

Expansion of sugarcane in Brazil: how inclusive was its impacts on working conditions and food securities from local communities´ perspectives

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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 two main aspects of the impacts: working conditions and food security. Each of these impacts are analyzed comparing local stakeholders' perceptions (collected through field research) with secondary data from official databases. The results show 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

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 [1,2]. However the sector's image was justifiably exclusionary [3] because of cases of mistreatment, deaths from exhaustion, non-payment of labor rights, lack of personal safety equipment, and even lack of food are still happen, although with much lower frequency [4].

The social effect of sugar cane expansion was also questioned regarding its potential exclusionary impact on food production, expulsion from communities, bad working conditions, among others [5–9]. Regarding the environmental side, limited reduction of CO_2 emissions, impacts on soil and water quality and deforestation are among the other issues of concern [10–13].

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 [14–16]. The result of this behavioral change in the sector would put sugarcane as one of the best types of biofuels in terms of social development and poverty alleviation as well as environmental aspects of sustainability [17–20].

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 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. Therefore, the central research question of this paper is to what extent did this expansion process allow different social classes to experience higher development levels and therefore be considered more "inclusive" in terms of access to goods and services?

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 [6,21,22]. 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 [23]. 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.

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 working conditions and food security, since these themes are directly linked with the desirable inclusion in the global debate.

In fact, these two 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 bad working conditions in the sector [13,20,24] is 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 second theme, food security, is one of the main concerns worldwide [25–28] and given the global value chain interconnection should also be analyzed even though is not considered as a main topic in the Brazilian context [29].

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

2. Methodologies

To perform the task of understanding and including local stakeholder perception in the global debate about the sugarcane expansion's impacts, the research group combined literature review, content analysis of previous field research interviews (both quantitative and qualitative), and secondary data to validate or complement community perceptions.

2.1. Field research interviews

The dataset used for the present study partially overlaps with the data set of [29].

2.1.1. Data collection

The assessment of sugarcane mills' local impacts demanded field research in the focal areas. After a training period and the completion of pilot' interviews to adjust the questionnaire, five teams of researchers were diploid into the regions; in almost one year and a half (April 2016-October 2017), they visited 33 municipalities of 5 Brazilian states (São Paulo, Minas Gerais, Goiás, Paraná and Mato Grosso do Sul, in the South, Center-West and South-East regions), which has been identified based on a rank of sugarcane expansion after 2000 performing the first level of selection (see Annex 1)[1] The date companies started operating consisted in the second level of the sampling defining procedure. (See Annex 2).

The scope of study is the ensemble of the five areas in the five states. The idea is to investigate the "local and regional impacts," aiming to capture the diversity of perception of the residents, with at least ten interviews by a municipality. The data bank consists of 353 respondents, divided into seven types of interest groups, but none of them are representative of the mills, since the main objective of the research is to check how the perceptions of local stakeholders agree/disagree with the critics of expansion of sugarcane biofuels in Brazil.

The research consisted of two instruments to collect data investigation: a) a brief questionnaire (with 17 questions, encompassing social, environmental and economic dimensions) to capture the perceptions of the stakeholders, using Likert scale (-3:3), allowing the creation of categorical variables; b) a semi-structured interview to justify the answers in each of seventeen questions of the three dimensions.

To follow the ethical guidelines and guarantee the viability of face-to-face interviews, the research has carried two kinds of previous contacts: a) with representatives of local organizations, including local government; and; b) with informal ones, approaching key opinion leaders (e.g., leaders of different kinds of associations) to generate a snowball sampling [31-33] involving community leaders, other crops growers (mostly soybean-corn) and urban entrepreneurs.

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). MAXQDA[2] software version 2020.0.7 was used to organize the files of interviews. The features of this software allowed us to implement a sequence of steps after the clear definition of the goals of the inquire [30]. The categorization

[1] Research procedures have followed the Code of "Good Scientific Practices" of São Paulo State Research Corporation., basically asking interviewees if they were in accordance in answering the questions, guarantying their privacy.

[2] www.maxqda.com

framework proposed by Gibbs [31] was used to perform the data analysis in the two selected subjects: working conditions and food, keeping the perspective of analyzing local/regional impacts of the sugarcane expansion.

The objective is to go beyond the simple obtention of word clouds and establish a relation between the two main subjects and the interviewers' answers, using tools that reduce at minimum necessary the intervention of the observers (Wu et al., 2014).

The initial step to perform text mining is to build a vocabulary of words from the data and calculate the frequency of appearance of comments, favoring the application of classical statistical methods and even find links with some categorical variables of interest. The lexicographic analysis deals with the frequency of words according to specific variables that describe the subject of the text, generating graphs that contain the organization of the terms according to some discriminating criteria. The last procedure allows a better interpretation of context involving what is relevant to the text, and consequently, understanding the stakeholder's view about selected issues.

Following is a brief description of the methodological steps with some comments on the adaptation to the paper's requirements.

1. *Building the word vocabulary*: initially, all the words are taken into account, providing text preparations, making it more homogeneous. Some initial outputs give some "food for taught," like the list of words in order of frequency;
2. *Looking for word contents*: the depart is the definition of context of a word to guarantee its interpretation. The field research that sustains has five fundamental issues with two selected to the present analysis: work conditions and food. The procedures allow the quantification of the sentences and consequently the calculous of their frequency.
3. *Forming groups of words forms that are equivalent:* improve the quality of the analysis it is essential to reach a cloud of words and the identification of repeated segments (see 3, below) capable of being interpreted and correlated with the relevant research issues, like "burning of sugarcane" and "working conditions." Using the semi-lemmatizer algorithm is necessary to input the vocabulary list (in alphabetical order). There is a separate file that guides de procedure with three groups of rules; a) grouping forms with the same connotation, b) deleting "function' forms, and c) taking out irrelevant lexical forms (based on their frequencies). After the operations, a list with the frequencies of the new vocabulary is issued;
4. *Applying a method to identify repeated segments:* aiming to understand the more relevant sentences in the text. Some expressions can be grouped while having similar meanings. The building of the "cloud of sentences" helps the interpretation of the content of the clusters.
5. *Finding the segments that are characteristic of groups of cases according to the frequency and creating codes*: after these "lemmatizing" of expressions, we develop codes as a synthesis of relevant meanings into hierarchical ideas that explain the two topics. Two basic procedures having been carried out, one using the simple correspondence analysis (taking the central theme as a reference, like Food or Work Conditions); and the other, by the direct inspection of the sentences with correlation with the important questions, according to their relevance (given by their scores). The main goal is to create blocks hierarchically organized, from the main subject (e.g., "Working Conditions") to specific short sentences correlated to it.

Figure 1 below shows the approximative procedures from single words to a more complex sentences to a larger sentence, regarding the correlation with the key issues and the qualitative inspection of the meanings to generate the hierarchical trees.

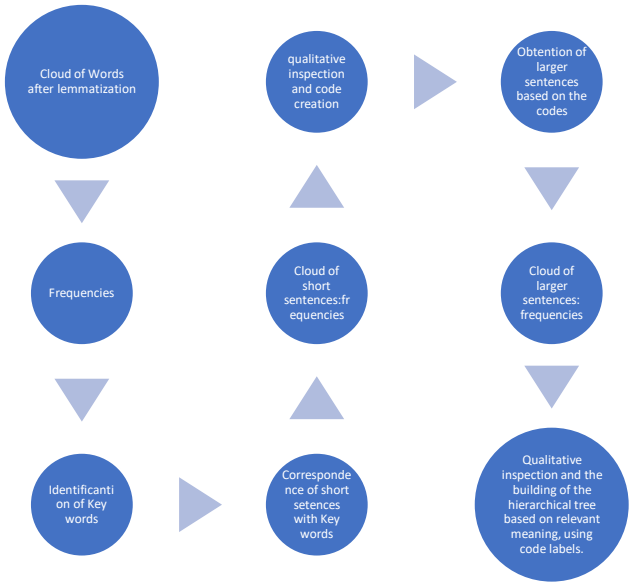


Figure 1 Methodological steps in analysing interviews content

3. 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 [6–8,32–36].

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 [37] 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 [8,38–41].

Although some studies analyzed 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?

3.1. Local perception of working conditions

3.1.1. 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.

3.1.2. Content analyses of interviews

After the first exploratory analysis of the consented 222 interviews on this theme, the results are presented in Figure 2.

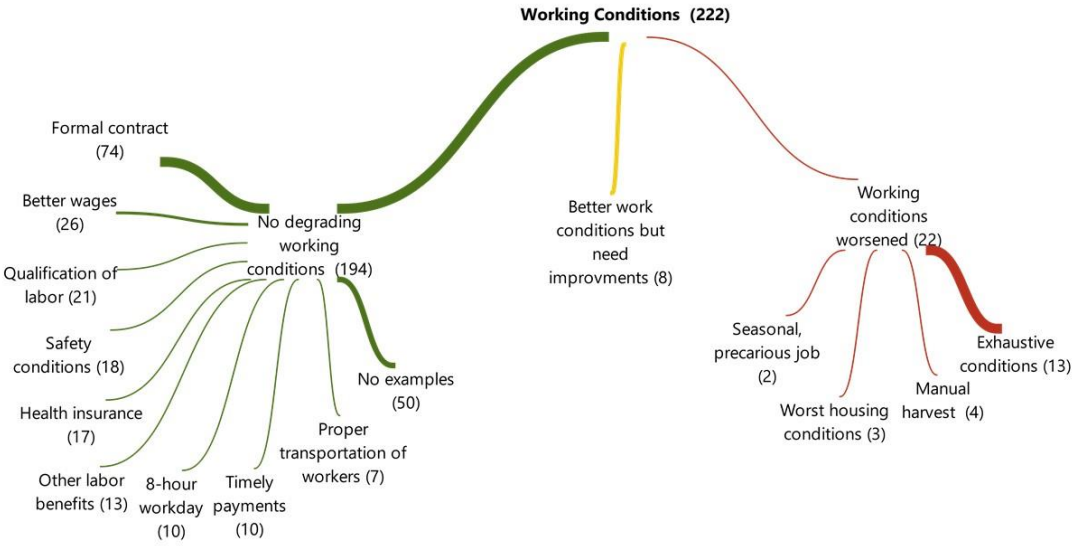


Figure 2 Working conditions - main comments from field research

Source: Prepared by the author using Maxqda 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 labor practices. The most cited was the formalization of contracts (74) followed by better wages (26), training and qualifications of labor (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 3 below shows the content analyses with systematized stakeholders' comments about the possible causes for working conditions changes.

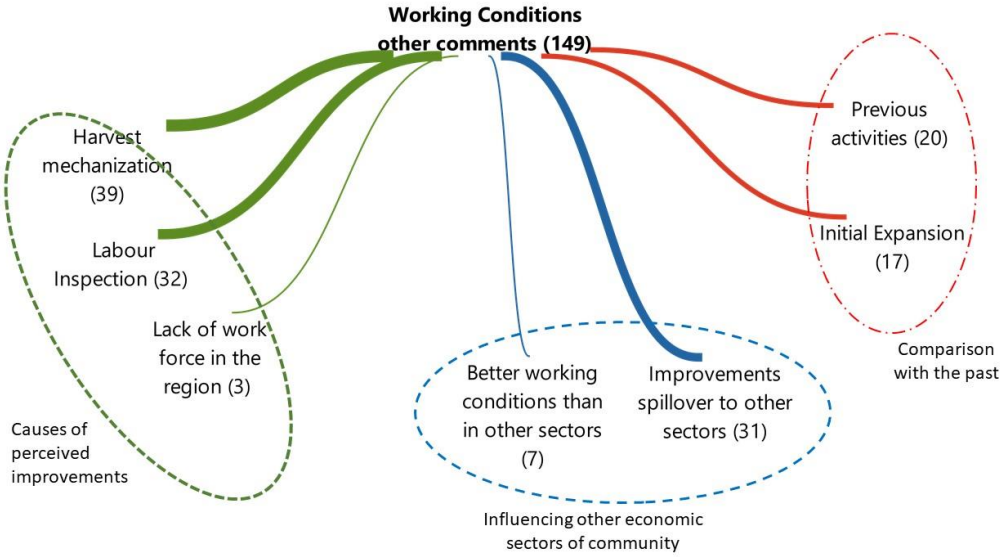


Figure 3 - Additional comments about working conditions in sugarcane expansion

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 labor rights are not respected accompanied with much lesser attention from the labor 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 labor 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 spillover effect was also referred to by Brinkman, [40] and can be represented by one testimonial:

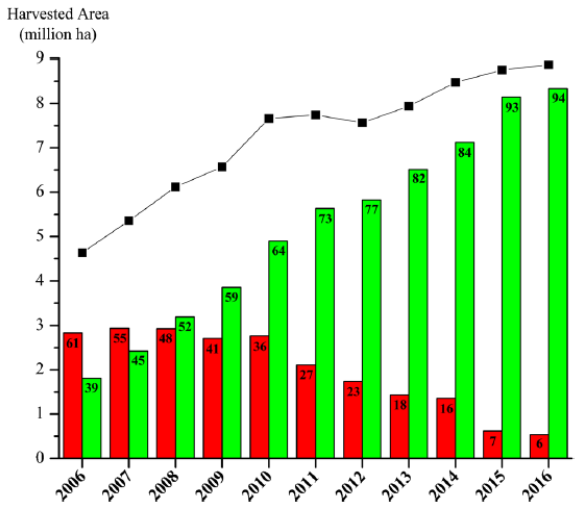
> *"Competition for labor between plants and farms forced the regularization of many agricultural workers who worked without formal contracts (on farms). This competition also caused a general increase in wages. Farms had to raise wages to keep workers." Producer of other crops - MG*

This third group of comments seems to point out two main reasons why this improvement took place. The intensification of labor 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 1 shows the changing pace of the introduction of mechanization.

Graph 1 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:[43]

The evolution of the harvest mechanization and its benefits to living conditions were mentioned by the community and are aligned with the findings of [43,44]. Technological improvements, increased governance for environmental issues, and labor 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.

3.2. 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 analyzed: the formalization of contracts and better wages. Table 1 presents the average evolution of contract formalization in each municipality of the sample in the period 2000 – 2010[3].

Table 1 Evolution of total labor 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%**

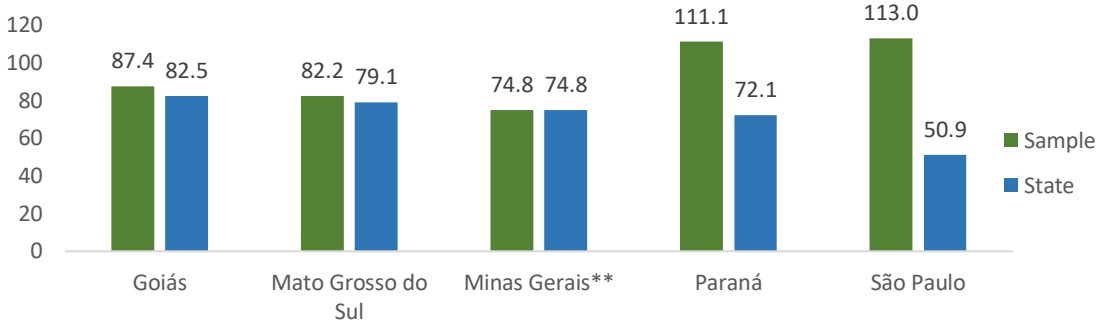
[3] The 2010 Brazilian Census provides the most recent official data since a new census is scheduled for 2020.

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%**
Mirante do Paranapanema	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 analyzed the evolution of income in the researched regions.

*Graph 2 - 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"* [14,45]. In Mato Grosso do Sul the importance of sugarcane for income is also referred in [46].

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. Food Security

As previously mentioned, food security was chosen as one of the topics to be analyzed, as it is commonly considered one of the main negative impacts of expansion of biofuels in the world [3,5,35,47–51]. 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 [52]. 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 [53]. 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 [29,54] and often overlook a distinction of the full criteria of food security [55,56].

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 [57]; 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 [43], and finally c) Brazilian society is already used to buying food from other regions of the country [58] 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?

4.1. 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" [4]. This concept is aligned with the four dimensions of the food security: availability, accessibility, stability and utilization as defined by the [59]. 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."

4.1.1. 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 analyzed 205 authorized registered interviews carried out during the field research.

4.1.2. Qualitative field research analyses

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

The 205 registered comments on food security were analyzed to group the answers into subcodes as presented in Figure 4 below.

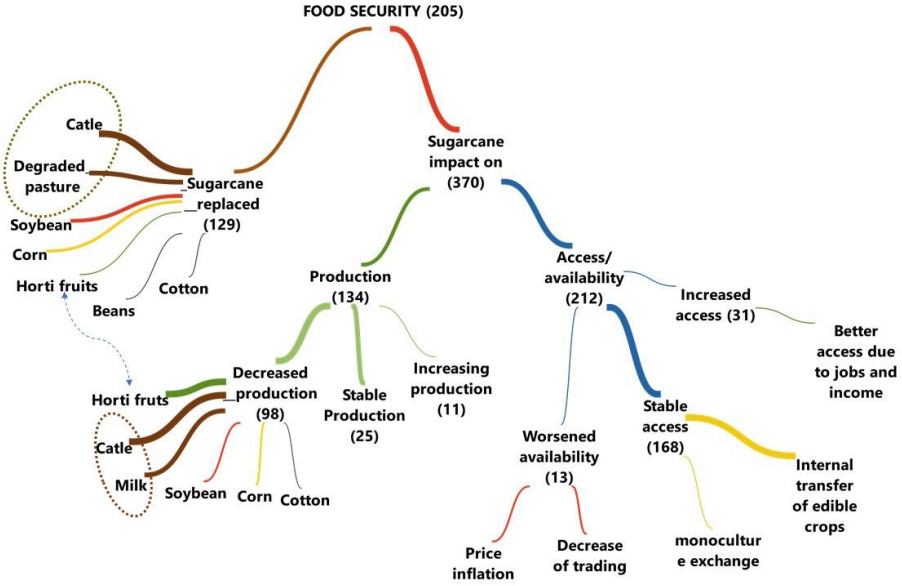


Figure 4 Food Security - main comments from field research

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 [55,60–63]. Fruit & vegetables and beans were referred to by 11 and 3 respondents, respectively.

Respondents mentioned two of the FAO's [59] 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 [62,64] 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". (Respondent from MG state)*

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 [57]. 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." (Respondent from 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 spillover effects of sugarcane expansion to other sectors of the region are well-recognized in the literature [39,42,65] 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." (Respondent from MS)*

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

> *"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." (Respondent from GO)*

4.2. 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.

4.2.1. 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 analyzed the evolution of the main items mentioned by local stakeholders. The indicator of production evolution in the selected municipalities was captured from the IBGE - PAM[5]. The results are presented in Table 2.

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

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

Table 2 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 [64].

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.

4.2.2. Secondary data on food access

According to FAO [59], 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.

Conclusion

The World Bank [66] 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 [67,68] 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 [69] [68], 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 3 below:

Table 3 Inclusive aspects of sugarcane expansion

Themes	Inclusive?		Main outcomes	Reasons	Main driver
	Result from local perceptions	Result from factual data			
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.

Working conditions 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 regarding the two analyzed aspects. 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 [66].

The advance of mechanical harvest technology, imposed by legal restrictions to the manual cutting, can be considered as one possible factor that allowed these perceptions since the higher quality of work force drove the whole sector to better working conditions, higher wages and better access to food security. This aspect will be explored in further studies.

Limitations

The current study is part of a larger project which explore different kinds of social and environmental impacts of sugarcane expansion. In this paper we explore just two aspects in a deeper view. Some other aspects can help to explain part of the arguments and perspectives regarding the issues explored here but, in name of readiness and clearness we just went deeper in the tow above mentioned aspects: food security and working conditions.

Declaration of interest

No potential conflict was reported by the authors.

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