

Chapter 12

Socio-Economic Impacts of Bioethanol from Sugarcane in Brazil

Arnaldo Walter and Pedro Gerber Machado

Abstract The impacts of sugarcane and ethanol production in Brazil are widely discussed in all steps of its production. The rapid expansion, the possible indirect land use changes, and the socio-economic impacts are of great concern for different stakeholders. As any economic activity, ethanol production and sugarcane cultivation have many positive and negative socio-economic impacts such as employment and income generation, health issues, and migration. In this chapter, three geographical levels of impacts and aspects are discussed for Brazil: national, with an overview of the country and the main macroeconomic impacts; regional, focusing on the Northeast region; and local level with two case studies, Pindorama mill and São Francisco mill.

Keywords Ethanol · Sugar · Brazil · Case studies · Sugarcane

12.1 Introduction

After its introduction in the country and for over two centuries, sugarcane was Brazil's most important product and one of the main pillars of the economy. In the 1970s, the sugarcane sector initiated a long transformation: a large-scale ethanol production program ("Proalcool") was created by the government aiming at the production of anhydrous ethanol for blending with gasoline. With the second oil crisis, started in 1979, hydrous ethanol was introduced in the market and, since then, the sales of light vehicles, able to run just with ethanol, increased very fast.

With decreasing oil prices in the mid-1980s, ethanol started to lose its competitiveness. The incentives given by the government were reduced and in a second moment ethanol lost room in some regions due to the introduction of Natural Gas Vehicles (NGV) in the late 1990s. However, almost at the same time, with the deregulation of

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Fig. 12.1 Sugarcane workers in Brazil. (Source: D. Rutz, WIP)



the sugarcane industry and the rising prices of oil, ethanol became a feasible option again. Nonetheless, the most important driver for the revival of hydrous ethanol was the introduction of flex-fuel vehicles (FFV) in 2003. In Brazil, the technology allows the use of any fuel blend, varying from gasohol (a blend of anhydrous ethanol—18–25%, volume basis—with conventional gasoline) to pure hydrated ethanol. The acceptance of this technology and the relative low prices of ethanol allowed a large increase of the sales of FFVs; currently, almost 90% of the new light vehicles sold are FFVs.

Being an important economic activity for the country, as it contributes with 2% of the total GDP, the sugarcane sector is interlaced between industry and agriculture, and its impacts are obviously related to both sides of the supply chain. Due to the number of economic operators and the heterogeneity within the supply chain, ensuring sustainability of ethanol production is, therefore, a highly complex task, which requires a wide view of the system and its peculiarities.

This chapter deals with socio-economic impacts of the sugarcane industry in Brazil. For many years the sector has been criticized mainly due to the large number of temporary workers (Fig. 12.1) and to the tough working conditions on sugarcane harvest. Improvements have been observed, but the critics are still strong, partially because of the lack of accurate information and also because of the tendency of generalizing the worst cases.

12.2 General Data

In 2011, 559.2 million t of sugarcane was harvested for sugar and ethanol production (EPE 2012) and this total required 9.6 Mha (UNICA 2012). The production of hydrated ethanol reached 13.9×10^3 m³, while the production of anhydrous ethanol was 9.120×10^3 m³. Altogether, there was a reduction of 18.1% comparing with the results of 2010 (EPE 2012). This result was mainly due to the lack of sugarcane, partially because of small investments in the agriculture, and also due to weather

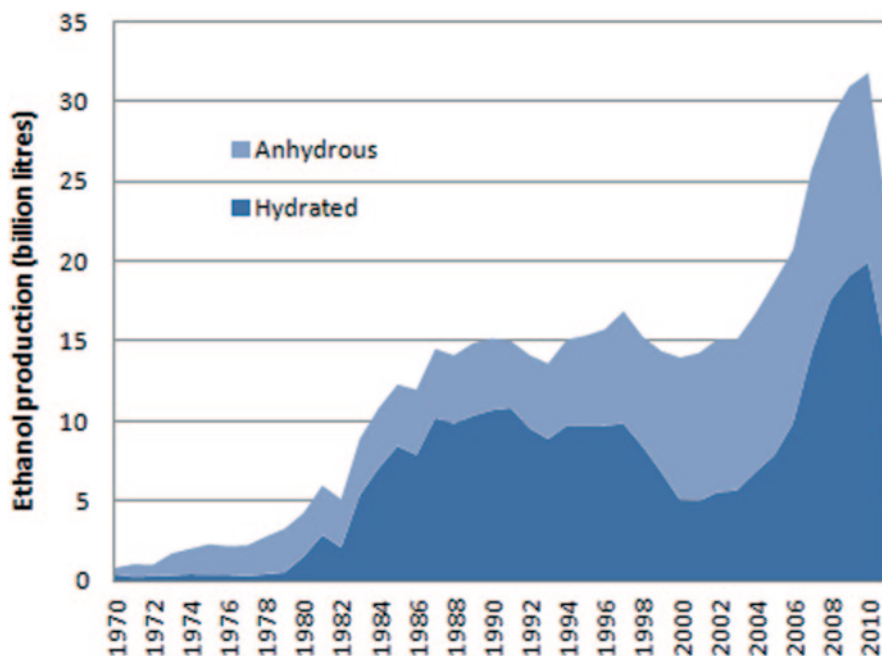


Fig. 12.2 Hydrated and anhydrous ethanol production—evolution 1970–2011. (Source: EPE 2012)

constraints. Figure 12.2 shows the evolution of ethanol production in the last four decades.

The exports of ethanol from Brazil were close to 2 million m^3 in 2011. Relatively to the year 2010, this volume increased only by 3%. On the other hand, in 2011, imports were 1.1 million m^3 of ethanol, 15 times more than 2010 (UNICA 2012). Atypical imports were due to the lower domestic production and exports were due to increasing demand in the USA for advanced ethanol (the Brazilian ethanol is the only one in a condition to fulfill the specifications).

As it is presented in Table 12.1, in 2010, 346 mills were located in the so-called Center-South region of Brazil. In 4 years, from 2006 to 2010, 98 new mills started operation in Center-South region.

In 2010, 246 mills were able to produce both ethanol and sugar, with some degree of flexibility between the two products (general sense, the production varies from 30 to 70% ethanol and, consequently, 70 to 30% sugar). In the same year, 163 mills were only able to produce ethanol (autonomous distilleries) and 17 mills were able to produce only sugar (MAPA 2011). The so-called “Brazilian model of ethanol production” refers to the combined production of sugar and ethanol, an option that brings some advantages to the producers, at least regarding risk reduction.

In 2011/2012, the bulk of sugarcane production (88%) occurred in the Center-South region and a small share in the North-Northeast region (12%, being more than 10% in the Northeast region). In the period 2000–2006, the production of sugarcane in states of the Amazon region was in average only 0.6% of the total. This

Table 12.1 Operating sugarcane mills in Brazil in 2010 and amount of sugarcane crushed (2011–2012). (Source: MAPA 2012; Conab 2012)

Region	State	Number of mills	Sugarcane crushed (1,000 t)
Center-South	Minas Gerais	40	49,741
	Espírito Santo	6	4,180
	Rio de Janeiro	7	2,174
	São Paulo	197	304,230
	Paraná	30	40,506
	RG do Sul	2	95
	Mato Grosso	9	13,154
	Mato Grosso do Sul	21	33,860
	Goiás	33	45,220
	Subtotal	346	493,160
North-Northeast	Alagoas	24	27,705
	Pernambuco	22	17,642
	Paraíba	9	6,723
	Bahia	4	2,557
	Maranhão	4	2,266
	Amazonas	1	287
	Piauí	1	992
	Tocantins	1	1,366
	Pará	1	666
	Rondônia	1	157
	Sergipe	6	2,548
	Ceará	3	120
	RG do Norte	4	2,973
	Subtotal	80	66,002
Brazil	Total	426	559,162

share has decreased to 0.2% in the 2010/2011 harvest. In the state of São Paulo, the region with highest concentration of sugarcane mills—Ribeirão Preto—has the best conditions for this crop, considering soil quality, weather adequacy, rainfall, and topography. This region has a high concentration of sugarcane areas and land is relatively expensive there. In the state of São Paulo, the tendency is the installation of new producing units in the west side of the state, displacing pasture and, in a smaller extent, other traditional crops (e.g., orange).

An important characteristic of ethanol production in Brazil is that there is a high concentration of industrial capacity in large mills. The weighted average capacity in the Center-South region has been close to 2 million t of sugarcane crushed per year, and new mills tend to be even larger (about 3–4 million t/year).

12.3 Economics

The sugarcane industry has been settled in Brazil for centuries, since early colonization periods. This long presence in the country has given the knowledge and experience to create an important economic sector. After 2003, with the introduction

of FFVs (Flex Fuel Vehicles), sugarcane production increased intensively due to the demand for ethanol. In 2008, the revenues for the mills were 4,562.7 million € due to sugarcane production and, for independent plantations, the revenue reached 3,658.4 million € (Neves et al. 2011). The industrial units earned 8.85 billion € with ethanol sales in 2008, both counting domestic and export markets.

The sugarcane industry generates wealth for other sectors of the economy as shown by Neves et al. (2011). The work done by the authors, using the methodology called Strategy Planning and Management of Agri-Industrial Systems, indicates that the sector generated 20.1 billion € in 2008, equivalent to 2% of Brazilian Gross Domestic Product.

Ethanol and sugar are still the most significant products in terms of revenues, accounting for 8.9 billion € and 7 billion € in 2008, respectively. Bioelectricity generated 285 million € and it is expected to grow.

Figures 12.3 and 12.4 show the gross billing for different industries and their impacts on the production costs of the sugarcane sector.

In 2008, sugarcane cropping was responsible for 14% of fertilizer sales in Brazil, with a consumption of 3.14 million t. As shown in Fig. 12.3, the expenses of fertilizers are among the largest in the agricultural phase.

With the increase in mechanized harvesting, the sales of new agricultural machines reached 981 units in 2008, i.e., a growth of 52% compared to 2007. The sector bought 22% of all harvesters sold in that year. Also in 2008, mechanized operations in sugarcane production and transportation from the field (to the mill) consumed almost 1 billion l of diesel oil and lubricants, according to Neves et al. (2011).

To quantify the billing of industrial equipment suppliers and companies that provide assembly services, the authors (Neves et al. 2011) considered the investments of the 29 industrial units that were built in 2008. The values shown in Fig. 12.4 represent the billings of these new units that started producing in 2008.

The GDP of the sugarcane sector was estimated for the Northeast region as well, using the country's average participation of the added value in the sugarcane, ethanol, and sugar production. The production value of the sector in the Northeast region in the year 2008, as well its added value, are presented in Fig. 12.5.

With a total GDP of 191 billion €, the sugarcane sector represented, in 2008, 0.76% of the GDP of the Northeast region. Sugarcane contributed with 0.246%, ethanol with 0.239%, and sugar production with 0.276%.

12.4 Social Aspects

12.4.1 Employment

There are two main sources of information regarding employment in Brazil: RAIS (instead) (Annual Social Information), and PNAD (National Survey by Household Sampling). RAIS is an administrative registration system that compiles yearly at

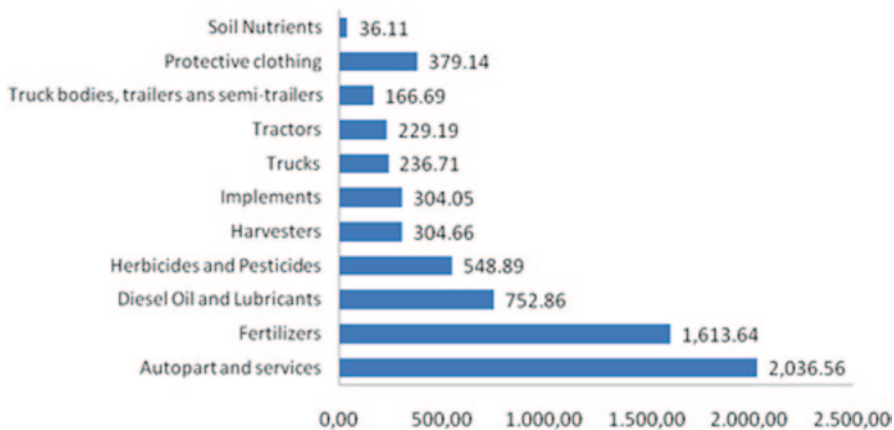


Fig. 12.3 Billings of agricultural inputs in 2008 (in million €). (Source: Neves et al. 2011)

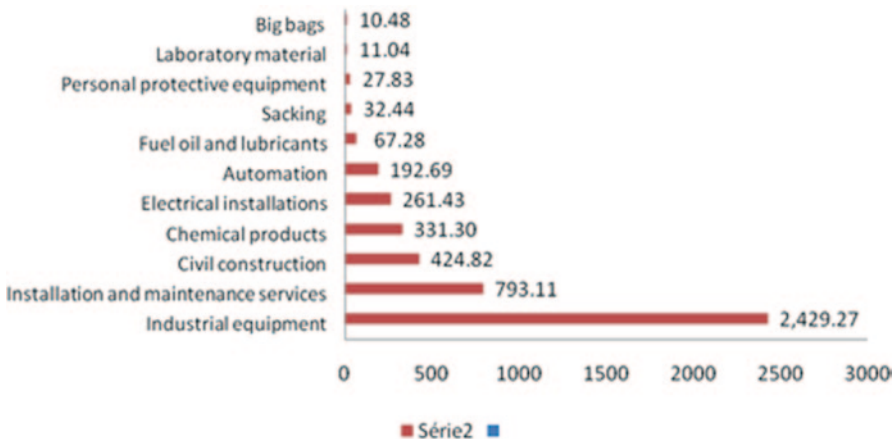


Fig. 12.4 Billing of industrial inputs in 2008 (in million €). (Source: Neves et al. 2011)

least 97% of all formal jobs. Every company has the obligation of reporting how many employees they have, as well as other social information, such as age, education level, length of service, and revenue; the results are published according to the occupational level, geographical regions, and economic sectors. The results also contain information on the number of jobs by size of establishment, payroll, and nationality of the employee.

PNAD, on the other hand, investigates general characteristics of the population, like education, work, income, and housing. It is based on a sample of the population and uses statistical methods. Estimates for the whole country are provided. When used in employment studies, it has the benefit of capturing the informal labor market.

Fig. 12.5 Sugarcane chain's added values and production values in Brazilian currency in 2008 (exchange rate: 1 € for R\$ 2.2)

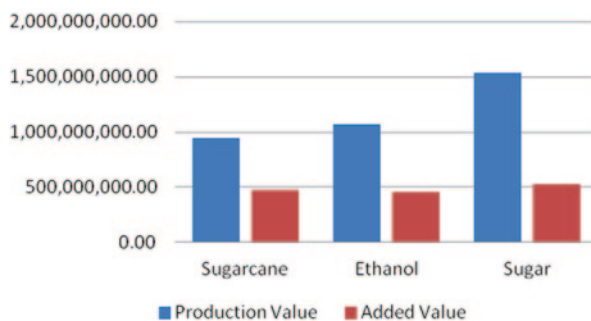


Table 12.2 Number of employees in the sugarcane sector (formal and informal) in 2009. (Source: PNAD 2010)

	Total	%
Sugarcane farming	576,353	68.9
Sugar production	125,311	15.0
Ethanol production	135,058	16.1
Total	836,722	100

Both systems were used to estimate the number of jobs generated by the sugarcane sector. Under RAIS, the number of active employees (working at the moment data were registered) in the sugarcane sector in 2010 was more than 612,000 formal jobs, being 183,700 in the sugarcane fields. The ethanol industry had 111,300 active employees in the formal market. The number of terminated employment in the year is an important information, since it gives an insight on how dynamic the sector is. Terminations of contracts are very common due to the seasonal characteristics of sugarcane production. Table 12.2 shows the number of employees on the formal job market for the sugarcane sector, from 2007 to 2010; the data basis is RAIS.

In order to capture the information regarding informal jobs, PNAD's data set was also analyzed. As it can be concluded from a comparison between Tables 12.2 and 12.3, it can be estimated that the informal job market represented about 25% of all employees in 2009.

According to PNAD, sugarcane farming activity employed over 576,000 people in 2009, while ethanol production employed over 135,000. This result includes the informal jobs.

The difference between the numbers of employees provided by both databases is clear. It is important to keep in mind that PNAD's data set result from a statistical analysis, done by interviewing a sample of the total population, while RAIS results from a direct compilation from the government, with information provided by the companies and employers themselves. PNAD is made with a sample of 399,000 people in different regions of Brazil, and then a weight factor is used to generalize the information to the whole population. Institutions used to mention the results by RAIS in order to give a figure of employees involved with sugarcane sector, e.g., about 1.2 million people by the end of 2010, but from this total only 613,000 were active employees at that moment and about 436,000 have been dismissed or had their contracts finished.

Based on econometric analysis it can be concluded that white workers are better paid, and incomes are higher as higher the educational level. In general, men receive more than women, and the employee working in ethanol production has a higher income than in sugar production. On average, the sugarcane employee is 35.4 years old and has 5.7 years of study. They work on average 46.7 h a week and have an income of 387.7 €/month (at the same time, the minimum wage in Brazil was 236.9 €). It is estimated that 68.8% of the workforce is concentrated in the agricultural production, and 68% are brown or black, and 90% are men.

In the Northeast region, the formal job market in the sugarcane sector stayed almost constant from 2007 to 2010, as shown in Table 12.4; the variation in this period was only 2.4%. The expansion of sugarcane cropping has not been in this region, due to the lack of good soils and also because of the constraints for mechanization (because of too steep slopes terrains).

In the sugarcane sector, in Northeast, workers are on average 34.6 years old, work 46 h a week, and have 3.7 years of education. The average income is 245.42 €. It is estimated that 80.5% of the working force is brown or black, 83% work in the agricultural side, and men represent 95%. In 2009, the total number of employees for the sector in the region, including informal workers, was 310,722 active employees (PNAD 2010). The figures for workers at the sugarcane farming activity in Northeast are even worse: they have on average 3.3 years of education, earn 216.5 €/month and the average age is 34 years.

In the sugarcane sector, which includes the cultivation of sugarcane and the industrial production of ethanol and sugar, the participation of rural workers, especially cutters, represents approximately 68% of the total.

12.4.2 Working Conditions

The main concerns regarding working conditions are related to the agricultural side of the supply chain, mainly when manual harvesting system is predominant. The main issues listed in different studies are: housing conditions, water provision during working hours, adequacy of tools, intoxication risk, personal protection equipment, inadequate rest time, transportation conditions, and quality of the meals.

As cutter's payment is directly linked to the amount of sugarcane harvested, many consider that working conditions are very inadequate and that workers are forced to work more. In fact, productivity has nearly doubled in 20 years, and there was no change of working tools (Alves 2006). Currently, the expected productivity is 10 t/day per cutter. However, it should be mentioned that this payment option has been imposed by the workers' union many years ago.

Forced labor is also a concern within the sector. According to the ILO's Convention 29 of 1930 (International Labour Organization), forced labor is defined as "all work or service exacted from any person under the menace of any penalty and for which has not offered himself voluntarily." In Brazil, there is a systematic procedure for verifying working conditions and reports are annually presented by the

Table 12.3 Active employees and employment terminations in 2007–2010 (formal jobs). (Source: RAIS 2010)

	Unjustified dismissal	End of employment contract	Resignation	Active employee	Other	Total
<i>2007</i>						
Sugarcane farming	134,898	97,512	50,891	181,847	32,522	497,670
Raw sugar production	105,748	86,896	37,883	295,188	39,183	564,898
Refined sugar	1,269	928	158	4,828	66	7,249
Ethanol production	42,073	31,446	18,428	90,331	8,616	190,894
Total	283,988	216,782	107,360	572,194	80,387	1,260,711
<i>2008</i>						
Sugarcane farming	138,378	73,994	51,694	188,036	29,560	481,662
Raw sugar production	117,763	87,640	42,601	296,708	16,580	561,292
Refined sugar	1,762	1,804	1,031	8,418	776	13,791
Ethanol production	52,132	33,034	23,238	107,300	10,809	226,513
Total	310,035	196,472	118,564	600,462	57,725	1,283,258
<i>2009</i>						
Sugarcane farming	115,364	64,898	35,544	191,306	17,915	425,027
Raw sugar production	115,167	76,017	31,399	314,435	17,603	554,621
Refined sugar	1,735	3,826	1,010	11,587	1,148	19,306
Ethanol production	48,183	28,654	16,049	111,883	8,548	213,317
Total	280,449	173,395	84,002	629,211	45,214	1,212,271
<i>2010</i>						
Sugarcane farming	118,071	63,392	32,741	183,742	22,114	420,060
Raw sugar production	104,595	70,291	33,620	310,206	17,201	535,913
Refined sugar	2,023	1,083	695	7,291	1,673	12,765
Ethanol production	46,796	30,646	16,156	111,310	8,200	213,108
Total	271,485	165,412	83,212	612,549	49,188	1,181,846

government. In case of the sugarcane industry, despite representing a small share of the reported cases across the country (7% in 2009), these cases accounted for 31% (1,911) of all workers involved in situations classified as slavery-like conditions. In São Paulo state, the largest producer of sugarcane, there was no single reported case of forced labor until 2009, but several labor irregularities were reported. The bulk of irregularities identified were related to the lack of rest after six consecutive hours of

Table 12.4 Active employees and terminations in the sector in the Northeast region 2007–2010. (Source: RAIS 2010)

	Unjustified dismissal	End of contract	Resignation	Active employee	Others	Total
<i>2007</i>						
Sugarcane farming	12,789	17,555	4,878	45,121	2,173	82,516
Raw sugar production	40,785	43,199	10,615	144,473	6,684	245,756
Refined sugar	753	807	52	3,433	32	5,077
Ethanol production	4,991	6,323	1,607	22,130	610	35,661
Total	59,318	67,884	17,152	215,157	9,499	369,010
<i>2008</i>						
Sugarcane farming	14,793	18,090	4,712	43,879	1,671	83,145
Raw sugar production	47,136	41,009	12,002	147,316	6,881	254,344
Refined sugar	1,254	1,425	722	7,205	300	10,906
Ethanol production	7,421	6,335	1,350	21,636	416	37,158
Total	70,604	66,859	18,786	220,036	9,268	385,553
<i>2009</i>						
Sugarcane farming	14,411	15,652	4,305	41,196	1,462	77,026
Raw sugar production	48,333	39,938	9,942	148,700	3,472	250,385
Refined sugar	1,285	3,499	858	9,764	801	16,207
Ethanol production	6,205	7,199	1,227	22,317	3,155	40,103
Total	70,234	66,288	16,332	221,977	8,890	383,721
<i>2010</i>						
Sugarcane farming	16,671	22,352	4,221	48,060	1,171	92,475
Raw sugar production	42,747	36,587	12,634	137,128	3,307	232,403
Refined sugar	1,207	981	517	5,783	1,204	9,692
Ethanol production	6,845	8,699	1,916	25,420	316	43,196
Total	67,470	68,619	19,288	216,391	5,998	377,766

work, excessive working hours along the day, failures on the records of employees, work on Sundays without authorization, and irregularities due to unhygienic toilets (Reporter Brasil 2010).

On the other hand, there are signs that companies are acting for improving working conditions and for enlarging the benefits given to the workers. Table 12.5 shows the benefits provided by sugarcane companies, based on a sample of 47 producing units.

Table 12.5 Benefits provided by sugarcane companies (2008). (Source: Adapted from Barbosa 2008)

Benefits	% of sample
Health insurance	95.7
Dental plan	93.5
Transportation	93.3
Group life insurance	91.5
Meal	87.0
Pharmacy AID	85.1
Hearing treatment	63.8
Christmas basket	59.1
Credit cooperative	37.8
Staple food	43.5
Education AID	35.6
Illness AID	20.0

The work of cutting cane depends basically on the strength, dexterity, and agility of the worker. This activity is of high risk for health, and Rocha (2007) indicates that the main diseases are linked to the execution of movements that require adoption of poor posture and to being exposed to adverse environmental conditions, such as solar radiation, intense heat, and large amounts of dust and soot. The work performed by the cutters exceeds the limits of tolerance of the musculoskeletal system and may cause diseases such as back pain, neck pain, tenosynovitis, tendonitis, bursitis, and arthritis. Many studies also indicate deaths in the cane fields, during or after the worker's activity (nine deaths in 2010, according to RAIS). Besides the deaths occurring in the cane fields, there are those not registered and occurring over a given time. Diseases such as cancer, caused by the use of poison sugarcane soot, respiratory illnesses, and those related with column impacted the workers also because their lack of financial resources (Mendonça 2007).

When it comes to accidents and occupational diseases, there are many concerns regarding sugarcane cultivation. In the late 1990s (between 1997 and 1999), 40% (14,661) of the accident types (accidents resulting from the worker's activity) that occurred in agriculture in the state of São Paulo were in sugarcane cropping, being the share of occupational diseases (any disease peculiar to a particular activity) even higher (52%). Considering the total work-related incidents in the state at that time, the cultivation of sugarcane was responsible for 28% of the accidents and 38% of the diseases. Fortunately, only 0.15% of the total cases of accidents resulted in deaths and only 0.11% caused permanent arrest (Teixeira and Freitas 2003).

When it comes to accidents, UNICA (Union of Industries of Cane Sugar) shows that in 2010 there were 6,075 accidents in the agricultural area and 2,552 in the industrial/management of its associated companies (a set of 88 plants for these data). According to the source, investments related to health and safety summed more than 39.5 million €. Putting in perspective, this represents 0.3% of the sales of the producing units (UNICA 2011).

The number of retirements and deaths due to labor accidents and labor diseases in sugarcane production is displayed in Table 12.6. Although the numbers are relatively low, sugarcane is responsible for most deaths due to labor accidents in the

Table 12.6 Labor accidents and retirements in 2010. (Source: RAIS 2010)

	Death due to labor accident	Death due to working rout (residence–work place)	Death due to labor-related disease	Retirement due to labor accident	Retirement due to labor-related disease	Total
Sugarcane farming	9	0	0	11	20	40
	10.34%	0.00%	0.00%	8.21%	12.27%	9.80%
Grain farming	3	0	3	6	17	29
	3.45%	0.00%	42.86%	4.48%	10.43%	7.11%
Cotton and other fiber farming	1	2	0	0	1	4
	1.15%	11.76%	0.00%	0.00%	0.61%	0.98%
Tobacco farming	0	0	0	1	0	1
	0.00%	0.00%	0.00%	0.75%	0.00%	0.25%
Soy farming	12	0	0	10	6	28
	13.79%	0.00%	0.00%	7.46%	3.68%	6.86%
Other temporary crops	6	2	0	2	3	13
	6.90%	11.76%	0.00%	1.49%	1.84%	3.19%
Total agricultural activities, livestock, and related services	87	17	7	134	163	408
	100%	100%	100%	100%	100%	100%

agricultural sector, as well as the number of retirements due to labor-related diseases and accidents. This should also be related to the number of employees working at the farming process. Sugarcane, in 2010, according to RAIS, had 184,039 workers in the field, while cotton, soy, and tobacco had 14,241, 89,351, and 1,511 employees on the field respectively. So, the number of accidents is not only related to the dangers of the activity, but rather to the high density of human force in the sugarcane fields.

In addition to labor-related health problems, sugarcane burning also affects the health of people living in areas where burning is intense (Arbex et al. 2000). Epidemiological studies conducted in two counties in the state of São Paulo (Araraquara and Piracicaba), which are surrounded by sugarcane fields, show that respiratory morbidity increased significantly with the concentration of aerosol particles from sugarcane burning (Arbex et al. 2000; Arbex et al. 2007; Cançado et al. 2006). During the sugarcane burning season of 1995 in Araraquara, a study found a significant correlation between the daily number of patients who visited hospitals in the region for inhalation treatment due to respiratory diseases, and the mass of particle aerosols (Arbex et al. 2000). In a second study, conducted in the Piracicaba region,

Cançado et al. (2006) found a significant correlation between PM_{2.5} (particulate matter $\leq 2.5 \mu\text{m}$), PM₁₀ (particulate matter $\leq 10 \mu\text{m}$), and black carbon concentrations, and the number of children and elderly patients admitted to hospitals. According to their results, increases of $10 \mu\text{g}/\text{m}^3$ of the PM_{2.5} concentration lead to an increase of 20% in the number of hospital admissions. The emissions of particulate matter should reduce since the decrease in sugarcane burning started. In 2010, for example, 54% of the total sugarcane was burned, and this number dropped to 44% in 2011. The impacts of this reduction of sugarcane burning on health are yet to be studied.

Regarding education, UNICA (Sugarcane Industry Union) and its associates have promoted workers' retraining due to the growth of mechanized harvesting and to the lack of qualified working force. According to the source (UNICA 2011), in 2 years almost 5 million € in agriculture and more than 5.9 million € were invested in the industrial area; putting in perspective, this represents 0.09% of total declared income of associates for the year 2009.

12.4.3 Land Use and Land Competition

An important issue regarding bioenergy production is the competition for land, especially when it comes to land for food production. The area cropped with sugarcane in 2011 accounted for 1.1% of the total area of Brazil, or 3.3% of the total area currently available for agriculture and livestock. However, at least in theory, its expansion throughout the country can generate conflicts with other food crops and livestock.

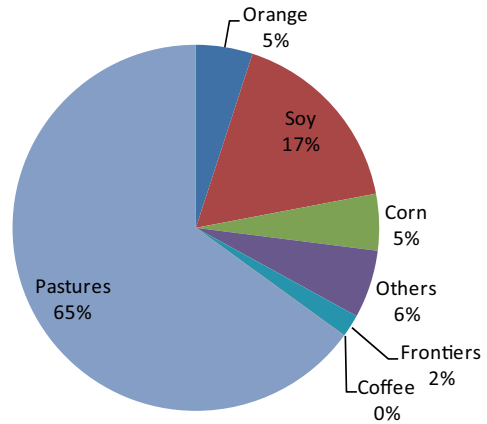
According to Ortiz (2007), the land market is an important component in the expansion of monocultures with consequent pressure on small and medium landowners. In that sense, the expansion of sugarcane is facilitated by a weakly ordered land market, both legally and socially, which leads to positive effects on production costs, while concentrates land ownership and prevents the practical uses by family farms. Since the increase in sugar industry's production is related to the expansion of cultivation in new areas, this leads to a reconfiguration of the geographic space and a pressure on livelihoods and rural activities.

A reasonable share of the supply of sugarcane in Brazil is due to small producers, with an average production range from 1,000 to 6,000 t and an average area of 60 ha. This is due to the high levels of land leasing in the sector. For Ortiz (2007), the land lease is the foundation to the expansion of sugarcane plantations and triggers a change in the complex types of production, the availability of jobs, in the migration to cities, food supply, and the possibility of demarcating land for agrarian reform.

In the state of Mato Grosso do Sul, land conflicts grew by 87.5% between 2003 and 2005, rising from 16 to 30 conflicts. The author points out that during the year 2004, 24 occupations were performed, with 15 of these in municipalities where new sugarcane plantations are being designed (Ortiz 2007).

Studies based on satellite images covering the Center-South region (close to 90% of the sugarcane production) show that between 2000 and 2010 sugarcane expansion occurred mostly over pastures (69.7%), followed by annual crops (25%),

Fig. 12.6 Change in crops in the fields of sugarcane expansion. (Data source: MAPA 2009)



citrus (1.3%), forest (0.6%), and sugarcane land under crop rotation (3.4%). These results are close to those presented by the Ministry of Agriculture and the National Supply Company (see Fig. 12.6) that shows that the expansion occurred mainly over pasture lands, due to increase in livestock productivity.

Nevertheless, when specific years are considered, the conclusions can be different. For instance, a study from *Reporter Brasil* (Reporter Brasil 2009), also based on the same satellite database previously mentioned, but just for the year 2008, shows that the sugarcane expansion in some states took place over other crops such as the case in Goiás (75%), Minas Gerais (65%), and Mato Grosso (57%).

12.5 Local Level Case Studies

At the local level the system boundary is a local area from, for instance, a farmer, a company, an association, or project level. The local area refers to the area where the biomass feedstock (including by-products) is produced and converted into the final or intermediate product. In the context of the case studies developed during the Global-Bio-Pact project, two cases were selected and investigated in Brazil: the São Francisco Mill and the Pindorama Mill.

São Francisco Mill was selected since it has a different model of production. It is located north of São Paulo state and is the largest organic sugarcane producer in the world. The hypothesis to be explored was that the differences between regular and organic sugarcane production should also correspond to different socio-economic and environmental impacts. It belongs to Balbo group.

On the other hand, Pindorama Mill was selected since it is a cooperative. This managerial system is not very common in Brazil, and Pindorama is the only cooperative in the sugarcane business in the Northeast region. Pindorama is situated in Alagoas, one of the poorest states in Brazil. The location of both mills is presented in Fig. 12.7.



Fig. 12.7 Geographical position of the two case studies considered

12.5.1 Case Study at the Local Level: São Francisco Mill

São Francisco mill is located 356 km away from the capital, São Paulo. The total sugarcane production area is 7,500 ha in the São Francisco mill, plus 6,000 ha in Santo Antônio mill. According to UNICA (2009), São Francisco mill and its suppliers produced 1,291,223 t of sugarcane in 2009, and the mill alone produced 83,941 t of sugar. In this sense, the mill is a small to medium unit considering Brazilian averages.

When São Francisco was established, the main objective was the development of a self-sustaining production system of sugarcane. After a decade of research, from 1987 to 1997, the São Francisco unit received the certificate of organic farming. Organic production does not allow the use of chemical fertilizers or pesticides. The control of pests is biological and the cane is cut raw. Special mechanical harvesters deposit straw and green leaves to the soil, optimizing the use of industrial organic wastes as sources of nutrients. There is practice of green fertilizing in a system of crop rotation.

The production system developed by the Balbo group allowed harvesting cane without burning. The harvesters, while they take away the cane, promote the deposition of green leaves in the soil, creating mulch that protects it from erosion and heat stroke. The soil also receives liquid and solid organic waste from the industry. As the production cycle of a sugarcane field is approximately 6 years, during which they get five crops, the soil is ploughed only every 6 or 7 years. Furthermore, machines and vehicles have mats and high flotation tires to minimize soil compaction. All these techniques help maintaining soil's fertility, creating a favorable environment for the action of beneficial microorganisms and the infiltration of air and water, essential for plant development. According to the mill, the combination of required practices (e.g., the biological control of pests and diseases and green manure in crop rotation with legumes and other crops) and the proper management of weeds, and the creation of islands of biodiversity in the midst of culture ensure the balanced coexistence and harmony between the farmer and nature.

Besides all the agreed practice of organic agriculture, biodynamic farmers (part of the mill's production is also biodynamic) also use:

- Lunar calendar based on astronomy
- Biodynamic preparations

The calendar suggests the most appropriate time for planting, processing, fertilization, cutting, and harvesting, according to the position of the moon and planets. The biodynamic preparations are homeopathic compounds made with medicinal herbs, minerals, and manure. They undergo a special process of fermentation and under the influences of the rhythm of the earth and the sun; these preparations are applied directly on the ground and on plants, helping the development of roots and fruit quality.

From sugarcane and organic industrial processes, Native (the brand behind the São Francisco mill) produces organic alcohol, which can be applied in industries such as cosmetics and pharmaceuticals, for example. Native also produces sugar and exports 85% of its production, being 90% to Europe and USA and 10% to Asia, especially Japan.

São Francisco mill produces about 1.4 million t of cane per year, as said, in total 13,500 ha. Recently, the total production was 85,000 t of sugar and 65,000 l of ethanol. From the total amount of ethanol, 14,000 l are hydrated organic.

The total number of employees during the harvest season is about 4,000 people, divided into the agricultural, industrial, and administrative sectors.

In 2009, Balbo group's organic sugar and ethanol division received the Ecosocial seal. Conceded by IBD (Biodynamic Institute), it establishes minimum social and environmental criteria to be completely accomplished, as well as actions for enhancing the performance regarding these aspects.

To receive the Ecosocial seal, all employees must be under the CLT regime, which is the main legislative provision related to the Brazilian labor law. The temporary workers (mainly those who work on the harvest) are hired under a "harvest contract," with a specific duration of 180 days. These rural workers are protected by NR-06, a regulatory standard for personal safety equipment (known

Table 12.7 Expenditures with social care and benefits - São Francisco mill (2009)

Item	Expenditure (in 1,000 €)	%
2009 payments (wages)	28,856.59	70.23
Total vacation	3,182.13	7.74
Social security contribution	2,800.15	6.81
13th salary	2,623.33	6.38
Private pension	1,551.20	3.78
In traffic hours payments	939.31	2.29
Maternity leave, paternity leave, and other leaves	3.67	0.01
Health insurance	1,031.61	2.51
Pharmacy aid	93.51	0.23
Dental care	8.22	0.02
Total	41,089.71	100

as EPI, in Portuguese), and are paid considering “traveling hour,” which means they start getting paid the moment they get into the workers’ bus.

The social projects conducted by São Francisco mill are divided in two areas: those to the employees and their families, and those targeted to the external community, under a 50-km distance from the mill.

The company has a profit-sharing program, based on a productivity incentive that aims to establish a form of recognition of the company to its employees for the effort expended in meeting or exceeding corporate goals. (see Table 12.7)

In the context of the Global-Bio-Pact project, it was not possible to do an accurate survey on the other mills located in the same region. In this sense, it is not possible to state if São Francisco mill has a better performance from a social point of view than the other sugarcane companies in the same region. On the other hand, considering the average figures of the whole sugarcane sector, in Brazil, it is possible to state that the São Francisco mill presents better results. This is probably related with the fact that the production and exports of organic sugar is very important for the company and exports are only possible with certified production. The certification schemes require a better performance (than the average) from a social point of view.

In this regard, the previous hypothesis was confirmed, that is, the focus on the production of organic sugar results better results from a social point of view than the average figures of the sugarcane sector.

12.5.2 Case Study at Local Level: Pindorama Mill

Pindorama is a cooperative of agricultural farmers, created in 1956 by a Swiss citizen and located 120 km away from Maceio, that is Alagoas’ capital. In the 1950s, there was a great exodus in the Northeast. People went to look for work in São Paulo and Paraná, mainly in coffee plantations due to lack of opportunities in that region. It was in 1953 when Henri Bertholet, who had arrived in Brazil in 1949 and was based in Guarapuava (PR) (South region), was invited by the Brazilian government to

Table 12.8 Disaggregation of the total sugar and ethanol costs provided by the financial department at Pindorama mill

	Contribution to total costs (%)
Raw material (sugarcane)	69.86
Labor	7.62
Direct materials	1.75
Industrial process	7.99
Harvest of sugarcane	8.59
Operation and maintenance	3.97
Other	0.22

join a working group in order to colonize the northeast, retaining the rural workers in their natural habitat. He accepted the invitation, and when arrived at that region identified the lands that belonged to a local family and that was home to a bankrupt project financed by a state-owned bank, Bertholet proposed the federal government to take the land on account of debt, developing a project that resulted the creation of the Cooperative Pindorama. In the period 1953–1956, he worked to organize the cooperative, with the recruitment of the first settlers and division and delivery of lots.

As a cooperative, it is formed by 1,160 small producers, who are the owners and the only providers of raw materials. The total cultivated area for fruits and sugarcane is 32,000 ha. The size of the lots range from 9 to 25 ha. Today, Pindorama is a major producer in the region, being among the 100 largest tax contributors in Alagoas, reaching in 2009 revenues of R\$ 125 million.

Initially, its main product was passion fruit and it slowly moved into juice production. Pindorama diversified their products: ethanol since 1982 and sugar since 2003. They also cultivate other fruits for juice production. The 2009/2010 production of sugarcane was 608,000 t, resulting in 32,549 t of sugar and 35.6 million l of ethanol. The production in the last harvest season was expected to be 900,000 t, with 50% designated to ethanol production and 50% to sugar production.

Ethanol is sold to big companies like Petrobras, Ipiranga, and Shell. About 15–20% of the sugar is exported. The expected sugar production is of 40,000 t and ethanol production is expected to be 45 million l for the 2010/2011 harvest period.

Currently, Pindorama's productivity is estimated at 70 t/ha of cane (5,000 t/day) which is quite high due to the rains. The average yield in the Northeast region is 55 t/ha. A 20% growth in productivity is expected in the next 4 years.

The disaggregation of the total sugarcane and ethanol costs at Pindorama mill are shown in Table 12.8.

Pindorama has a total of 1,823 employees. From the total, more than 50% are fixed employees and the others temporary workers, working 8 h a day (from 7 am to 4 pm). In the mill sector, there are 250 workers, divided in 3 shifts of 8 h each. From all the cane cutters, 56% have less than 8 years of education. For the other 44%, there is no information.

According to the company, Pindorama makes a big effort to provide social benefits to their employees, associates, and their families. The so-called CETRUP (Centro de Treinamento Rural de Pindorama), offers professional training to local people. They have educational projects such as reading and computer classes, as well as sewing, handcraft, and silk screen printing classes. A group of approximately 45–50 local seamstresses make and provide the uniforms for all the employees in

Table 12.9 Price paid per t of cane cut. (Source: FETAG 2010)

Sugarcane cut	
Burned cane, minimum price for 4 t	R\$ 4.35 (1.89 €)
Burned cane, minimum price for 4–8 t	R\$ 4.60 (2.00 €)

Pindorama which includes individual protection equipment. An additional project in Pindorama includes a vegetable garden run by locals where the products are for own consumption. Another important project is the pepper garden. The participants are mostly young students, who can sell their production every week for R\$ 500. The participants in the social programs receive psychological support if needed and receive also education for regular school. Most of the local people enjoying these benefits have a high chance to stay working at the cooperative.

The cooperative Pindorama is an example for a good land reform in the country. To reach its goals of social inclusion, the cooperative develops, aside its partners, projects that seek education, professional capacity, and employment and income growth.

The sugarcane cutters are provided with fresh water, bathroom facilities, shadow, tables and chairs, and two snacks during the working hours. The workers are brought to the field by special buses. They also have 1 h of lunch break. The cutters have a leader, who controls the amount of sugarcane they cut each day. The average harvesting per man is 8 t/day, sometimes reaching 10 t/day. The amount of sugarcane cut influences the cutters salary. They are all guaranteed with a basic salary of R\$ 557 per month (242.1 €) but if the cutter's productivity is high, its salary would be also higher. The current tariffs paid for the amount of sugarcane cut for Alagoas region is given in Table 12.9. Pindorama mill has life insurance to all workers including the temporary workers. Fifteen accidents with leave of absence were registered in 2009/2010 harvest period, being 11 among rural workers and 4 in the industrial site.

As for the regional context, it is possible to compare Pindorama with other sugarcane business in the region. Coruripe mill, for example, is the largest industrial sugarcane unit located in Northeast region and is nearby the Pindorama mill: in 2012, Pindorama crushed 924,000 t of sugarcane, while Coruripe crushed about 3 million t, i.e., Coruripe is about three times larger than Pindorama. In the context of the Global-Bio-Pact project it was possible to visit both mills.

In general, Coruripe has more environmental and social programs than Pindorama, and this can be understood by its largest economic power. The main issues are addressed by Pindorama, but also in general sense, everything is simpler there in comparison to Coruripe mill.

In the Pindorama case, the largest advantage is for sugarcane producers, as they are associated to the cooperative. In regard to the workers, it was not possible to notice any advantage in comparison to other mills in the same regions and with the Coruripe mill. However, it is fair to state that no specific problem was noticed.

In this regard, the previous hypothesis was partially confirmed, that is, the ownership by a cooperative brings some advantage, from a social point of view, along the supply chain. The impact in the municipality and surrounds is partially shadowed by the fact that there are other mills in the region, and one of them is the largest in Northeast Brazil.

12.6 Conclusions

The social impacts of large-scale ethanol production in Brazil are a controversial issue. Due to the size of the industry and the large number of stakeholders, it is very easy to identify good and bad examples. Two consensual points are, first, that improvements are noticed and, second, that there is still a lot to do in order to have all main problems solved.

Working conditions are very tough in the sugarcane supply chain, mainly in the harvest stage. Mechanization is advancing very fast and in few years the number of sugarcane cutters will be extremely reduced. In general, working conditions are similar or even better in the sugarcane sector in comparison to other agricultural sectors.

In the context of the Global-Bio-Pact project, two case studies were investigated: one considering a sugarcane mill located in state of São Paulo, that is the richest area in the country, and one considering a mill located in state of Alagoas, that is one of the poorest regions in Brazil. The importance of sugarcane activities is clear in both cases, mainly because both studied regions depend a lot on the sugarcane industry. However, a simple comparison is not possible, because the differences between the two states is very large which can be noticed when single indicators are compared (for instance, wages and benefits given).

The two case studies were chosen based on two hypotheses that are verified. In the case of São Francisco mill, that produces organic sugar and has its production certified, social impacts are larger than in the sector as whole, in average terms. In this sense it can be concluded that sustainability initiatives and certification schemes can have a positive impact as long as environmental and social aspects are considered. In the case of Pindorama mill, that is a cooperative of farmers, at least suppliers of sugarcane have more benefits comparing with the conventional situation in which small farms rent the land or work as outgrowers of large companies.

It seems that certified production is a tendency in Brazil, as many sugarcane companies want to reach international markets of sugar and ethanol. On the other hand, there are few cooperatives in the agricultural sector in Brazil, and even less in the sugarcane industry. In this sense, the experience and the results of Pindorama mill should be disseminated.

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