



## Towards strengthening sustainability instruments in the Brazilian sugarcane ethanol sector

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### ARTICLE INFO

#### Article history:

Received 6 November 2016

Received in revised form

30 January 2018

Accepted 31 January 2018

Available online 8 February 2018

#### Keywords:

Certification

Sugarcane ethanol

Environmental impact assessment

Environmental impact statement

Brazil

Sustainability

### ABSTRACT

Among the most applied sustainability-oriented instruments in the sugarcane ethanol sector are the Environmental Impact Assessment (EIA) and the Bonsucro Certification. EIA is a mandatory decision support tool for environmental authorities to approve sugarcane ethanol projects, and the Bonsucro certification is a voluntary scheme that aims to demonstrate to external stakeholders the performance of sugarcane ethanol industry on sustainability issues. The objective of this research is to analyze the environmental, social and economic issues addressed in the Bonsucro certification that could be included in Environmental Impact Statement (EIS) – the technical report of EIA process – in order to extend EIA to the non-environmental dimensions and thus strengthen its contribution for sustainability in the sugarcane ethanol sector. The Brazilian context was chosen because the country is a pivotal producer of sugarcane, and whose production practices are continuously subject to the scrutiny of the international markets and academia. This is an applied research based on an exploratory-descriptive approach, employing a multi-case study in which data collection was accomplished by gathering document data, as well as semi-structured interviews with key sources and actors from the Brazilian sugarcane ethanol industry. Although most themes concerning the sustainability of the sugarcane ethanol sector are recognized in both instruments, some relevant sustainability issues are not included in either of the two and included in one but not in the other. As expected the main similarities between these two instruments are largely related to environmental issues – soil and water; biodiversity; emissions and effluents and recycling of waste – while differences can be observed in the economic and social dimensions. Promotion of energy efficiency was seldom included as a criterion in the EISs, whereas production and process efficiency, training for employees, quality of products and research and expertise were criteria completely absent from the EISs. We conclude that harmonizing the topics covered by the EIS and the Bonsucro certification would result in advantages: helping to mainstream sustainability within the lifecycle of the sugarcane production and to address some relevant social and economic issues within EIA processes in the sugarcane ethanol sector.

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### 1. Introduction

Sugarcane biomass is a versatile and efficient product to concomitantly guarantee food and energy supply by providing liquid fuels, electricity, chemicals and food. Due to these benefits, sugarcane is a pivotal product not only in Brazil, but also in other countries in Asia, South America and Oceania, representing a

potential thrust to expand sugarcane production to parts of Africa and Caribbean.

Sugarcane ethanol is supposed to play an important role in sustainability (Pereira and Ortega, 2010; Filoso et al., 2015) as a relevant alternative source of renewable fuel in global energy scenario (Neamhom et al., 2016). There are strong international forces driving the demand for biofuels, and in particular, driving the demand for more sustainably produced biofuels. The USA Energy Policy Act of 2005 provides gradually increasing targets for the share of biofuel in the gasoline sold in the US (Sousa and Macedo, 2010); the subsequent USA Energy Independence and Security Act of 2007 emphasizes that an amount of biofuel must be derived from non-cornstarch products; the Renewable Energy Directive 2009 (European Parliament and the Council of the European Union, 2009a) compels European countries to use renewable transport fuels; the Fuel Quality Directive (European Parliament and the Council of the European Union, 2009b) requires reduction in greenhouse gases (GHG) emissions in the transportation sector by using biofuels.

At the same time, there is a controversy regarding the sustainability of sugarcane ethanol production in Brazil (Goldemberg et al., 2008) and in other parts of the world – such as Southern Africa (Watson, 2011), Thailand (Prasara-A and Gheewala, 2015) and Latin America (Janssen and Rutz, 2011) – because significant negative impacts are inherent to all the stages of production, from the agricultural to the industrial phase (de Mattos Fagundes et al., 2016).

Brazil is the largest sugarcane producer in the world and sugarcane cultivation in the country dates back centuries. The use of large-scale sugarcane ethanol started in 1975 with a programme from the Brazilian Federal Government called Proalcool, which encouraged the growth of sugarcane crops to produce fuel with the goal of decreasing oil imports (Gallardo and Bond, 2011a). Since 2003, sugarcane ethanol production has been mostly devoted to supply the internal market of biofuels for flex-fuel vehicles (FFV) (Goldemberg et al., 2014). There is a current prospect for growth in the internal market and for exporting to the foreign markets (de Mattos Fagundes et al., 2016).

However, the same international markets have drawn attention to the serious environmental and social problems generated by biofuel production (Triana, 2011). As a response, various assessment instruments have been recommended for evaluating the expanding production of biofuels (Christiansen and Kardel, 2005; Royal Society, 2008; Van Dam et al., 2010; Buytaert et al., 2011; Janssen and Rutz, 2011; Harnesk et al., 2017).

In the Brazilian sugarcane ethanol production, two socio-environmental management instruments stand out: the Environmental Impact Assessment (EIA) process – and its technical report called the Environmental Impact Statement (EIS) – and the Bonsucro certification. Despite its very well-known value for planning, EIA – the most widely used environmental instrument in the world (Morgan, 2012) – has proven to be an efficient management tool (Hollands and Palframan, 2014; Gallardo et al., 2015, 2016b). The Bonsucro certification is the main multi-stakeholder instrument directed to achieving sustainability standards in the sugarcane industry (Pacini and Assunção, 2011; Selfa et al., 2014). Brazil holds the vast majority of accreditations in the world (Bonsucro, 2016).

The assumption of the pivotal place of these instruments in this context is supported by some previous works regarding the importance given to ethanol certification projects in Brazil (Hall et al., 2009; Mohr and Bausch, 2013); and the essential role of EIA for evaluating energy production in the world (Jay, 2010), as well as in Brazil (Landim and Sánchez, 2012; Duarte et al., 2015).

Although the EIA and the Bonsucro certification present different features and timing – they are applied at different stages

of the life cycle of a sugarcane ethanol planning, implementation and operation – both are expected to help to promote sustainability (Bond et al., 2016; Mathews, 2008, respectively). In this context, we assume that introducing some features of the Bonsucro certification in the EIA process can help to expand the sustainability perspective in this sector, at least starting with a better integration of environmental, economic and social impacts.

Also, despite not clearly addressing long term impacts, both instruments are based on frequent evaluation, so these impacts are controlled to be always in desirable levels, which works for many environmental, social and economic impacts.

Many researchers (Scanlon and Pope, 2012; Hollands and Palframan, 2014; Gallardo et al., 2016b) have discussed the benefits of integrating different instruments so that the instruments could complement each other. Buytaert et al. (2011) highlighted the value of combining the procedural parts applied to the use of biomass energy for seeking sustainability. For Tajima and Fischer, 2013, pp. 29), exploring these connections is a way of verifying “whether the integration of different instruments is achieving its aim of supporting sustainable decision-making”.

Moreover, the EIA is a tool to advocate for the environment rather than for sustainability (Gallardo and Bond, 2011b). However Morrison-Saunders and Retief, 2012, pp. 34) argue that “there is a growing demand for environmental impact assessment (EIA) to move away from its traditional focus towards delivering more sustainable outcomes”. Expanding some economic and social considerations requested by the Bonsucro certification in the EIS may be a way of overcoming the challenge of “mainstreaming sustainability” within the EIA process (Sánchez and Croal, 2012, p. 51).

The objective of this research is to analyze the environmental, social and economic issues addressed in the Bonsucro certification that could be included in Environmental Impact Statement, in order to extend Environmental Impact Assessment to the non-environmental dimensions and thus strengthen its contribution for sustainability in the sugarcane ethanol sector. Our analysis focuses on the relationship between the analytical/conceptual frameworks of these two instruments. The following research questions are addressed: i) What is the balance between the sustainability pillars in the contents of the EIS and the Bonsucro certifications? ii) What are the similarities and dissimilarities between the EIS and the Bonsucro certification? iii) What are the advantages and the barriers to associating the Bonsucro certification with the EIS for promoting sustainability?

## 2. Assessment of instruments applied to Brazilian sugarcane ethanol

Due to the importance of sugarcane ethanol for the Brazilian energy supply mix and for the economy, the direct response by the sector and by the government to the global pressure on the Brazilian ethanol industry was to promptly apply mandatory and voluntary instruments to ensure its sustainability (Jordão and Moretto, 2015; Gallardo et al., 2016a). In Brazil, the state of São Paulo is the main sugarcane producer (Gallardo and Bond, 2011a); its sugarcane crop represented, in 2013, 66.61% of the total cultivated area (Camara and Caldarelli, 2016). After the predictions that demand for ethanol would double between 2008 and 2018 (Goldemberg et al., 2008; Smeets et al., 2008), data from sugarcane producers indicate a decline in the production rate since the 2009/2010 harvest until the 2016/2017 harvest (UNICA, 2017). However, prospective Brazilian energy planning documents expect a growing production trend for the period 2015–2024. These documents place sugarcane biomass as the country's second largest energy source after fossil energy in both 2015 and 2024 (MME, 2015). The first Bonsucro certification was issued to a sugar mill in São Paulo

(Moura and Chaddad, 2012) in 2011.

In 2009, the São Paulo Secretariat for the Environment launched the Green Ethanol Program, aimed at promoting best practices in the sugarcane ethanol sector. Also in 2009, this Secretariat complemented the obligatory requirements concerning the EIA process and the contents of EIS for sugarcane enterprises (Gallardo and Bond, 2011a, 2011b). In addition to this institutional effort, this sector has been a subject of international scrutiny concerning its sustainability. The main proof is the number of Brazilian sugarcane ethanol enterprises certified by Bonsucro: out of the 55 certifications granted worldwide, Brazil has obtained 43 (Bonsucro, 2016). Fig. 1 illustrates the role of the EIA process, its pivotal EIS report, and the Bonsucro certification in the sugarcane ethanol life cycle planning.

2.1. Sustainability certification applied to Brazilian sugarcane ethanol

Smeets et al. (2008) highlighted some of the negative social heritage from the sugarcane industry such as slavery, working conditions and workers' rights, concentration of land ownership and child labor, among others. This can be a potential bottleneck for sustainable production.

Certifications are advocated as means to achieve sustainable production from crops to biofuels (Smeets et al., 2008; Huertas et al., 2010; van Dam et al., 2010; Diaz-Chavez, 2011; Janssen and Rutz, 2011). For Diaz-Chavez (2011), the certifications are able to respond to commercial and to legal regulations; however, they are limited to sustainability issues related to the environment and to the local population. For De Mattos Fagundes et al. (2016), Bonsucro certified companies employ good sustainability practices. Scarlat and Dallemand (2011) also stressed the potential of certifications

to encourage less harmful ways of producing bioenergy in terms of both the environment and society.

There is a series of international certification schemes adopted voluntarily to demonstrate the sustainability of biofuels (Scarlat and Dallemand, 2011; Harnesk et al., 2015) and some of them are exclusively related to sugarcane ethanol (Diaz-Chavez, 2011). For Janssen and Rutz (2011), the motivation of European countries for requiring sustainability certification for biofuels is minimizing harmful social and environmental impacts, while securing acceptance by the European public.

According to Pacini and Assunção (2011, p. 595), “the European Union adopted a set of mandatory sustainability criteria for biofuels in its Renewable Energy Directive from 2009”; and “recognizing the growing concern among biofuel producers and consumers related to market entry, market access and nontariff barriers to biofuel trade, the EU has identified an initial batch of seven sustainability schemes in July 2011”. These schemes were divided into three categories: the first are roundtable initiatives, in which a great number of companies related to biofuel supply chains are directly engaged in developing their certificates (Bonsucro, Roundtable on Responsible Soy Association and Roundtable on Sustainable Biofuels). The second category is industry schemes, which focus on supply chains of specific trading groups (Biomass Biofuels Voluntary scheme, RED Bioenergy Sustainability Assurance and Greenery Brazilian Bioethanol Verification Programme). The final category is multi-stakeholder initiatives composed of companies, research organizations and NGOs financed by a German government agency. Two certifications – one from the first category and the other from the second category – are exclusively devoted to sugarcane ethanol: the Bonsucro certification and Greenery.

Greenery is “a standard to guarantee the sustainability of bioethanol supply from Brazil to be used for bioethanol in the UK”

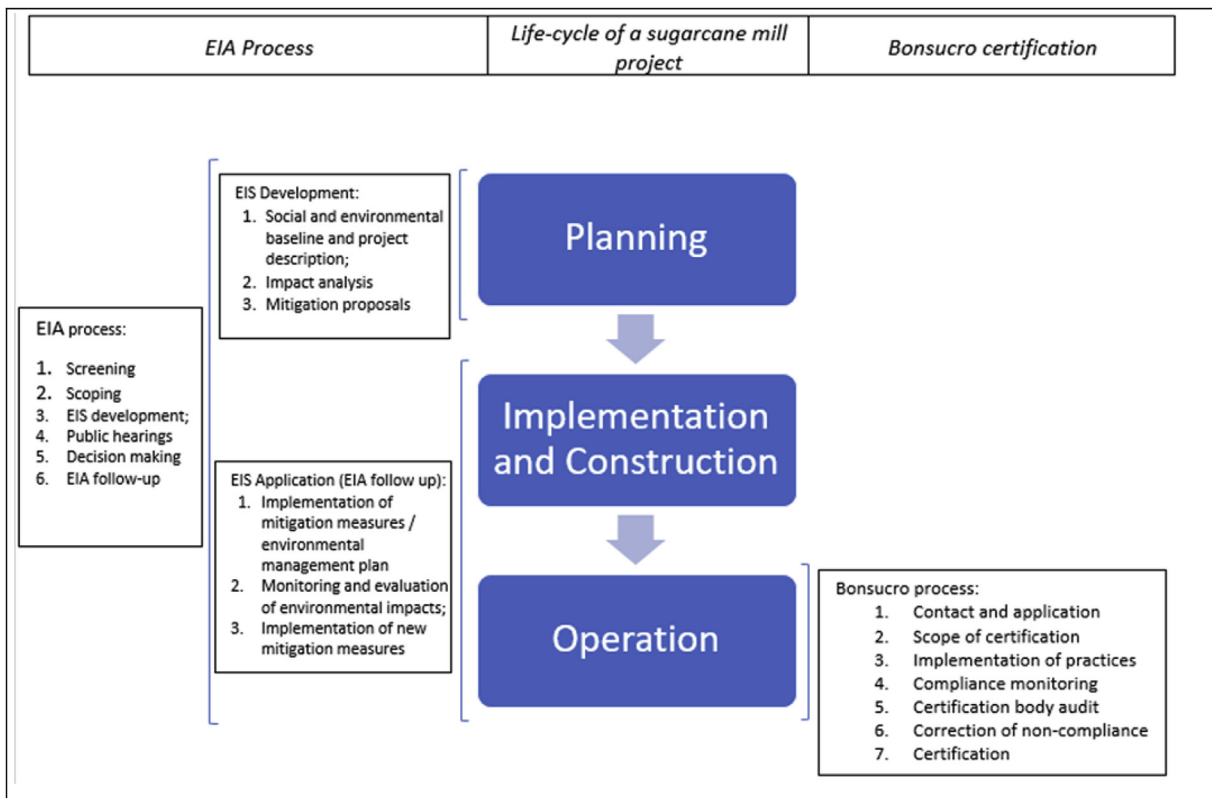


Fig. 1. Application of EIA and of Bonsucro certification to the project stages of a sugarcane mill life cycle.

(Van Dam et al., 2010, pp. 2450). Previously, a Swedish ethanol enterprise set quite a similar initiative (Huertas et al., 2010). The Bonsucro certification, formerly called Better Sugarcane Initiative (BSI), was proposed “to determine principles and to define globally applicable performance-based standards for ‘better sugarcane’ with respect to its environmental and social matters” (Van Dam et al., 2008, pp. 763). According to Janssen and Rutz (2011), sugar retailers, investors, traders, producers and NGOs recognize that sugarcane production connects a wide range of issues; this certification thus aims at improving sustainability by reducing social and environmental impact whilst enhancing the economic status of farmers.

Although some Brazilian ethanol plants have already been granted both private standards, we focus on the Bonsucro certification because it is established by a multi-stakeholder process which has a broader goal than providing a guarantee to specific consumers and, according to Selfa et al. (2014), it is considered the major certification for sugar and sugarcane ethanol production.

Therefore, the problems to overcome are related to an effective mitigation of the impacts of biofuels (Ribeiro, 2013) and the governance for social justice in the Brazilian ethanol industry (Labruto, 2014). According to Zezza (2012), some potential benefits from certifications are difficult to measure, mainly those related to social capital and to expanding community-cooperative governance structures. Upham et al. (2011) observe that in countries with weak enforcement and regulatory systems, certification protocols may not be complied with. This may undermine the credibility of certification.

According to Moura and Chaddad (2012, p. 22), “Bonsucro has achieved positive outcomes that other multi-stakeholder initiatives have not yet been able to achieve”. However, according to Selfa et al. (2014), as applied in Colombia, Bonsucro revealed to be deeply flawed, because Bonsucro may reinforce the paradigm of commodity agrofuel production rather than moving towards an alternative model of biofuel production that would enhance sustainability. Some challenges for the success of the Bonsucro certification towards sustainability involve the opportunity in Brazil for this certification to make “a normative contribution to raise awareness of sustainability issues” (Mohr and Bausch, 2013, p. 11).

## 2.2. EIA of sugarcane ethanol and related public policies in Brazil

Over the last 40 years, the Environmental Impact Assessment (EIA) has been widely recognized as a key component of environmental management focused on analyzing the implications of environmental change due to human actions (Morgan, 2012).

In Brazil, EIA “[...] is largely applied to projects that may cause significant effects to the environment, and is legally bonded with environmental licensing and management requirements” (Montaño and Souza, 2015, pp. 2288). In addition, it has been applied since 1981, when the Brazilian National Environmental Policy was introduced, obliging projects that cause significant negative impacts to be assessed within an EIA process by an EIS presented by the project developer and analyzed by the environmental authorities. The institutional framework for EIA in Brazil has some examples of good practice, especially in the State of São Paulo (Gallardo and Bond, 2011b). According to Sánchez and Silva-Sánchez (2008, p. 522) “the project EIA process project is quite robust in the State, featuring 20 years of continuous experience”.

The regulatory and institutional framework that guides the Brazilian EIAs processes has a series of procedures that include public consultation and the presentation of an Environmental Impact Statement (EIS) for projects that can cause significant environmental impact (Sánchez, 2013), which includes any new or expansion of existing agribusiness enterprises in the ethanol

sugarcane sector.

EIA is broadly used for assessing the expected impacts of the planned expansion of the Brazilian sugarcane ethanol (Gallardo and Bond, 2011b; Duarte et al., 2015; Gallardo et al., 2016a). Also related to the EIA process, the State of São Paulo established the Agro-environmental Zoning in 2008 with the aim of promoting sustainability in the sugarcane production. It contains zoning guidelines applied to new ethanol projects. The zoning guidelines influence the scope of EIS and thereby redirect the whole EIA process to pay more attention to the cumulative impacts from the ethanol sugarcane expansion (Gallardo and Bond, 2011a, 2011b).

## 3. Methods

This is an applied research based on the exploratory-descriptive approach, employing a multi-case study (Yin, 2009). The data consisted of documents (EIS and the Bonsucro certification criteria) and four semi-structured interviews.

### 3.1. Case selection criteria

To define the cases, we adopted the approach recommended by Patton (1990), the purposeful sampling – a kind of non-probability sampling technique.

In Brazil, there are currently 382 sugarcane plants capable of producing ethanol fuel (357 in operation and 25 more authorized). Out of those in operation, 164 are located in the State of São Paulo (ANP, 2016), the foremost Brazilian producer.

For our analysis, we selected those sugarcane plants which:

- a are located in the state of São Paulo - where there is evidence of good practice in the EIA processes (Glasson; Salvador, 2000; Sánchez and Silva-Sánchez, 2008; Montaño and Souza, 2015), and where the EIA guidelines were recently modified in order to promote sustainability (Jordão and Moretto, 2015). Moreover, São Paulo hosts most Brazilian mills, as well as being the headquarters of Unica – the Brazilian Sugar Cane Industry Association, the producers' union, comprising 120 companies accounting for over 50% of the ethanol and 60% of the sugar produced in Brazil and one of the members of Bonsucro certification.
- b have undergone an EIA process and have obtained the Bonsucro certification.

From 2011 until July 8, 2016, 55 sugarcane mills around the world received a Bonsucro certification. Out of those, 43 are located in Brazil, 6 in Australia, 3 in India, 1 in the Dominican Republic, 1 in Honduras and 1 in Guatemala. Out of the 43 plants in Brazil, 31 are located in the State of São Paulo (of the remaining 12, four are in Goiás, five in Minas Gerais, while Mato Grosso do Sul, Paraná, and Alagoas each host one certified plant) (Bonsucro, 2016). Out of these 31 plants, 19 do not have an EIS because their operations started prior to 1981, in a period when EIA was not mandatory (Montaño and Souza, 2015). Amongst the 31 plants certified by Bonsucro in the State of São Paulo, we selected as case studies the 12 sugarcane plants for which an EIS had been prepared and were certified by Bonsucro. Fig. 2 presents a brief description of the 12 case studies.

### 3.2. Analysis criteria

The analytical framework (Table 1) used for featuring environmental, social and economic sustainability issues in document data (EIS and Bonsucro contents), was obtained from an extensive literature review regarding sustainability issues related to the



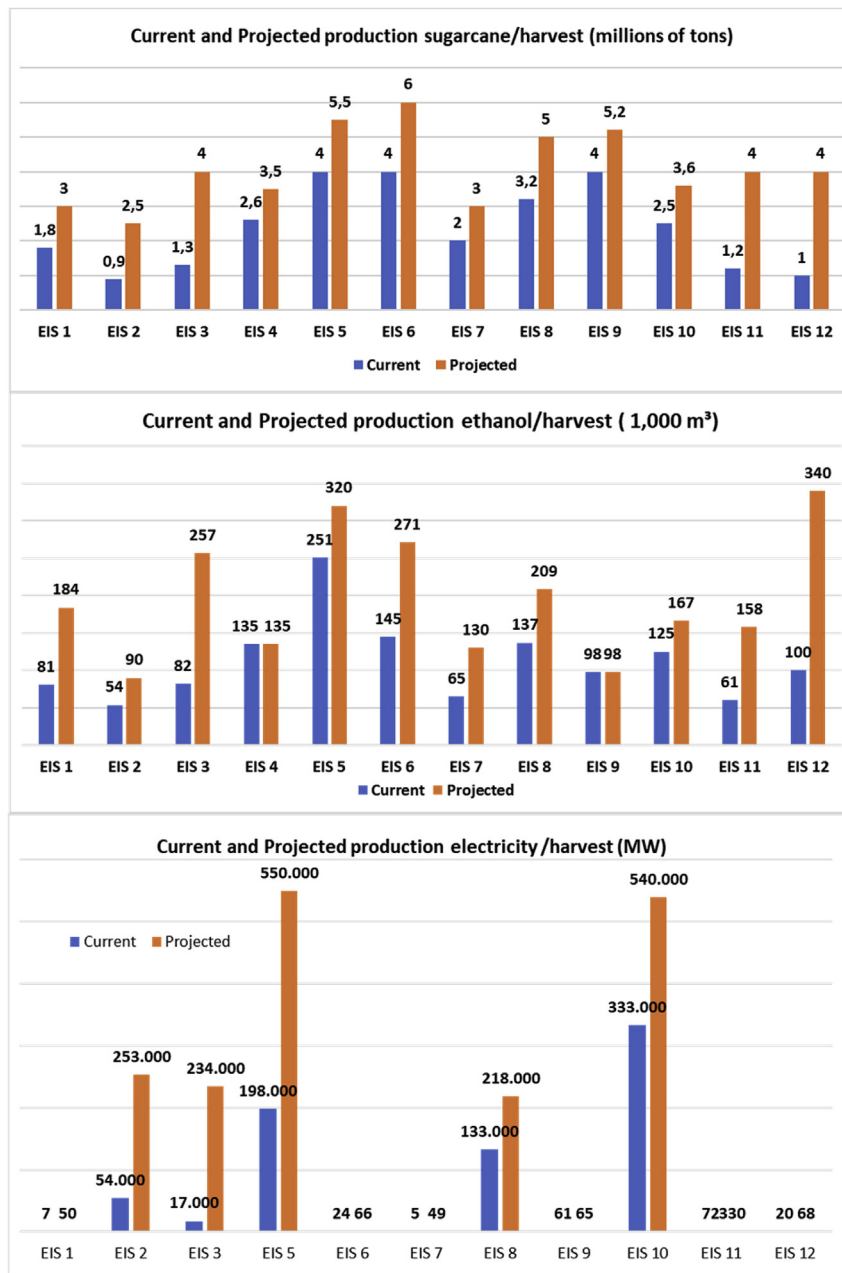


Fig. 2. Brief description of the 12 sugarcane ethanol mills in terms of current and projected of sugarcane, ethanol and electricity production.

expansion of sugarcane cultivation for ethanol production, compiled by Gallardo and Bond (2011a; 2011b), and from the vast list regarding potential sustainability indicators for biofuels established by Florin et al. (2014).

We used this analytical framework according to the principles of content analysis proposed by Bardin (1986) to categorize data according to the three dimensions of sustainability.

Fig. 3 presents the methodological design of this research.

### 3.2.1. Analysis from document data

We used the EIS reports from the EIA processes of the 12 selected sugarcane mills and the contents of the Bonsucro certification as a key source of empirical material for this research. According to Fig. 2, the first step was the categorization of contents of 12 EIS named EIS 1 to EIS 12 in this article. The categorization of

each EIS of a sugarcane ethanol enterprise mainly focuses on two of the main chapters of the report (Sánchez, 2013) – environmental impact assessment, which analyzes impacts, and management plan, which includes mitigation, offset measures and also a monitoring plan. For applying the categories presented in Table 1, a single impact could be classified in more than one category, depending on how this impact was described.

The second step focused on the categorization of the contents of the Bonsucro Certification criteria (Bonsucro, 2016). For categorizing the Bonsucro Certification, the Bonsucro Production Standard document – Version 3.0 March 2011 – was used. This document comprises five principles, 22 criteria (named CR.1.1 to CR.6.2) and 50 indicators, plus two additional and mandatory criteria exclusive for compliance with the EU directives for renewable energy (2009/2008/EC) and Fuel Quality (2009/30/EC) (European Parliament and

**Table 1**  
Analytical framework used for guiding content analysis of sustainability issues of sugarcane ethanol sector.

Issues (compiled from Gallardo and Bond, 2011a, 2011b)	Indicators (compiled from Florin et al., 2014)	Categories of analysis
<p>GHG emissions; forest protection; biodiversity; land use; energy consumption; water consumption and supply; eutrophication; water and air pollution; biodiversity; air quality; deforestation; soil and water resources; residues; energy balance; soil erosion; fertilizer and pesticide use; sugarcane burning; global climate.</p>	<p>Greenhouse gases and energy production (Net energy production (GJ ha<sup>-1</sup>); Energy ratio (%); CO2 equivalent emissions (CO2eq ha<sup>-1</sup>; CO2eq GJ<sup>-1</sup>); Carbon sinks (Prior land use/cover (descriptive); Carbon payback times (years)); Soil fertility (Soil organic carbon (Mg Mg<sup>-1</sup>); Soil carbon saturation deficit (%); Bulk density (g m<sup>-3</sup>); Total N (gg<sup>-1</sup>); Total P (g g<sup>-1</sup>); pH; Nutrient balance (kg ha<sup>-1</sup>/farm); Soil loss (kg ha<sup>-1</sup>); Description of management practices (e.g. 'best' management)); Water quality and quantity (Nitrate and Phosphorus concentration (mg L<sup>-1</sup>); Turbidity (suspended sediment) (mg L<sup>-1</sup>); Biological oxygen demand (mg L<sup>-1</sup>); Water footprint (m<sup>3</sup> GJ<sup>-1</sup>); Water used (m<sup>3</sup> ha<sup>-1</sup>; m<sup>3</sup> GJ<sup>-1</sup>)); Biodiversity (Presence of specific taxa; Habitat area of taxa (ha) – Species abundance and richness (counts, indices)</p>	<p><b>Environmental pillar</b> Water resources; Water and soil pollution; Residues; Soil erosion; Land use change, deforestation and biodiversity; Air emissions; Energy balance and GHG; Waste management.</p>
<p>Historic environments; cultural heritage; food security; labor conditions (workload, health and job safety); use of land; competition between food and fuel; vulnerable populations and respect for traditions; gender, child and slave labor; burning mechanization and unemployment; training and living conditions; genetically modified organisms; workers' conditions; worker rights; social responsibility and benefits.</p>	<p>Social equity of smallholders (Means-based such as consultation, compensation and terms of contracts (qualitative); (Changed) access to resources that facilitate livelihoods such as land, water, labor, credit and skills (qualitative and quantitative); Livelihood stability (Diversity of livelihood activities (diversity index and/or qualitative description); Coefficient of variation or standard deviation of household income through time (% or \$); Reliability and stability of market access (qualitative); Food security (Food prices (\$); Coefficient of variation or standard deviation of food prices (% or \$); Fraction of own land required for food self-sufficiency; Staple food crop sales and purchases (kg or \$)</p>	<p><b>Social pillar</b> Food security; Labor conditions and workers' rights; Social Responsibility and Benefits.</p>
<p>Unsustainable agricultural expansion; costs of the production of ethanol and innovation technology; financial aspects; land use and energy; number of jobs; income distribution and land tenure; wages.</p>	<p>Food and feed production (Biofuel crop productivity; Yields (kg ha<sup>-1</sup>); Food, feed and fuel production areas (ha); Production efficiencies (kg kg-of-input<sup>-1</sup>); Economic development of smallholders (Household income (\$ household<sup>-1</sup> year<sup>-1</sup>; \$ capita<sup>-1</sup> year<sup>-1</sup>); Returns to labor and land (\$ labor-hour<sup>-1</sup>; \$ ha<sup>-1</sup>); Description of rural infrastructure (markets, education, health)</p>	<p><b>Economic pillar</b> Jobs, wages, income distribution and land ownership; Production</p>

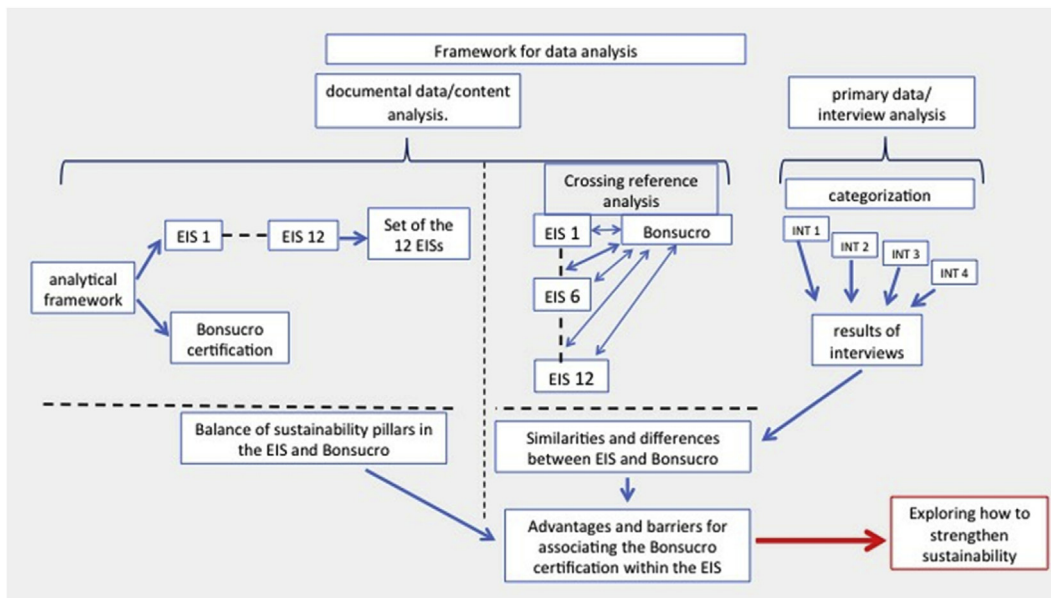


Fig. 3. Methodological design of the research.

the Council of the [European Union, 2009b](#)).

The final step was crossing references between the contents of EIS and the Bonsucro certification: we identified cases in which both schemes included the same issue, or when at least a close semantic association existed between the two schemes in the way they addressed a given topic ([Bardin, 1986](#)).

From the document data, the analysis identifies the environmental, social and economic issues addressed in the Bonsucro certification that could be included in EIS. For this, we consider how these two instruments are associated or can be associated by comparing the impacts presented in each EIS with the Bonsucro certification categories in terms of sustainability issues. The term association is understood here as a means of representing similarities of the two schemes in the way they address the terms of sustainability presented in the analytical framework and are recognized as relevant to the sustainability of the sugarcane-ethanol sector. The discussion presents whether this association is desirable or not, the arguments in favor of enhancing this association and how it might be achieved, thus strengthening the sustainability of the sugarcane ethanol sector.

### 3.2.2. Data from interviews

The participants of the interviews were selected based on their experiences related to the issue under study. To select the interviewees for this research, the criterion established was that the company personnel should have been involved in the approval of the EIS and in obtaining the Bonsucro Certification. In this case, the professional interviewed should have sufficient knowledge of both processes. This premise was fulfilled by only 4 companies.

The interviews were conducted with a technical professional, such as Environmental Coordinator or Manager of the environmental and safety work department, from 4 sugarcane ethanol enterprises out of the 12 selected. These four enterprises are called INT 1 (EIS 3), INT 2 (EIS 5), INT 3 (EIS 10) and INT 4 (EIS 12) in this work. First, relying on a preliminary interview guide, we conducted a semi-structured test interview with a professional of Unica in order to understand the Bonsucro certification application in Brazil, and to design an interview guide for the other interviews. Then subsequent interviews were oriented by an interview guide with only four main questions asked to all respondents. Additional questions were asked when more information was necessary to clarify the answers. According to [Fig. 3](#), the results of the interviews were categorized as presented in [Table 2](#).

## 4. Results

The results are organized as follows: individual content analysis

of each instrument – EIS and Bonsucro – regarding the pillars of sustainability; integrated analysis of the similarities and differences between the two instruments and the major findings of interviews.

### 4.1. Sustainability pillars in the contents of the EIS and the Bonsucro certification

The analytical framework ([Table 2](#)) was applied to the set of 12 EIS reports. [Fig. 4](#) consolidates the distribution of environmental, social and economic impacts for each EIS analyzed.

[Fig. 4](#) shows that out of the 382 impacts presented in the 12 EIS reports, 198 (52%) are environmental, 102 (27%) are social, and 82 (21%) are economic. Thus, considering there is an imbalance between the distribution of environmental, social and economic issues in the EISs. There is a strong predominance of environmental impacts (generally over 50% in most EISs) over the social and economic impacts in all the EIS. Social impacts are the second frequent sustainability pillar identified in the data set of the 12 EISs. Combined together, the number of social and economic impacts covered surpasses that of the environmental impacts only in four EISs. The number of economic impacts exceeded the social impact in only 3 reports (EIS 4, EIS 11 and EIS 12).

[Table 3](#) presents in detail how the categorization of one EIS, EIS 3, was undertaken. EIS 3 was chosen because it represents the most common pattern of the data set obtained and it is a case in which the representative of the company was interviewed.

In [Table 3](#), each impact described has a corresponding set of mitigation measures in a management plan for EIS 3. The same relation was observed in the set of 12 EIS analyzed. By analyzing [Table 3](#), the description of the impacts in EIS, using EIS 3 as an example, is verified to be associated with the analytical framework proposed in the literature. This means that the description of the impacts in EIS and also the other EISs matched the contents described in the literature for the social, economic and environmental pillars of sustainability presented in the categories of the analytical framework ([Table 1](#)).

This means that the description of the impacts in EIS and also the other EISs matched the contents described for the social, economic and environmental pillars of sustainability, in accordance with the literature, presented in the categories of the analytical framework ([Table 1](#)).

[Table 4](#) presents the categorization for the 22 criteria of the Bonsucro certification compared with the analytical framework established in this research ([Table 1](#)).

The analysis of [Table 4](#) reveals that environmental and social criteria are equivalent in the Bonsucro certification criteria. Both the environmental and social criteria are more frequent than

**Table 2**  
Guidelines used for the interviews.

Unit of analysis	Questions	Categorization	
Data source from the EIA to Bonsucro	Q1) Was the EIS used as a data source for the Bonsucro certification process?	Yes	totally partially
Bonsucro certification process by the EIS data	Q2) Can the EIS be considered a source of data to facilitate the certification process?	No	Impacts Socio environmental Programs Mitigation measures Enterprise features Baseline Legislation
Linking both instruments with each other	Q3) Is it possible to better link these two instruments with each other? How can the contents of EIS be used for the Bonsucro certification process?	Yes Maybe No	
Identifying advantages and barriers	Q4) Which are the opportunities and obstacles to better linking these two instruments with each other?	Related to the instruments processes Related to the contents of the instruments	

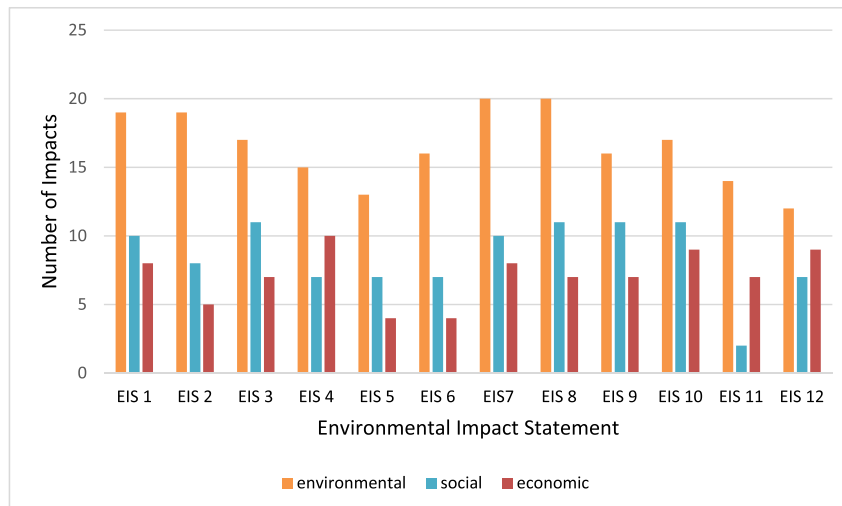


Fig. 4. Distribution of environmental, social and economic impacts in the 12 EIS.

economic criteria within the Bonsucro certification. The description of the categories of the Bonsucro certification matched with the contents described for social, economic and environmental pillars of sustainability in accordance with the literature presented in the categories of analytical framework (Table 1).

#### 4.2. Cross reference between the contents of EIS and Bonsucro certification

Every EIS (Table 3 as an example) was associated with the categories of the Bonsucro certification (Table 4) by using the analysis categories of the analytical framework (Table 1). Each social, environmental and economic impact classified in Table 3 was compared to each social, environmental and economic criterion classified in Table 4. This analysis allowed associating the EIS and the Bonsucro certification, as shown in the example of Fig. 5, which presents this analysis for EIS 3 (described in Table 3).

Content analysis showed that the associations of each category between these two instruments might be additive, meaning that a type of impact presented in EIS may be associated with more than one criterion of the Bonsucro certification and vice versa. Fig. 5 shows that one particular impact of EIS 3 may be associated with more than one category of the Bonsucro certification. This means that EIS has 34 impacts (see Table 3) and in Fig. 5 and 2 associations were identified between these two instruments. To explore how this dialogue between EIS and Bonsucro certification occurs, we performed the same analysis for the set of the 12 EIS, as presented in Fig. 6.

The comparison between one EIS individually analyzed (Fig. 5) and the aggregated analysis of the set of 12 EISs (Fig. 6) reinforces that the associations can be added and the same varied pattern of association found between impacts and certification categories was verified.

By examining data from Fig. 6, the number of Bonsucro criteria without any association to impacts presented in EISs ranges from 7 to 12 (one EIS for each – EIS 11 and EIS 2); EIS 11 has 12 criteria without any association with impacts presented in this EIS and EIS 2 has 7 criteria without any association with impacts presented in this EIS. EIS 4 shows 8 associations and in the remaining 9 EISs, the criteria without any association with EIS vary from 9 to 11. This can be confirmed by considering the Bonsucro criteria related to EIS: there are 4 criteria that do not appear in any EIS, 4 criteria that appear once, and 1 criterion that appears in two EISs. It is evident

the environmental criteria are the most frequent in the EISs. The same Bonsucro criteria related to environmental matters (see Table 4) could be observed more than once in an EIS. This shows that the issues related to environmental matters are the most frequent criteria in EIS reports.

Fig. 7 summarizes the frequency of similarities and differences between the contents of the EIS and the Bonsucro certification, which allows considering three levels of association: without any association, with intermediary level of association, and with high level of association. CR 5.2, which is the most frequently addressed criterion in the EISs, concerns soil and water; CR 4.2, biodiversity related mitigation measures, and CR 5.5, regards emissions, effluents and the recycling of waste. These three topics are included in all EISs, because they are covered by the Brazilian EIA legislation.

By the integrated analysis of Figs. 6 and 7, considering the 6 principles of the Bonsucro certification and the set of the 12 EISs, at least one association for each Principle was verified. However, three criteria included in Bonsucro were not covered in EISs.

Principle 2 of the Bonsucro criteria related to human and labor standards has fewer associations than the other principles. Among the five criteria, only one (CR.2.3 which ensures a safe and healthy work environment for business operations) is addressed in most EISs, and the other four, mainly related to labor conditions, are mentioned in just two EISs. Criteria related to complying with labor conventions and to applying human rights (CR.2.1 and CR.2.2) were identified in EIS 4, while criteria related to national minimum wage and to contracts (CR.2.3 and CR. 2.4) were identified only in EIS 2.

Besides the four categories of Principle 2, the greatest differences between the EISs and Bonsucro were observed for other four economic and social criteria related to efficiency and continuous improvement in the sugarcane mill. Then, the criteria related to production and to process efficiency, to training for employees and to quality of products and research (CR.3.1, CR.5.1, CR.5.3 and CR.5.6, respectively) have no association between the two instruments.

Principle 4, related to actively managing biodiversity and ecosystem services and to implementing mitigation measures (CR.4.1 and CR.4.2), is covered in all EISs. The same situation is observed for Principle 6, related to criteria exclusive to the European Union Market for monitoring GHG emissions and to protected areas.

Considering the criteria of the Principles, besides the criteria of Principle 4 and Principle 6, other criteria fully associated with the EISs are related to GHG emissions, soil and water resources,



**Table 3**  
Categorization of impacts from EIS 3 according to the analytical framework.

Impacts/Category EIS	Management Plan	Categories of analysis (Table 1)	Code
<b>Protected areas affected</b>	Environmental monitoring program; Communication and social participation plan	Labor conditions and workers' rights; social responsibility and benefits.	EIS 3.01
<b>People's perceptions</b>	Communication and social participation plan; recruitment and dismissal procedures	Jobs, wages, income distribution and land ownership	EIS 3.02
<b>Pollution by construction site and construction works</b>	Environmental management program; Soil conservation plan	Water resources; Water and soil pollution; Residues; Waste management.	EIS 3.03
<b>Urban facilities and services</b>	Environmental monitoring program; Communication and social participation plan	Social responsibility and benefits.	EIS 3.04
<b>Vegetation removal and interference with permanent preservation area</b>	Integrated plan for permanent preservation area recovery; Wildlife conservation plan	Land use change, deforestation and biodiversity.	EIS 3.05
<b>Earthworks services</b>	Environmental management program; Soil conservation plan	Water resources; Water and soil pollution; Residues; Soil erosion; Land use change, deforestation and biodiversity; Waste management	EIS 3.06
<b>Local noise level</b>	Medical control of occupational health program; Hearing conservation program; Conservation program of environmental risks	Air emissions; Waste management.	EIS 3.07
<b>Tax revenues in municipalities</b>	Communication and social participation plan; Recruitment and dismissal program	Jobs, wages, income distribution and land ownership	EIS 3.08
<b>Pressure on health infrastructure, housing and education of municipalities</b>	Inclusive policy of social welfare, health, housing and education; communication plan and social participation plan; Recruitment and dismissal program	Food security; Social responsibility and benefits.	EIS 3.09
<b>Pressure on public safety infrastructure of municipalities facing the arrival of workers from other regions</b>	Communication and social participation plan; Recruitment and dismissal program	Social responsibility and benefits.	EIS 3.10
<b>Land use change for cropping sugarcane in areas occupied by pastures and other crops</b>	Environmental monitoring program; Integrated plan for permanent preservation area recovery; Wildlife conservation plan.	Food security; Social responsibility and benefits.	EIS 3.11
<b>Erosion process</b>	Soil conservation practices plan; Environmental management program	Water and soil pollution; Soil erosion; Land use change, deforestation and biodiversity.	EIS 3.12
<b>Pressure on conservation areas</b>	Agri-environmental Protocol; Integrated plan for permanent preservation area recovery; Wildlife conservation plan; reforestation program	Land use change, deforestation and biodiversity.	EIS 3.13
<b>Disturbance of wildlife</b>	Wildlife monitoring program; Integrated plan for permanent preservation area recovery; Wildlife conservation plan	Land use change, deforestation and biodiversity.	EIS 3.14
<b>Use of areas degraded by previous monocultures and pastures</b>	Integrated plan for permanent preservation area recovery; Wildlife conservation plan; reforestation program	Water and soil pollution; Soil erosion; Land use change, deforestation and biodiversity.	EIS 3.15
<b>Increase of jobs</b>	Manpower qualification plan; communication and social participation plan; Recruitment and dismissal program	Jobs, wages, income distribution and land ownership.	EIS 3.16
<b>Impacts on urban infrastructure that might affect the workers</b>	Communication and social participation plan; mobilization and manpower demobilization program	Social responsibility and benefits.	EIS 3.17
<b>Interference in archaeological sites</b>	Archaeological program; Heritage education program	Social responsibility and benefits.	EIS 3.18
<b>Pollution of surface water</b>	Targeted use of pesticides; Control of handling and disposal of packaging; Biological control; water resources conservation plan	Water resources; Water and soil pollution; Residues; Waste management.	EIS 3.19
<b>Groundwater pollution</b>	Targeted use of pesticides; Control of handling and disposal of packaging; Biological control; water resources conservation plan	Water resources; Water and soil pollution; Residues; Waste management.	EIS 3.20
<b>Changing the soil chemical quality</b>	Targeted use of pesticides; Control of handling and disposal of packaging; Biological control; water resources conservation plan	Water resources; Water and soil pollution; Residues; Soil erosion; Land use change, deforestation and biodiversity; Waste management.	EIS 3.21
<b>Risk to workers in the application of pesticides</b>	Training employees; Use of protective equipment; Safe storage of packaging and products; environmental monitoring program	Labor conditions and workers rights; Social Responsibility and Benefits.	EIS 3.22
<b>Pollution of surface water by ferti-irrigation</b>	Control of fertirrigation practices; water resources conservation plan	Water resources; Water and soil pollution; Residues; Waste management.	EIS 3.23

<b>Groundwater pollution by Fertigation</b>	Control of Fertigation practices; water resources conservation plan	Water resources; Water and soil pollution; Residues; Waste management.	EIS 3.24
<b>Job offer reduction in agriculture due to mechanization</b>	Manpower qualification plan; communication and social participation plan; Recruitment and dismissal program	Jobs, wages, income distribution and land ownership; Production	EIS 3.25
<b>Impacts on traffic</b>	monitoring and maintenance of roads program; Avoid transportation of heavy loads; Traffic control Program	Labor conditions and workers' rights; Social Responsibility and Benefits.	EIS 3.26
<b>Increased road risks</b>	Adequate cargo; safety conditions of vehicles; secure transport of agricultural machinery and inputs.	Labor conditions and workers' rights; Social Responsibility and Benefits.	EIS 3.27
<b>high consumption of water resources to meet the demands in the factory</b>	Water resources conservation plan; environmental monitoring program	Water resources; Water and soil pollution; Residues;	EIS 3.28
<b>Pollution of surface water by industry operation</b>	Water resources conservation plan; environmental monitoring program	Water resources; Water and soil pollution; Residues;	EIS 3.29
<b>Air pollution emission</b>	Environmental monitoring program	Residues; Air emissions; Energy balance and GHG; Waste management.	EIS 3.30
<b>Reducing pollution by ethanol use</b>	Environmental monitoring program	Water resources; Water and soil pollution; Residues; Land use change, deforestation and biodiversity; Air emissions; Energy balance and GHG; Waste management	EIS 3.31
<b>Pressure on the road system</b>	Traffic control Program	Social Responsibility and Benefits.	EIS 3.32
<b>Increasing employment and income and increasing municipal revenues</b>	Communication and social participation plan; Recruitment and dismissal program	Jobs, wages, income distribution and land ownership.	EIS 3.33
<b>Reduction of industrial and agricultural activity</b>	Communication and social participation plan; Recruitment and dismissal program	Jobs, wages, income distribution and land ownership.	EIS 3.34

Note: the words in bold in the first column represent the categories used in content analysis.

emissions and effluents, and to promoting economic sustainability (CR.3.2, CR.5.2, CR.5.5 e CR.5.9, respectively).

As verified in Fig. 7, from the 22 certification categories considering the ones of high level of association (ranging from 27 to 116 associations), nine have the greatest association regarding EIS categories. From these, the majority of the associations between certification categories and EIS were achieved for the criterion related to environmental matters. These results allow considering that the environmental impacts of the certification criteria are those best addressed in the EIS scope. Among the environmental ones, only two are related to the economic aspects: the consultative processes, and the economic sustainability of the agribusiness (CR.5.8 and CR.5.9).

Moreover, nine out of the 22 certification categories have an intermediary association situated between the two extremes (ranging from 14 to 1 association). With the exception of the economic category of energy efficiency promotion (CR.5.4), all the other categories are related to social matters. These data again demonstrate that the EIS is more devoted to environmental topics and that economic and social issues have a more restricted coverage in this instrument. There are four social criteria that are mentioned in most EISs, albeit with intermediary frequency. These are: complying with the laws (CR.1.1 (12)), land tenure (CR.1.2 (14)), safe and healthy working environment (CR.2.3 (14)), and greenfield expansion and cumulative effects (CR.5.7 (8)). The other social criteria (CR.2.1, CR. 2.2, CR. 2.4 e CR. 2.5) do not appear so much. In addition, the economic criterion (CR.5.4), which is occasionally mentioned, indicates that promoting energy efficiency is not included as a relevant issue in EIS of the sugarcane mill.

Out of the 22 criteria, five (CR.1.1; CR.2.1; CR.2.4; CR.4.1; CR.5.7) are considered essential and must be fully met before the Bonsucro certification. From these five criteria, CR.4.1 which relates to biodiversity is fully covered in all EIS. This is followed by the criteria related to complying with the laws (CR.1.1), mentioned in 10 out of the 12 EISs, and the one related to greenfield expansion and to cumulative effects (CR.5.7), presented in 6 of the 12 EISs. The remaining two criteria related to applying human rights (CR.2.1)

and to the contracts of the sector (CR. 2.4) were only identified in one EIS each. Although the essential matters of the Bonsucro certification – the five criteria (CR.1.1; CR.2.1; CR.2.4; CR.4.1; CR.5.7) – are found in the EIA process, they are not strongly represented in the EIS in the sugarcane sector.

For analyzing how each EIS is associated with the consolidated Bonsucro certification criteria, Fig. 8 highlights if one association is occasional or if it is widespread in both instruments.

In Fig. 8, except for EIS 5, EIS 9, EIS 11 and EIS 12 (ranging from 36 to 45 associations), the remaining 8 EISs have more than 50 associations between the impacts presented in the EIS and the Bonsucro criteria. There is a difference in the total number of impacts presented in each EIS. The difference in the number of the impacts in each EIS seems to influence the number of associations, at least in the following cases: EIS 5, EIS 6 and EIS 12 (that range from 36 to 50) where we found a small number of impacts and a consequently lower number of associations. However, EIS 9 has 34 identified impacts but only 45 associations and it deviates from this main pattern (more than 50 associations).

#### 4.3. Interviews

Table 5 presents the results of the interviews with key actors from the 4 selected sugarcane mills case studies.




The major findings from the interviews are: at the present stage, the EIS can be partially used to obtain the Bonsucro certification; the EIS chapters related to the analysis of impacts and to describing mitigation measures represent the most cited among the EIS contents; three of the four interviewees believe that it is possible to enhance the coherence/coordination between these two instruments. All of them agree that the management plan required by an EIS can be used also for the Bonsucro certification process. Only one of the interviewees believes that not all the impacts identified in the EIS cover the contents of the Bonsucro certification. However, all of them emphasized that an in-depth review of the EIS is necessary, so as to ensure that the EISs cover most of the Bonsucro criteria, and thereby to help producers to obtain the Bonsucro

**Table 4**  
Categorization of the Bonsucro certification criteria.

Principle	Code	Bonsucro Categories/number of indicators per category	Categories of analysis (Table 2)
1 : Abide by the law.	CR.1.1	1.1 To comply with relevant applicable laws (1).	Labor conditions and workers' rights; Social responsibility and benefits.
	CR.1.2	1.2 To demonstrate clear title to land in accordance with the national practice and law (1).	Labor conditions and workers' rights; Social responsibility and benefits.
2: Respect human rights and labor standards.	CR.2.1	2.1 To comply with ILO labor conventions governing child labor, forced labor, discrimination and freedom of association and the right to collective bargaining (4).	Labor conditions and workers' rights; Social responsibility and benefits.
	CR.2.2	2.2 To apply BSI human rights and labor standards to suppliers and contractors (1).	Labor conditions and workers' rights; Social responsibility and benefits.
	CR.2.3	2.3 To provide a safe and healthy working environment in workplace operations (6).	Labor conditions and workers' rights; Social responsibility and benefits.
	CR.2.4	2.4 To provide employees and workers (including migrants, seasonal and other contract labor) with at least the national minimum wage (1).	Labor conditions and workers' rights; Social responsibility and benefits.
	CR.2.5	2.5 To provide clear, equitable and comprehensive contracts. (1).	Labor conditions and workers' rights; Social responsibility and benefits.
3: Manage input, production and processing efficiencies to enhance sustainability.	CR.3.1	3.1 To monitor production and process efficiency; to measure the impacts of production and processing so that improvements are made over time (6).	Jobs, wages, income distribution and land ownership; Production.
	CR.3.2	3.2 To monitor global warming emissions so as to minimize climate change impacts (1).	Residues; Land use change, deforestation and biodiversity; Air emissions; Energy balance and GHG; Waste management.
4: Actively manage biodiversity and ecosystem services.	CR.4.1	4.1 To assess impacts of sugarcane enterprises on biodiversity and ecosystem services (7).	Water resources; Water and soil pollution; Residues; Land use change, deforestation and biodiversity; Air emissions; Waste management.
	CR.4.2	4.2 To implement measures to mitigate adverse impacts where identified (1).	Water resources; Water and soil pollution; Residues; Soil erosion; Land use change, deforestation and biodiversity; Air emissions; Energy balance and GHG; Waste management.

5: Continuously improve key areas of the business	CR.5.1	5.1 To train employees and other workers in all the areas of their work and develop their general skills (1).	Labor conditions and workers' rights; Social Responsibility and Benefits
	CR.5.2	5.2 To continuously improve the status of soil and water resources (4).	Water resources; Water and soil pollution; Residues; Soil erosion; Land use change, deforestation and biodiversity; Waste management.
	CR.5.3	5.3 To continuously improve the quality of sugarcane and products from the sugar mill (2).	Income distribution and land ownership; Production.
	CR.5.4	5.4 To promote energy efficiency (3).	Production
	CR.5.5	5.5 To reduce emissions and effluents. To promote recycling of waste streams where practical (2).	Water and soil pollution; Residues; Soil erosion; Land use change, deforestation and biodiversity; Air emissions; Waste management.
	CR.5.6	5.6 To foster effective and focused research, development and extension expertise (1).	Social Responsibility and Benefits.
	CR.5.7	5.7 For greenfield expansion or new sugarcane projects, to ensure transparent, consultative and participatory processes that address cumulative and induced effects via an environmental and social impact assessment (ESIA) (2).	Labor conditions and workers' rights; Social Responsibility and Benefits.
	CR.5.8	5.8 To ensure active engagement and transparent, consultative and participatory processes with all the relevant stakeholders (2).	Jobs, wages, income distribution and land ownership; Production.
	CR.5.9	5.9 To promote economic sustainability (1).	Jobs, wages, income distribution and land ownership; Production.
6: exclusive criteria for the European Union market	CR.6.1	6.1 To monitor global warming emissions so as to minimize climate change impacts (1 indicator - Global warming burden per unit of energy measured in g CO <sub>2</sub> eq/MJ fuel l)	Land use change, deforestation and biodiversity; Air emissions; Energy balance and GHG; Waste management.
	CR.6.2	6.2 To protect land with high biodiversity value, land with high carbon stock and peatlands (1).	Land use change, deforestation and biodiversity; Air emissions; Energy balance and GHG; Waste management.

Legend:

	Social criteria - 8
	Environmental criteria - 8
	Economic criteria - 6

certification. None of the interviewees mentioned procedural issues as an obstacle or an advantage in efforts to better link the two instruments applied to the sugarcane ethanol production with each other.

##### 5. Discussion: advantages and barriers for associating the Bonsucro certification criteria within the EIS

The impact distribution follows a similar pattern in all of the 12 EISs analyzed, showing that regardless of the particularities of each ethanol sugarcane mill project, the EIA processes in the sector mainly focus on environmental matters. The limited approach to the social and economic impacts was verified by [Gallardo and Bond \(2011a\)](#), with a different sample of EIS on the same sugarcane sector

of the state of São Paulo. This is in line with previous research such as [Sheate \(2012\)](#), [Morrison-Saunders et al. \(2014\)](#) and [Morrison-Saunders and Pope \(2013\)](#) who highlighted that EIA represents a traditional form of assessment guided by a biophysical approach, in which the scope of the sustainability issues is quite limited.

The EIS is a preventive tool that mainly focuses on the impacts that can affect project design ([Sánchez, 2013](#)). Although the set of the 12 EISs involve impacts for the life cycle of the mill project, most refer to impacts that modify the ecological environment and result from the first stages of design and construction (see [Table 4](#)). In addition, some impacts related to the mill operation such as human rights and labor conditions were not frequently found in the set of the 12 EISs. However, at least one EIS (EIS 4) mentions these issues implying that labor issues may have room in environmental



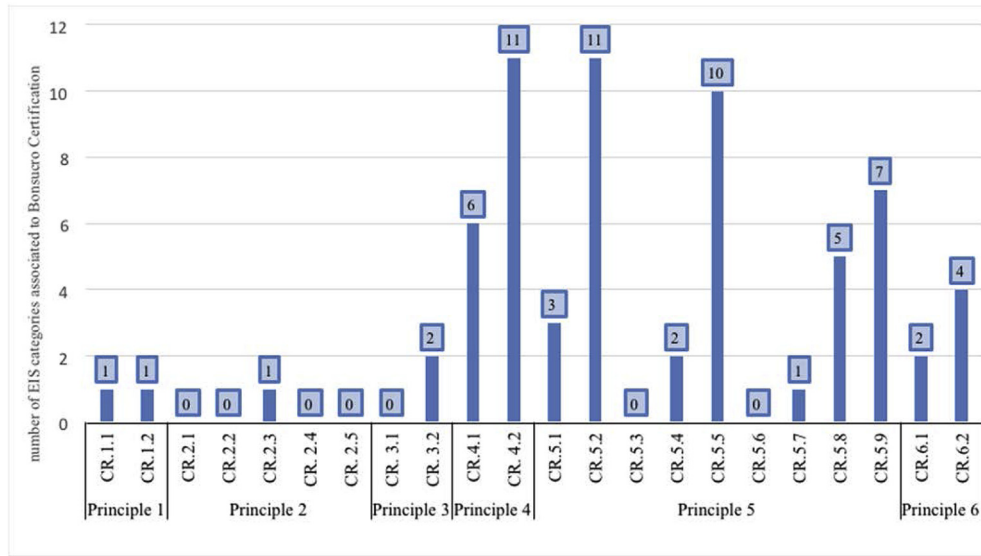


Fig. 5. Association between the EIS 3 and the Bonsucro certification.

	EIS 1	EIS 2	EIS 3	EIS 4	EIS 5	EIS 6	EIS 7	EIS 8	EIS 9	EIS 10	EIS 11	EIS 12	TOTAL
CR.1.1	1	2	1	1	1	2	0	1	1	1	0	1	12
CR.1.2	1	2	1	1	2	2	0	1	1	2	0	1	14
CR.2.1	0	0	0	1	0	0	0	0	0	0	0	0	1
CR.2.2	0	0	0	1	0	0	0	0	0	0	0	0	1
CR.2.3	1	1	1	2	2	1	2	1	1	1	0	1	14
CR.2.4	0	1	0	0	0	0	0	0	0	0	0	0	1
CR.2.5	0	1	0	0	0	0	0	0	0	0	0	0	1
CR.3.1	0	0	0	0	0	0	0	0	0	0	0	0	0
CR.3.2	3	2	1	2	1	3	6	3	2	2	1	1	27
CR.4.1	5	5	4	6	3	3	5	5	3	4	5	2	50
CR.4.2	10	13	10	9	8	10	9	10	4	9	5	4	101
CR.5.1	0	0	0	0	0	0	0	0	0	0	0	0	0
CR.5.2	10	11	11	9	9	10	10	11	10	9	8	8	116
CR.5.3	0	0	0	0	0	0	0	0	0	0	0	0	0
CR.5.4	0	0	0	0	0	0	0	0	0	0	1	1	2
CR.5.5	10	8	10	5	4	8	6	9	8	8	5	8	89
CR.5.6	0	0	0	0	0	0	0	0	0	0	0	0	0
CR.5.7	2	1	1	0	0	0	1	1	2	0	0	0	8
CR.5.8	1	2	2	5	0	2	3	4	2	8	1	8	38
CR.5.9	7	5	5	9	2	3	7	7	6	8	6	7	72
CR.6.1	3	2	1	2	1	3	6	3	2	2	1	1	27
CR.6.2	4	6	4	5	3	3	5	5	3	4	5	2	49
TOTAL	58	62	52	58	36	50	60	61	45	58	38	45	

Fig. 6. Association between the categories of sustainability addressed in the set of the 12 EIS and in the Bonsucro Certification.

studies. An interviewee (INT 1) also emphasizes that “EIA needs improvement in some aspects, such as issues related to work safety”. This would address the need to improve the way in which social issues are dealt with in an EIA process because the sugarcane industry has been historically associated with improper practices regarding labor issues, such as slavery, child labor, informal

contracts and excessive workload (Baccarin et al., 2011; Vilela et al., 2014; Mohr and Bausch, 2013; Moura et al., 2012).

Even though the EIA legislation in Brazil strongly emphasizes the environmental dimension, at least the EIA scoping guidelines provide some scope for considering social matters (Borioni et al., 2017). It may be the reason why social impacts have been more

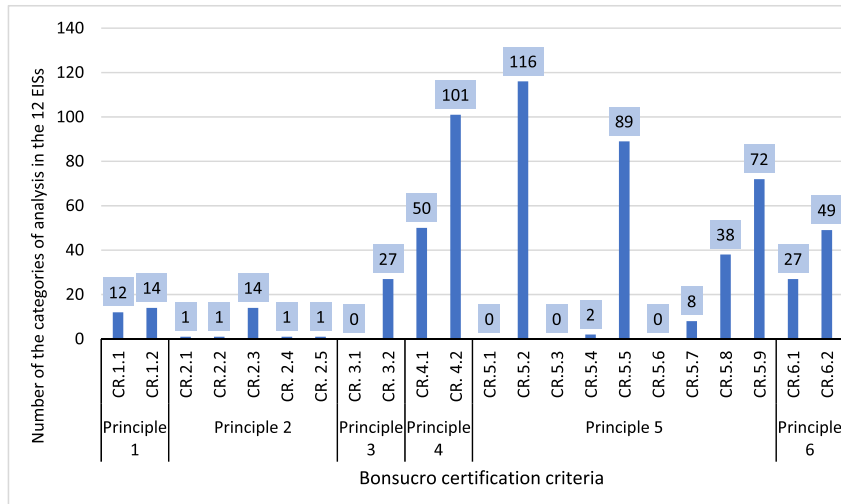


Fig. 7. Number of impacts presented in the 12 EISs associated with 22 Bonsucro Certification Criteria.

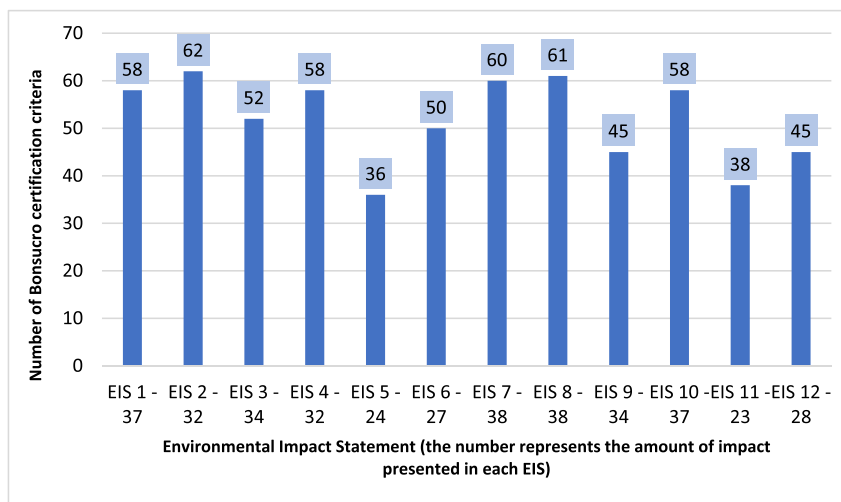


Fig. 8. Number of associations between the impacts presented in each EIS and the consolidated Bonsucro Certification Criteria.

prominent than economic ones in these Brazilian case studies. Among the Impact Assessment tools, the Social Impact Assessment (SIA) has advanced in addressing social impacts in-depth (Burdge, 2002; Esteves et al., 2012). It is meant to deal with the impacts not properly addressed by the EIA (Morgan, 2012), and can be developed as part of an EIA or as an independent process (Burdge, 2003; Vanclay, 2002; Wong and Ho, 2015). In fact, the need for an SIA is expressed in criterion CR.5.7 of the Bonsucro certification and was mentioned in half of the EISs analyzed. However, social license to operate described by Sánchez and Croal (2012) related to the acceptance by local communities is a habitual deficiency of the EIA process. The companies would not obtain a social license to operate merely by integrating these instruments. This is because the Bonsucro certification only covers a few social issues. According to Esteves et al. (2012, pp. 39), it is important to consider the local content that “refer to the participation of local people in the workforce and supply chain of a project” (such as local labor conditions, goods and services) as desirable benefits from a project. These benefits should be embraced in an EIA process, without missing the achievement of “sustainable regional development”, also a goal of the EIA process. Integrating ESIA (environmental and social impact assessment as expressed in criteria CR.5.7 of the

Bonsucro certification) into the EIA process has to be carefully considered in order to avoid losing the imperative of EIA to highlight the environmental dimension against the economic aspects which usually dominate in information basis that underpins decision-making.

As regards sustainability, strong sustainability refers to the understanding “that the overall capital within each of the environmental, social and economic categories is maintained” (Morrison-Saunders and Pope, 2013, p. 58). Conversely, a weak view of sustainability presumes that the natural capital can be replaced with the other forms of capital. Regarding EIA Sheate (2012) argues that the rationalist (positivist) approach to environmental assessment leads to a weak sustainability view, essentially because the “rationalists” fail to recognize the political nature of EIA and its role in policymaking. For this author EIA should acknowledge and address key elements of political decision-making processes: power relations, plurality of values, social learning among others.

Regarding the Bonsucro certification, our research demonstrates that this certification addresses issues in all dimensions of sustainability. Most of the issues described in the literature as important topics for the sustainability of the sector were identified. This does not mean that a strong view of sustainability has been totally

**Table 5**  
Summary of the data from the interviews.

	categorization		INT 1 (EIS 3)	INT 2 (EIS 5)	INT 3 (EIS 10)	INT 4 (EIS12)
Q1 - Was the EIS used as a data source for the Bonsucro certification process?	yes	totally partially	Yes, partially “in the beginning of certification process	Yes, partially “the EIS was used during the certification process, but only partly	Yes, partially “in the beginning of certification	Yes, partially “it was used in the initial procedures for certification
Q2 - Can the EIS be considered a source of data to facilitate the certification process?	Impacts	Socioenvironmental Programs	Programs “Only a few programs presented in the EIS, since the EIS does not contain all the conditions of the certification”	Mitigation Measures “Partly, because not everything required by the certification is in the EIS	Programs Mitigation Measures Partially because the EIA is an instrument directed to specific aspects of environmental licensing and certification is more comprehensive”	Programs Mitigation Measures “only partly”
Q3 - Is it possible to better link these two instruments with each other? How can the contents of EIS be used for the Bonsucro certification process?	Yes Maybe No	Legislation	Yes “by enhancing the management plan of EIS” that comprises socio environmental programs and mitigation measures.	Yes “by using socio environmental programs and mitigation measures, because some of these are still being implemented during the certification process	Maybe “by using socio environmental programs and mitigation measures presented in the EIS	Yes “by using socio environmental programs and mitigation measures generally presented in the EIS
Q4 – Which are the opportunities and obstacles to better linking these two instruments with each other?	Related to the processes of the instruments	Related to the contents of the instruments	The contents. The contents of the EIS are limited; conversely, the contents of certification are broad for sustainability”. “questions related to social matters; labor conditions are poorly addressed in the EIS	The contents. “If some EIS contents improve the association between both instruments it may be possible”. “some EIS contents are limited. They generally cover the contents of the certification related to biodiversity, soil and water well”	The contents. Considerable improvements in the content of the EIS mainly related to the impacts and the programs are needed”	The contents. “It is necessary to improve EIS directed to the certification in many aspects”

embraced for the Bonsucro certification. To [Diaz-Chavez \(2011\)](#), although this certification generally addresses the three main themes of sustainability, a concern remains regarding how the broader issues of sustainability can be accounted for the local population and for the environment. According to the review by [Van Dam et al. \(2010\)](#), the main purpose of 67 ongoing bioenergy sustainability certifications includes environmental matters and undervalues the widely recognized important social and economic issues, such as food security and indirect land use change. We could confirm that there is no requirement for food security and for indirect land use change in the Bonsucro certification. For [Smeets et al. \(2008\)](#) there is a lack of region-specific and up-to-date information related to the compliance with the local legislation, standards and guidelines in biofuel certifications. However they recognized the efforts to design schemes targeting sustainability for the Brazilian ethanol sugarcane. We could confirm compliance with the local legislation in the Bonsucro certification by the criterion of Principle 1.

Considering the differences and the similarities of the association between the EIS and the Bonsucro certification, the largest number of associations revealed in this research related to environmental matters were also mentioned as key issues of the sugarcane sector by several authors ([Goldemberg et al., 2008](#); [Gallardo and Bond, 2011a, 2011b](#); [Duarte et al., 2015](#)). The differences perceived for some social and economic matters in this analysis were also reported as usual for the sector by [Ribeiro \(2013\)](#) and [Labruto \(2014\)](#). However, it can be considered that social issues are still more widespread throughout the set of the 12 EISs than the economic ones.

Both differences and similarities were also perceived by the interviewees. According to INT 1, the two instruments need to be better integrated on certain topics such as safety and social aspects: “It (the EIS) usually covers aspects related to biodiversity, water and soil, but not the social ones of the certification”. This shortcoming of the EIS emphasized by some authors ([Sánchez and Croal, 2012](#)) is a very old concern for EIA practitioners ([Vanclay, 2002](#)) that still remains in the current EIA practice ([Wong and Ho, 2015](#)). The mismatches regarding the core contents of the instruments are clearly perceived in the interviews: “the EIS was used throughout the certification, but only parts of it were used” (INT 2); “we use the environmental management plan established in the EIS and some environmental programs, because the EIS does not include the issues of certification” (INT 3); “Some points, because not all the certification required were present in the EIS” (INT 2); “Partly because the EIA is an instrument focused on specific points related to environmental licensing, and certification is more comprehensive” (INT 4).

Despite these dissimilarities there is already an association between the contents of EIS and the Bonsucro criteria. One advantage from enhancing the association of the Bonsucro certification criteria with the EIS (and thus the EIA process) is to use the EIS as a tool for coordinating various certification requirements, and thereby simplifying the process of certification. Another advantage is to foster mainstreaming sustainability within the sugarcane production lifecycle from the planning phase (EIS) to the operating phase (Bonsucro certification). It would guarantee that some social and economic concerns considered in this certification and not involved in EIS can be included not only for analyzing impacts in environmental studies but also for fostering the EIA follow-up requirements (see [Fig. 1](#)) as highlighted by [Gallardo et al. \(2016b\)](#). Some authors such as [Van Dam et al. \(2010\)](#); [Buytaert et al. \(2011\)](#) argue that biofuel certification should pay greater attention to broader sustainability issues. In this sense, embedding EIA in the Bonsucro criteria can help to meet the challenges faced for the Bonsucro certification towards sustainability, thus contributing to

increasing the awareness of sustainability issues, as discussed by [Mohr and Bausch \(2013\)](#). It can also help to overcome the limited approach of social issues in the EIA process in the international ([Vanclay, 2012](#)) and in the Brazilian practice ([Montaño and Souza, 2015](#)); and also to highlight an EIA follow-up that has received less attention among EIA process ([Gallardo et al., 2015](#)). Applied at the end of the EIA process, the EIA follow-up can guarantee an appropriate discussion of the sustainability issues along all stages of the project life cycle for sugarcane ethanol production until requesting the certification.

A possible barrier of this approach would be adding cost and time to the EIA process stakeholders, mainly proponents and environmental agency staff, to embrace other social and economic matters not usually embedded in the EIA process. On the other hand, it would be convenient only for plants that want to pursue this certification, meaning it could not represent an advantage for a proponent who does not intend to acquire a Bonsucro certification. If EIS is adopted as the basis for the certification, it must be carefully considered in order not to overload the EIA process, which is often criticized for not reaching its expected potential ([Morrison-Saunders and Retief, 2012](#); [Duarte et al., 2017](#)). Three out four respondents consider that the EIS can complement the Bonsucro certification, affirming that a better association between these instruments would be advantageous to the sector, also from a financial point of view. INT 1 agreed by saying “Yes, but we do not clearly know how it can happen”. [Mathews \(2008\)](#); [Janssen and Rutz \(2011\)](#); [Pacini et al. \(2013\)](#) highlighted the concerns about the costs of sustainability certification for producers. [Florin et al. \(2014\)](#) emphasized that these concerns can be greater for the smallest ones. The interviewees underline the fact that EIA is compulsory for the ethanol sector in Brazil. Furthermore, a closer association between these two tools may lower the costs for certification. A closer association between these instruments might also concern future EISs, which would include aspects related to environmental certification in the sugarcane production chain. This may encourage the adoption of the Bonsucro certification highlighting the need to explore complementarities and possibilities for integrating them, as described by [Buytaert et al. \(2011\)](#).

The final question regards the practical means of enhancing the association (as emphasized for [Tajima and Fischer, 2013](#)) between these two instruments. Differently from the perception of the interviewees which calls for a “deep revision of the EIS content”, analyzed documentary data from this integration show that the dialogue between them occurs and is directed towards sustainability, at least for the issues recognized as relevant in the literature. The challenge is to agree on which social and economic issues required by the Bonsucro certification could be requested in the EIA process without harming their core purpose.

Out of the 22 Bonsucro certification categories, 9 present high level of association and 4 others were considered with an intermediary association; however, they are widespread in the set of the 12 EISs. Work towards closer association between the instruments should start from the following four social criteria –complying with the laws, land tenure, a safe and healthy working environment, greenfield expansion and cumulative effects – which were mentioned at least once in most EIS. Consequently, an appreciation of these aspects of sustainability from the beginning of the decision-making process would be promoted. The remaining 9 criteria with very poor or absence of association have to be reflected upon. First, it is necessary to understand why 4 social criteria from the remaining 9 – related to complying with labor conventions, to applying human rights, to the national minimum wage and to the contracts – were not mentioned in the EISs. Unfortunately, the data from this research is insufficient to answer this. However, these social issues are not usually considered in EIA practice ([Sánchez,](#)



2013) and including these social criteria in EIS may reinforce the valorization of the local environment, which is absent from the Bonsucro certification (Díaz-Chavez, 2011) and from the good practice of EIA (Esteves et al., 2012). The impact promotion of energy efficiency was seldom included in the EISs, while the impacts production and process efficiency, training for employees, quality of products and research and expertise were completely absent from the EISs. These absent social matters, especially the last criteria referring to research and expertise, have been recognized as a need for improvement in the EIS contents. Bond and Morrison-Saunders (2011); Sánchez (2012), Morgan (2012); Sánchez and Mitchel (2017) criticize the EIA for being often limited to identifying impacts and mitigation, instead of privileging improvements, knowledge and learning. Maybe the inclusion of this criterion (research and expertise) in the EIS could later provide improvement throughout the mill production process, regarding some sustainability matters and emphasizing the link between two instruments related to the same sector. To consider these criteria within the EIA process, they have to be deeply discussed to avoid deviations from the core objectives of EIA tool and to prevent the purpose of sustainability from being compromised.

## 6. Conclusions

This research showed that there is potential for moving forward with the association of the Bonsucro certification criteria within the EIA for strengthening sustainability in the Brazilian sugarcane ethanol production. At the current stage of applying both instruments to the sugarcane sector, the EIS has been partially used for contributing to the Bonsucro certification requirements in some Brazilian sugarcane ethanol mills. Exploring this association is a relevant and current subject at a time when there are prospects for increasing sugarcane ethanol production in Brazil and other countries. Certification applications are also raising as a way for the sustainability of the sector to be scrutinized and for meeting the international market demand. Recent research on EIA has emphasized that a sustainability approach can be integrated in this instrument (Sheate, 2012; Morrison-Saunders and Pope, 2013; Morrison-Saunders et al., 2014).

Both instruments approach sustainability matters in terms of issues expected by the international audience. Although similarities and differences between the EIS and Bonsucro certification contents are evident, the potential to include more issues of the certification in the EIS is promising. We conclude that reinforcing some features of the Bonsucro certification in the EIA process can help to expand the sustainability perspective in this sector at least starting with a better integration of environmental, economic and social impacts.

The main similarities between these two instruments are largely related to environmental issues, while differences can be observed in the economic and social dimensions. Within the decision-making process at large, the EIA process often pays less attention to the social and economic dimensions of sustainability. This raises another relevant question for future research: what kind of economic matters have to be included in a decision-making process and what kind of economic issues have to be integrated as part of sustainability as a whole?

The current barrier for strengthening the association of the instruments refers to the range of the social and economic matters addressed in the Bonsucro certification not completely matched by the EIS contents. Advantages of expanding economic and social dimensions in the EISs include: gaining resource savings, expanding the traditional contents of the traditional EIS, simplifying the procedures for obtaining the Bonsucro certification by including terms of this certification within the EIS, fostering mainstreaming

sustainability within the lifecycle of sugarcane production among others. Despite these advantages, there is a limit for their full inclusion in the EIA process. Social and economic criteria poorly considered or not considered require further studies to demonstrate their usefulness in this context. Social criteria related to labor conditions, social responsibility and research expertise are among them and are recognized as useful to the EIS practice, and to enhance the sustainability of the sugarcane ethanol production.

Reinforcing the inclusion of some social and economic aspects of ethanol sugarcane projects in EIA could be a way to internalize and to consolidate these missing sustainability issues in the initial steps of the sugarcane production chain. These social and economic matters, added to the well-considered environmental ones, can later be evaluated and enhanced by the Bonsucro certification promoting sustainability in the sugarcane ethanol production.

## Acknowledgements

The authors thank the careful review of the references made by Edna Gubitoso who works at the Institute for Technological Research.

The authors are deeply grateful for the in-depth and careful analysis of our manuscript by the reviewers. All the proposed comments were extremely useful to deepen the findings of our research and highlight its contribution.

## Appendix A. Supplementary data

Supplementary data related to this article can be found at <https://doi.org/10.1016/j.jclepro.2018.01.261>.

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