova Londrina	Grupo Melhoramentos (Copersucar)	2012
PR	Santo Inácio	Grupo Alto Alegre	2007
PR	Umuarama	Santa Terezinha	2008
SP	Luiziânia	None	
SP	Meridiano	Noble Group	2010
SP	Mirante do Paranapanema	Odebrecht Agroindustrial	2009
SP	Monções	Grupo Virgolino De Oliveira	2008
SP	Nova Independência	Grupo Pedra Agroindustrial (Copersucar)	2005
SP	Queiroz	Grupo Clealco	2006

Source – Prepared by the author based on field research and website information

Blanked cells – There is no mill in the specific city but there are farms that supply the mill in the surrounding areas

F – Respondents' Profile

Stakeholders per State

Stakeholder/State (a)	GO	MG	PR	MS	SP	Total	Sector of Society	
Visited Municipalities (a)	**8**	**10**	**5**	**4**	**6**	**33**		
Govern	18	20	5	10	9	62	62	1st Sector Govern (1)
Experts	15	15	6	6	5	47		
Urban Entrepreneurs	13	8	6	10	4	41	129	2nd Private Sector (2)
Sugarcane Producers	9	13	5	7	9	43		
Other Crops Producers	9	12	3	8	13	45		
Workers	19	16	13	12	12	72	162	3th Civil Society (3)
Community Leaders	13	9	4	6	11	43		
Total	**96**	**93**	**42**	**59**	**63**	**353**		

(a) States and municipalities defined by rate of growth of sugarcane area from 2006 to 2016

(1) Includes Govern

(2) Includes Urban Entrepreneurs, Sugarcane Producers and Other Crop Producers

(3) Includes Workers, Community leaders and experts (academia)

Respondent's income per State

Income Level/State	GO	MG	PR	MS	SP	Total
< 2 mw	15	7	8	13	10	53
2 - 5 mw	35	39	11	19	30	134
5 - 10 mw	20	31	8	13	8	80
10 > mw	26	16	15	14	15	86
Total	**96**	**93**	**42**	**59**	**63**	**353**

mw = minimum wage in Brazil

Age of the respondents per State

Age/State	GO	MG	PR	MS	SP	Total
20 - 30 y old	20	11	5	4	11	51
31 - 60 y old	70	69	29	38	42	248
above 60 y old	6	13	8	17	10	54
Total	**96**	**93**	**42**	**59**	**63**	**353**

Education Level of the Respondents

Age/State	GO	MG	PR	MS	SP	Total
Until fundamental School (1)	10	22	7	13	15	67
Secondary school (2)	26	26	11	19	18	100
Graduated school / above (3)	60	45	24	27	30	186
Total	**96**	**93**	**42**	**59**	**63**	**353**

(1) – includes illiterate, incomplete, and complete elementary school education
(2) – includes incomplete and complete high school education
(3) – includes incomplete and complete undergraduate and graduate education

Length of dwelling per State

Length of dwelling/State	GO	MG	PR	MS	SP	Total
Less than 5 years	10	6	2	2	3	23
5 to 10 years	9	7	6	5	3	30
11 to 20 years	14	14	1	6	5	40
More than 20 years	63	66	33	46	52	260
Total	**96**	**93**	**42**	**59**	**63**	**353**

Place of Residence per State

Place of residence/State	GO	MG	PR	MS	SP	Total
Urban Area	81	77	37	45	40	280
Rural Area	15	16	5	14	23	73
Total	**96**	**93**	**42**	**59**	**63**	**353**

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List of Publications

Peer Reviewed Journal Articles

Marques Postal, Andreia; Pashaei Kamali, Farahnaz ; Asveld, Lotte ; Osseweijer, Patricia ; Silveira, Jose Maria F. J. Da . The impact of sugarcane expansion in Brazil: Local stakeholders' perceptions. Journal of Rural Studies JCR, 2019. https://doi.org/10.1016/j.jrurstud.2019.10.041

Marques Postal, A., Benatti, G., Palmeros Parada, M., Asveld, L., Osseweijer, P., & Maria J Da Silveira, J. F. (2020). The Role of Participation in the Responsible Innovation Framework for Biofuels Projects: Can It Be Assessed? https://doi.org/10.3390/su122410581

Under Review

Marques Postal, A., Felício,A. Asveld, A., Osseweijer, P., Da Silveira, J.M.F.J. 2020. Inclusion in the expansion of sugarcane in Brazil? Local perceptions on how and why. Journal of Cleaner Production (submitted)

Conference Proceedings

1. Marques Postal, A.; Pashaei Kamali, F. ; Asveld, L. ; Osseweijer, P. ; Da Silveira, J.M.F.J . The impact of sugarcane expansion in Brazil: local stakeholders' perceptions. 2020. 28 th European Biomanss Conference & Exhibition - Bioeconomy´s role in the post-pandemic economic recovery

2. Marques Postal, A.; Pashaei Kamali, F.; Asveld, L.; Osseweijer, P.; Da Silveira, J.M.F.J. The impact of sugarcane expansion in Brazil: local stakeholders' perceptions. 2020. BBEST/BIOFUTURE SUMMIT- II Brazilian Bioenergy Science And Technology Conference

3. Marques Postal, A.; Felicio, A. ; Asveld, L. ; Osseweijer, P.; Da Silveira, J.M.F.J. . Inclusion in the Sugarcane Expansion Process in Brazil. 2020. 28th European Biomanss Conference & Exhibition - Bioeconomy´s role in the post-pandemic economic recovery

4.Marques Postal, A.; Benatti, G. S. S.; Palmeros Parada, M.; Asveld, L.; Osseweijer, P.; Da Silveira, J.M.F.J. Responsible Research and Innovation Framework as a Theoretical Tool for Evaluating Initiatives related to Biofuels Production. 2020. 28th European Biomanss Conference & Exhibition - Bioeconomy´s role in the post-pandemic economic recovery

5. Marques Postal, A.; Felicio, A. ; Asveld, L. ; Osseweijer, P.; Da Silveira, J.M.F.J.. Sugar-enegy in Brazil? an inclusive expansion. 2020. Building Inclusive Agricultural Value Chains Online Seminar Series – Tu Delft

6. Marques Postal, A.; Felicio, A. ; Asveld, L. ; Osseweijer, P.; Da Silveira, J.M.F.J. .. Sugar-enegy in Brazil? an inclusive expansion. 2020. 24th ICABR Conference "Accelerating The Bioeconomy"

7. Marques Postal, A.; Pashaei Kamali, F.; Asveld, L.; Osseweijer, P.; Da Silveira, J.M.F.J.. Perception of Sugarcane Expansion Impacts according to local stakeholders in Brazil. 2019. International Conference on Renewable Energy – ICREN 2019.

8.Marques Postal, Andreia; Reydon, B.; Da Silveira, J.M.F.J. Access to land or access to feedstock? The changing on the sugarcane business sector land strategy in Brazil. 2019. 2nd International Conference on Energy Research and Social Science.

9. Marques Postal, A.; Pashaei Kamali, F.; Asveld, L.; Osseweijer, P.; Da Silveira, J.M.F.J. Perception of sugarcane expansion impacts according to local stakeholders in Brazil. 2019. International Conference on Renewable Energy – ICREN 2019

10. Marques Postal, A.; Palmeros Parada, M.; Asveld, L.; Osseweijer, P.; Da Silveira, J.M.F.J.. RRI beyond Europe - The suitability of the scheme for biofuels innovations. 2019. 2nd International Conference on Energy Research and Social Science

11. Marques Postal, A.; Benatti, G. S. S. ; Ribeiro, C. H. . Inovação responsável como ferramenta teórica para avaliação de iniciativas voltadas à produção de biocombustíveis -57 Congresso da Sociedade Brasileira de Economia, Adminstração e Sociologia Rural. 2019.

12.Marques Postal, A.; Da Silveira, J.M.F.J. . The challenges for inclusion and attractiveness of contracts for land owners and growers in plantations of sugarcane biofuels in Brazil. 2018. LANDac governance Annual International Conference 2018

13.Marques Postal, A.; De Mello, H; Da Silveira, J.M.F.J.. Multiple correspondence analysis Of Sugarcane Expansion in Brazil - Perception of Local Development According Model of the Access to Land. 2017. 21st ICABR Conference "Bioeconomy in Transition: New Players and New Tools"

14. Marques Postal, A.; De Mello, H; Osseweijer, P; Da Silveira, J.M.F.J . The local stakeholders' perceptions on biofuels in Brazil. 2017 55th SOBER Conference "Inovação, Extensão e Cooperação para o Desenvolvimento"

Curriculum vitae

Andreia Camargo Marques-Postal was born on First of June, 1967 in São Paulo, Brazil. In 1991 she completed her Degree in Economic Sciences from the Instituto de Economia Unicamp (Brazil) and in 1993 her Degree in Law and Social Sciences (PUC Campinas – Brazil). After long experience on different areas of private sector (financing, pharmaceutics, consulting and energy) in commercial and sustainability departments, she decided to start a master program on Economic Development at Unicamp. In 2014 she received her master's degree having completed her thesis about the land governance on sugarcane sector. In 2016 she started a dual degree program of Professional Doctorate in Biotechnology and Society at the Biotechnology and Society Group in the Department of Biotechnology of the Delft University of Technology and at the Economic Development at Institute of Economics – Unicamp, as a PhD student under the supervision of Prof. Dr. P. Osseweijer, Dr. L. Asveld (both TU Delft) and Prof. J.M Da Silveira (UNICAMP) as promotors. Since then, she has worked on the research presented in this thesis. As part of this programme, she worked on the analysis of local stakeholder's perceptions regarding the sugarcane expansion in Brazil.

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The reward of the eternal apprentice is to
remain constantly young.

I grew up hearing my grandmother say that "curiosity is the mother of intelligence". The family of humble origin took the concern about studies to heart, and I found myself surrounded by parents and uncles, all of them public elementary school teachers. For that generation, a daughter, a woman, going to college was already too good. Master's degree? Doctorate degree? Only for true geniuses! What a distant dream ...But curiosity, and the pleasure of learning new topics and perspectives, has led me even further, in every way! This academic journey, which only happened in the mature stage of my life, was inspired by various circumstances, people and events that forged me in the person I am today.

Starting with Gandaia, my group of "adventures, amusements, caves, parties and trips" that, has been showing me the value of environmental issues since 30 years ago, influenced the switch my career, and even today teaches me the power of friendship to overcome the setbacks in our lives. And thanks to my jogging group "the baronesas" who helped to keep the mental and physical healthy during these doctorate and pandemic times. Also, my girlfriend, friends devoted to the academic life and having that spark in their eyes shine when mentioning the progress of their students and who taught me the importance of academic rigor. That is what happened with Herta Viegas (in memoriam), Yara Schiavenatto, Lúcia Avary and Renata Brito. As well my professional friends from the field of sustainability who in their daily activism to make the world a better place are always concerned about having careful and scientifically-based positionings. In this group, I would like to thank each of the professionals from the Uniethos staff with whom I have had the pleasure of working together in projects of great relevance and affection. This group, initially led by Ricardo Young, Gláucia Térreo, Vivian Smith, Tarcila Ursine and Mariana Kohler made history in Brazil in the field of sustainability and in my own personal experience. And what about my great friend and business partner João Paulo Altenfelder who always collaborated with and exchanged ideas about this thesis, as well as supported the field research by providing some interview management software. I would also like to thank Joaquim Cunha, Viviane Gurgel and Pedro Maeda for all the helpful discussions, insights and question, and for sharing your excellent views about the sugar-energy sector. There's a little bit of you in this thesis!

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And then I arrived in The Netherlands with my whole family on a cold January morning for an adventure in unknown lands. How lucky I was of being part of such a welcoming, heterogeneous and multicultural group, which vibrated and shared their time with me at various moments. For instance, when I finally managed to rent an apartment (Anka, you were amazing by calling the real estate agents and reviewing my contract). Or when Mar introduced me to the Buinradar app so I would not be caught off guard by the frequent rain. Also, to Farahnaz who welcomed me during my moments of insecurity and despite my imperfect English. I am thankful for the conversations with Philip and Mar about how to deal with my daughter's first boyfriend! Or how to be a "cool" mother at my daughter's farewell party. Thanks to Brite who helped me when I had to make phone calls in Dutch and represented the Dutch side of the team. But when it came to leisure it was Pablo who introduced me to the Latin community in Delft, Zoe who introduced me to Lindy Hop and the yoga classes with Zhinzhen. Farahnaz and Mar were also my confidants, friends, mentors and companions for all seasons. I will take them forever in my heart.

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In the end, each day brings a new learning, each day I spend more time together with the future generations and the different ways of thinking, and each day I better understand that the secret for a young mind is to remain an apprentice.