Sustainability of Brazilian bio-ethanol

Edward Smeets
Martin Junginger
André Faaij

Arnaldo Walter
Paulo Dolzan

UNICAMP

Universiteit Utrecht
Copernicus Institute
Department of Science, Technology and Society

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Edward Smeets
Martin Junginger
André Faaij
(Utrecht University)

Arnaldo Walter
Paulo Dolzan
(State University of Campinas)

This study was commissioned by:

SenterNovem, The Netherlands Agency for Sustainable Development and Innovation
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3503 RE Utrecht, The Netherlands
This study was supervised by; Ir. Peter Versteegh and Kees Kwant, contact: k.kwant@senternovem.nl

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Copernicus Institute – Department of Science, Technology and Society
Utrecht University
Heidelberglaan 2
3584 CS Utrecht
The Netherlands
Phone: +31-30-2537600, Fax: +31-30-2537601
Web: http://www.copernicus.uu.nl

Contact persons: Martin Junginger and André Faaij
Email: M.Junginger@chem.uu.nl, A.Faaij@chem.uu.nl

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State University of Campinas
13083-970 Campinas, São Paulo, Brazil
Phone: +55-19-3788-3283
Contact person: Arnaldo Walter
Email: awalter@fem.unicamp.br

Executive summary

The Dutch society recognizes the need for sustainable production and use of biomass. This has been expressed by environmental groups and the Parliament. The Dutch government decided to seek solutions by developing sustainability criteria and certification of biomass by a commission sustainable production of biomass (duurzame productie van biomassa, DPB). Between January 2006 and July 2006 these criteria have been developed. Parallel to these developments, in February 2006 this project was commissioned by SenterNovem on behalf of the Dutch Ministry for Housing, Spatial Planning and the Environment. As Brazil is one of the most likely countries to export bio-ethanol from sugar cane to the Netherlands, the sustainability of Brazilian bio-ethanol is the main topic of this report.

The main objective of this report was a comparison of Dutch sustainability criteria and the current Brazilian practice, and quantification of the consequences for ethanol production in terms of production method and production costs if these sustainability criteria are applied. To this end, the Dutch sustainability demands for bio-ethanol were investigated, including stakeholder consultation in the Netherlands (NGO's, industry), and an extensive assessment of the current ecological, economic and social impacts of ethanol production based on sugar cane in Brazil was carried out.

While the current study contains many different types of uncertainties, *no prohibitive reasons where identified why ethanol from São Paulo principally could not meet the Dutch sustainability standards set for 2007.* In many impact categories, Brazilian ethanol from sugar cane scores average to (very) positive, see also table I for a summary. For a number of other criteria, problems are identified, but it also appears that these may differ strongly between the individual plants. Furthermore, for most of these issues, measures can be identified to improve performance (when needed).

For the future and the whole of Brazil, too many uncertainties remain to determine whether also additional criteria from 2011 onwards can be met. First of all, it is as yet unclear how additional land use for sugar cane may cause indirect / induced land-use, and how large the actual impacts will be on land use, biodiversity etc. Second, it is also uncertain whether and how the Dutch sustainability criteria will deal with these indirect impacts, as these criteria are not yet clearly defined.

It is important to recognize that sustainability criteria lead to higher production costs - depending on the strictness of the sustainability criteria, we estimate additional ethanol costs of up to 56%, though in case mechanical green harvesting is applied, additional ethanol costs are estimated at 24%.While the latter may not necessarily be prohibitive given current oil prices, it is clear that some financial support is most likely needed to stimulate sustainable ethanol production.

Regarding the future developments, first of all, Brazil is currently intensifying its agriculture and meat production. Further raising the productivity of agriculture and meat production is a key factor of keeping a neutral land balance, thus enabling compliance with criteria on biodiversity, food and fodder availability etc. Second, a promising example is the organic sugar cane production (as demonstrated and in the São Francisco sugar mill), where substantial ecological and social improvements compared to conventional sugar cane production have been achieved over a period of twenty years, including development of native forest area, and a yield increase of over 20% compared to conventional cane production. This could be a case study for the development of additional sustainability criteria. However, it should also be clear that switching on a large scale to organic farming cannot be achieved within a short period of time.

Recommendations for further research include amongst others additional local data collection (e.g. on occurrence of child labour), development of new methodologies, e.g. on carbon soil, biodiversity, food security and land use dynamics, and exploring the possibilities and requirements of a certification system for sustainable ethanol.

Table I. Summary of Dutch sustainability criteria and expected compliancein São Paulo and Brazil

Criterion and level	Indicators for 2007 & 2011	Compliance with NL criteria in São Paulo now	Compliance with NL criteria, whole of Brazil, future
1. GHG balance , net emission reduction by >=30% in 2007 and >= 50% in 2011	Use of developed methodology Use of reference values for specific steps in logistic chain	Full, both 30% and 50%	Probable
2. Competition with food & energy supply, and others		Unknown	Uncertain
3. Biodiversity, No decline of protected areas or valuable ecosystems in 2007, also active protection of local eco-systems in 2011	No new plantations near protected areas or high conservation value areas, reference year for ethanol is 2006, max. 5% conversion of forest to plantations within 5 years, 2011:Additional obligatory management plan for active protection of local ecosystems	Probably most plantations in São Paulo	Very uncertain
4. Wealth, no negative effects on regional and national economy in 2007, and active contribution to increase of local wealth in 2011	Based on Economic Performance indicators of the global reporting initiative	To a large extent	Uncertain
5. Welfare:			
5.a Labor conditions	Compliance with ILO standards, social Accountability 8000 and other treaties	partially in cane harvesting	Same as 2007, situation in rest of Brazil probably worse than in São Paulo
5.b Human rights	Compliance with universal declaration of HR	Not fully, child labor observed incidentally	Same as 2007, situation in rest of Brazil probably worse than in São Paulo
5.c Property and use rights	Three criteria from existing systems (RSPO 2.3, FSC 2, FSC 3)	Unknown	Same as 2007, situation in rest of Brazil probably worse than in São Paulo
5.d Social conditions of local population		Unknown	Unknown
5.e Integrity	Compliance with Business principles of countering bribery	Not investigated	Not investigated
6. Environment:			
6.a Waste management	Compliance with local & national laws GAP	Unclear how many plants have GAP compliance	Depending on GAP compliance
6.b use of agro-chemicals (incl. Fertilizers)	Compliance with local & national laws, from 2011 also with EU legislation	For 2007 yes, for 2011 uncertain	Partially, very likely organic production methods do comply
6.c prevention of soil erosion and nutrient depletion	Erosion management plan, avoid plantations on marginal or vulnerable soils, or with high declivity, monitoring soil quality, nutrient balance	Unclear, but probably possible	Strongly depends on development of NL criteria
6.d Preservation of surface & ground water	Special attention for water use and treatment	Probable, depending on local situation	Unclear, but probably possible
6.e Airborne emissions	2007: Comply with national laws, 2011: Comply with EU laws	For 2007 yes, for 2011 to large extent likely not	Compliance with strict EU criteria possibly on medium term?
6.f Use of GMOs	2007: Compliance with USA (safety) rules, 2011: Compliance with European (safety) rules	Yes	Possible

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Chapter 1 Introduction

1.1 Background and rationale

Over the last decades, the Netherlands have increasingly imported significant quantities of biomass for energy production. Important examples are wood pellets from Canada, residues from palm oil production from Malaysia as well as palm oil itself, which are used for co-firing in existing coal-fired and gas-fired power plants for renewable electricity production (Junginger and Faaij, 2005).

Given the limited national biomass resources available and the ambitious targets on the longer term for biomass use for production of both renewable energy & materials (PGG, 2005), a further strong increase of biomass imports is foreseen. In addition, international biomass and bio-energy markets are developing rapidly and pressure on available biomass resources is increasing. Bio-ethanol production and its' international trade is in particular growing rapidly. In the EU, several countries (most notably Sweden) are already importing ethanol from Brazil, especially to build up the national market and infrastructure. The Netherlands, where to date almost no biofuels are used, may decide to allow for bio-ethanol imports already on the short term to meet the targets set by the EU Biofuel directive (5.75% biofuel use in 2010). Bio-ethanol from Brazil is an attractive biofuels because of its low price and relatively large greenhouse gas emissions reduction potential.

Imported biomass however cannot simply be considered a sustainable energy source. The production and removal of biomass in other places in the world results in ecological impacts, land-use, socio-economic impacts and GHG emissions (e.g. for transport and vs. alternative use on-site). The debate in 2005 in the Netherlands about palm oil imports for green electricity production illustrates that there is an urgent need for procedures that maps the impacts of biomass production, import and use and evaluates whether such schemes are sustainable or not. Various efforts (e.g. from Essent, IEA Bioenergy Task 40, FairBiotrade research project carried out by Copernicus UU) have been undertaken as steps towards certification and track-and-trace systems for imported biomass. However, a sound certification procedure that takes into account the wide array of impacts linked to active biomass production in other regions in the world, does not exist to date (see e.g. Lewandowski et al., 2005).

1.2 Objectives and scope

The Dutch society recognizes the need for sustainable production and use of biomass. This has been expressed by environmental groups and the Parliament. The Dutch government decided to seek solutions by developing sustainability criteria and certification of biomass by a commission sustainable production of biomass (duurzame productie van biomassa, DPB).Between January 2006 and July 2006 these criteria have been developed.

Parallel to these developments, in February 2006 this project was commissioned by SenterNovem on behalf of the Dutch Ministry for Housing, Spatial Planning and the Environment. As Brazil is one of the most likely countries to export bio-ethanol from sugar cane to the Netherlands, the sustainability of Brazilian bio-ethanol is the main topic of this report. One of the aims of this project is to support the working group by providing scientific input on the constraints and possibilities for sustainable production and import of ethanol in the Netherlands, which can be used to support further policy development in this for the energy transition crucial arena.

In principal, it is deemed desirable to develop a method and procedure for assessing the impacts, certification and verification of biofuel production and import. However, this would have exceeded the scope and resources (both in time and financially) of this project. The work presented in this report should be considered as the ***first phase*** of such a project. The main objectives and scope of the study are:

1. Determination of Dutch sustainability demands for bio-ethanol, including stakeholder consultation in the Netherlands (NGO's, industry)[1]

An inventory will be made on Dutch viewpoints on sustainability criteria, mainly from Dutch industry stakeholders (Nedalco, Shell, Cefetra) and NGOs (Both Ends, Stichting Natuur en Milieu), and other stakeholders.

2. Assessment of the current ecological, economic and social impacts of ethanol production based on sugar cane in Brazil.

A comparison will be made of Brazilian social, economic and ecological boundary conditions, legislature and guidelines with Dutch standards. It will be investigated on which aspects Brazilian agricultural practices are already in agreement with Dutch sustainability criteria, and on which aspects improvements are potentially necessary. Also, it will be attempted to judge in how far the identified relevant criteria are verifiable in practice. However, it is emphasized, that as the first phase does not involve any direct fact-finding of stakeholders in Brazil, the possibilities to do so will be limited. The study focuses on the impacts of current sugar cane based ethanol production in Brazil, as little sustainability issues are expected for the long-distance transport of ethanol. The study focuses especially on the situation in the São Paulo state area, as the vast majority of ethanol is produced here, but also to some extent on the south-west and central areas, which are the most likely areas for further ethanol production. This work involved mainly literature study (e.g. Coelho et al. 2005, Macedo et al, 2005), aimed at the assessment of existing practices in sugar cane agricultural sector and processing industry and local data collection by the Brazilian project partners. The study mainly focuses on the current situation in Brazil, but also covers expected future land-use changes directly or indirectly caused by sugar cane.

3. Comparison of Dutch sustainability criteria and the current Brazilian practice, and quantification of the consequences for ethanol production in terms of production method and production costs if these sustainability criteria are applied, using the (adapted) method developed by Smeets et al. (2005).

Previously, two case studies have been carried out in which the constraints resulting from meeting certain key criteria are analyzed (see Smeets et al. 2005). Criteria included were on e.g. deforestation, biodiversity, soil erosion, nutrient leaching, child labor, wages, health care etc. Meeting these criteria may require additional investments in crop management (higher ethanol production costs), and these criteria may also limit the availability of bioethanol for export. Based on a similar methodology, the costs required to compensate for the possible discrepancies between Dutch sustainability demands and current Brazilian practices are estimated.

It is emphasized that the work in this report is to a large extent a desk-top study. While desirable to investigate, the following points were not included within the scope of this study:

- A Brazilian stakeholder consultation on the desired boundary conditions and criteria for sustainable ethanol, in relation to current national and state legislation, standards and practices, and to determine in how far criteria are measurable and verifiable. To this end, data should be collected from a number of local Brazilian stakeholders, such as Brazilian Agricultural Research Corporation EMBRAPA, the São Paulo Sugar Cane Agroindustry Union UNICA and Key NGO's, e.g. WWF Brazil and the Sustainable Agriculture Network (SAN), in cooperation with the Brazilian project partners
- An organizational model how impacts can be monitored via a workable track-and-trace system, directly applicable for intended imports of Brazilian bio-ethanol to the Netherlands
- Validation of the impacts determined in the first phase and compare them with the criteria and boundaries identified by Brazilian stakeholders.

[1] The original project proposal covered a wider range of stakeholders. However, due to the parallel work of the working group "duurzaamheid import Biomassa" and this project, it was decided to limit the consultation to a small number of key experts, and additionally use the results from a questionnaire sent to a large number of stakholders by the working group.

- Monetarization of the different impacts (both potentially positive and negative), making use of existing methodological frameworks (see the FairBioTrade project) and evaluate how different profiles of ethanol production can be translated into different support levels for green transport fuels.
- Formulation of general conclusions and a strategy how the experience of this project can developed further into a more generic certification, labeling and support scheme for imported biomass and bio-energy.

1.3 Structure of the report

The report organizes as follows: chapter 2 provides an overview of current developments in the Netherlands regarding sustainability criteria in the Netherlands, including the recent work of the commission DPB, general viewpoints of a broad range of Dutch stakeholders towards sustainability criteria, and specific views on sustainability of key stakeholders. Next, in Chapter 3 the current sustainability of the sugar cane and ethanol production process is investigated, including current and potential future impacts, available legislation and implications for certification. In chapter 4, the additional costs coupled to meeting various sustainability criteria are estimated. Consequently, in chapter 5, the Brazilian situation is compared to the Dutch sustainability demands, while in chapter six deals with general discussion, conclusions and recommendations for further research.

Chapter 2 Developments on sustainability criteria for biomass in the Netherlands

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2.1 General developments of biomass sustainability criteria

With the increasing trade in biomass resources, concerns have been growing whether all imported biomass streams can be considered sustainable. The production and removal of biomass in other places in the world results in ecological impacts, land-use, socio-economic impacts and GHG emissions (e.g. for transport and vs. alternative use on-site). These aspects have been recognized in the Netherlands from 2001 onwards by policy makers, scientists and the industry, and various preliminary efforts have been undertaken as steps towards certification and track-and-trace systems for imported biomass. Examples are the development of the Green-Gold-Label, a biomass track-and-trace system developed by Essent (GGL, 2006), the FairBiotrade research project carried out by Copernicus UU (see e.g. Lewandowski et al, 2005, Damen and Faaij, 2004 and Smeets and Faaij, 2006), the start of an IEA Bioenergy Task on International Sustainable Bioenergy Trade (see www.bioenergtrade.org), and various other studies on sustainability and certification of biomass (Hamelinck, 2004; Bergsma and Harmelynck, 2005).

The need for biomass sustainability criteria has also been recognized in other countries and by different international bodies. Current examples are:

- Ongoing development of GHG and sustainability criteria for biomass transportation fuels under the renewable transport fuel obligation (RTFO) in the UK (Archer, 2006).
- Existing regulations energy/CO_2 balances and sustainability criteria for Belgian biomass for co-firing (Ryckmans, 2006)
- The EU strategy for biofuels (EC, 2006), in which standards to ensure the sustainability of biofuel feedstocks are explicitly mentioned

In the autumn of 2005, awareness regarding the necessity of biomass sustainability criteria increased when environmental NGOs condemned the use of palm oil for green electricity production in natural gas-fired power plants. While the short-term policy reaction was to reduce feed-in tariffs for (a.o.) palm oil strongly, the urgent need for biomass sustainability criteria was felt by the Dutch parliament. Thus, the commission sustainable production of biomass (duurzame productie van biomassa, DPB) was installed in January 2006 to develop a system for biomass sustainability criteria for the Netherlands. The commission finished its work in July 2006, and in section 2.2 a summary of the results is given.

2.2 Current development of general sustainability criteria

(Selected) starting points of the commission were (Cramer et al., 2006)[2]:

- Development of a long-term vision about biomass sustainability (2020-2040)
- Based on this vision, development of concrete, measure biomass sustainability criteria on the short term
- Development of a universal framework of sustainability criteria, with the emphasis on non-food applications (chemical industry, fuels, energy production). The sustainability criteria and indicators developed could also be of importance to judge food production on sustainability aspects. It is acknowledged that biomass, feed, fuel and fodder can barely be regarded separately.
- Compliance with international treaties, EU regulations, WTO rules etc.
- Development of minimum sustainability demands for the short term, and stricter criteria on the longer term
- Sustainability criteria are valid for both biomass energy crops and biomass crops, and both applicable for imported biomass and domestic biomass

[2] This list is neither exhaustive nor final.

Based on these starting points, consultations with Dutch stakeholders and scientific support, the commission developed a number of biomass sustainability criteria and indicators/procedures for the short-term (2007) and the medium term (2011), see Table 1. This set of criteria and indicators was taken as Dutch reference for assessing the sustainability of bio-ethanol from Brazil.

Table 2.1 Summary of sustainability criteria, indicators/procedures and suggested levels for 2007 and 2011 (Cramer, 2006).

Criterion and level	Indicator/procedure 2007	2011
1. GHG balance , net emission reduction by >=30% in 2007 and >= 50% in 2011	Use of developed methodology Use of reference values for specific steps in logistic chain	As 2007
2. Competition with food supply, local energy supply, medicines and building materials Supply is not allowed to decrease	Footnote a	Footnote b
3. Biodiversity, No decline of protected areas or valuable ecosystems in 2007, also active protection of local eco-systems in 2011	No plantations near gazetted protected areas or high conservation value areas; max. 5% conversion of forest to plantations within 5 years, Footnote a	As 2007 Additional obligatory management plan for active protection of local ecosystems Footnote b
4. Wealth, no negative effects on regional and national economy in 2007, and active contribution to increase of local wealth in 2011	Footnote a, based on Economic Performance indicators of the global reporting initiative	Footnote b
5. Welfare, including		
5.a Labor conditions	Compliance with Social Accountability 8000 and other treaties	As 2007
5.b Human rights	Compliance with universal declaration of HR	As 2007
5.c Property and use rights	Three criteria from existing systems (RSPO 2.3, FSC 2, FSC 3)	As 2007
5.d Social conditions of local population	Footnote a	Footnote b
5.e Integrity	Compliance with Business principles of countering bribery	As 2007
6. Environment, including		
6.a Waste management	Compliance with local & national laws; Good Agricultural Practice (GAP)	As 2007
6.b Use of agro-chemicals (incl. Fertilizers)	Compliance with local & national laws	As 2007 & EU legislation
6.c Prevention of soil erosion and nutrient depletion	Erosion management plan Avoid plantations on marginal or vulnerable soils, or with high declivity Monitoring soil quality Nutrient balance	Footnote b
6.d Preservation of quality and quantity of surface water and ground water	Footnote a, special attention for water use and treatment	Footnote b
6.e Airborne emissions	Comply with national laws	Comply with EU laws
6.f Use of genetically modified organisms (GMOs)	Compliance with USA (safety) rules	Compliance with European (safety) rules

a For this criterion a reporting obligation applies. A protocol for reporting will be developed.
b New performance indicators will be developed for this criterion between 2007-2010.

2.3 General view of Dutch stakeholders on sustainability criteria for biomass

Within the frame of the work of the commission DPB, a questionnaire was sent to about 250 Dutch stakeholders. About 40% of the stakeholders replied to the questionnaire. Below, we present a brief summary of the main results. A comprehensive overview of the results is available in Dutch (CE, 2006).

- Almost all respondents (90%) are of the opinion that sustainability criteria are necessary for all applications for biomass. This could also have implications for the use as food, fodder, and other products.
- Whether or not sustainability criteria should differentiated between geographic regions is disputed (about 50% in favor, 50% against).
- The majority of the respondents is of the opinion that sustainability criteria should be applied, independent of financial support for biomass. About 72% of the respondents thinks that (the height of) a subsidy for biomass should be dependent on the sustainability of the biomass, especially GHG emission reduction performance
- The six categories presented in table 1 are widely supported within the different stakeholder groups of the respondents, between 88-100%.
- The stakeholders were asked to distribute 100 points over the various criteria to indicate their relative importance. The most important three types of categories were GHG reduction (20%), nature and bio-diversity (13%) and food supply (11%).
- NGOs submitted six additional criteria, mainly on indirect nature deterioration, human rights & self-determination and corruption prevention, which have been included in table 1.
- GMOs are strongly disputed – 75% of the NGOs want to include a criterion on GM's, which is supported by only 10% of industrial stakeholders.

2.4 Viewpoints of Dutch stakeholders specifically on sustainability of bio-ethanol from Brazil

In addition to the general framework on sustainability criteria for biomass, a number of Dutch stakeholders were interviewed to assess their viewpoints specifically regarding the sustainability of bio-ethanol. The stakeholders interviewed were:

- Martin Weissmann (MW), business development manager biofuels, Nedalco (Dutch ethanol producer).
- Ewald Breunesse (EB), manager Energy transitions, Shell the Netherlands (Dutch-British Oil Company).
- Hugo Stam (HS), CEO Cefetra (trading company in agricultural commodities)
- Johan Maris (JM), Control Union (specialized in independent cargo surveying and certification)
- Hans Jager (HJ), Stichting Natuur en Milieu (Dutch environmental NGO)
- Nicole Walshe (NW), Both Ends (Dutch development aid NGO)

In the following sections, a summary and comparison of their viewpoints is given. The general interview questions and the interviews can be found in Appendices A-G.

2.3.1. General agreement

All stakeholders agree that in general:

- Sustainability criteria for bio-ethanol (and biomass in general) are principally necessary
- Identical criteria have to apply to both imported ethanol and domestically produced ethanol
- Identical criteria have to be applied for all end-uses (i.e. energy, food, chemical feedstock, etc.)
- Sustainability should be introduce in phases, a minimal level & practicable feasible now, additional criteria & stricter levels later, but clear timetables should be established

Regarding specific sustainability criteria, all stakeholders agree that:

- Use of ethanol from sugarcane should not lead to net GHG emissions
- Minimal working conditions should be in accordance with ILO standards
- Food security is an important issue, but in practice it is expected that this is hard to link directly to ethanol production
- General criteria for biomass are useful in the form of meta-standards, but for specific biomass streams such as bio-ethanol, additional specifications may be required

2.3.2 Differing views

On many sustainability criteria, differing views were expressed, often by NGOs on the one hand and industrial parties on the other:

- All stakeholders agree that ethanol from sugarcane should not lead to net *GHG emissions*. However, differing views exist on how much emission reduction and/or energy balances must be achieved by biofuels in order to be considered sustainable. EB, MW and JM are favoring relatively modest emission reduction levels. MW and EB emphasizes that the reference systems play a big role in this. MW also warns about the dangers of solely focusing on GHG emission reductions, which in his view will lead to combustion of residues instead of using them as feedstock for biofuels, which has a much higher value. Also, this may hamper the development of more efficient 2nd generation technologies. EB advises to set emission reduction levels in a manner that all current feed stocks can be used to produce ethanol, and that levels should be raised later. On the other hand, HJ and NW both emphasize that in their view, substantial emission reduction have to be achieved, though they do not provide a concrete level. HJ also adds that conversion of pastures and forests to agricultural land may release soil carbon, which can have a strong impact on the GHG balance of ethanol.

- Regarding *nature conversation*, both NGO's and industrial parties agreed that valuable nature areas have to be protected; however, the definition of 'valuable' is disputed. On the one hand, HS agrees with the definition of tropical rainforest in the Amazon region, and does not agree with the definition of Greenpeace of the "Amazon basin". The Greenpeace definition encompasses large amounts of land, which are well-suited for agriculture. HS emphasizes that Brazil is a very diverse country, and that regional definitions of valuable nature areas are required. On the other hand, NW emphasizes that in Brazil, large amounts of land are fallow because of agricultural mismanagement in the past. In her view these fallow areas must be used first before any new areas are converted to agriculture. Another main issue is the use of cerrados (savannahs), which is in the interest of the sugar cane industry, but disputed by Brazilian NGOs. EB states that deterioration of neither direct nor indirect deterioration of valuable nature areas is acceptable.

- Opinions vary strongly about the use of *genetically modified organisms* (GMO's), from fully acceptable in a closed environment and potentially acceptable in the field (HS, EW) to not acceptable at all (NW).

- *Employment* is seen as an important factor which should be taken into account when analyzing the sustainability of sugarcane and ethanol production. HS estimates that increased sugar cane and ethanol production will lead to a conversion of pastures to sugar cane, and thus from an labor-extensive to labor-intensive agriculture. This will result in an increase in the number of jobs, also because of the additional jobs involved in sugar and ethanol production. On the other hand HJ states that ethanol in Brazil is increasingly produced on large-scales, thus including increasing mechanization, which leads to a lower number of jobs per hectare. In addition, HJ and NW state that *income/wealth distribution* is rather unequal in Brazil. Sustainable ethanol production could contribute to decrease these differences.

- Regarding *labor standards*, ILO standards are widely accepted as minimum levels. However, MW suggests that such levels could be country specific. For example, least developed countries (LDC) have not the means to include/enforce strict labor standards. Imposing stricter norms on LDCs would effectively result in trade barriers, thereby hampering the development of these countries. However, in the case of Brazil, with an advanced industrialized ethanol industry, stricter labor standards similar could be applied.

- *Food security* is an issue mentioned especially by HJ and NW. The negative effects of soy expansion in Argentina should not be repeated in Brazil. HJ expects a dramatic increase in demand for ethanol, and which may directly and indirectly influence prices and availability of food. While on the longer term, increasing agricultural productivity may be a solution, on the short term, a rapid expansion of sugar cane area may have negative social and environmental effects.

Also on the way how sustainability criteria (specifically for ethanol from Brazil and in general) should be implemented, varying viewpoints were voiced:

- Most stakeholders emphasize the need for *a limited amount of criteria* to enable swift implementation. A system of majors (criteria that have to be fulfilled) and minors (criteria, of which e.g. only 50% have to be fulfilled, the percentage can be raised over time) is generally seen as a good way to do this. Both ends however does not support a system of majors and minors, as in their view all criteria are important have to be fulfilled.

- A *certification system* which includes procedures to monitor compliance with some or all sustainability criteria is considered feasible by all stakeholders interviewed. A comparison with the FSC system is frequently made, though NW emphasizes, that the lessons learned from FSC should be incorporated. Monitoring should not be limited to certifiers, but to strongly involve the local population/stakeholders in monitoring, as well as in identification of criteria. JM emphasizes that criteria for food security and general welfare will be impossible to include in a certification system dealing with individual producers; such criteria can only be measured on a national or regional level.

- All stakeholders find it hard to estimate the *cost of implementing the sustainability criteria*. NW emphasizes that in the end this is an internalization of external costs, while HS mentions example in the food sector were additional quality criteria have led to lower production costs in the end.

- Regarding the *cost of certification* (i.e. the costs of monitoring the compliance with sustainability criteria), according to JM, these depend on two major factors. The first is the amount of sustainability criteria, and the level of detail. For example, general biodiversity can be measured during field visits by a single expert. However, if e.g. specific demands for the number of birds are formulated, this may require an additional specialist, which will increase costs. The second factor is the scale of the plantations. It is very expensive to certify small-scale producers, while producers with production areas above 10,000 ha generally face acceptable production costs.

2.3.3 Other recommendations and remarks

Apart from the common and differing view points on possible sustainability criteria, a number of stakeholders had additional points, which are summarized below

- MW would like to see a preferred use of residues above dedicated crops and stimulation of 2nd generation technology, and should have a higher priority than current CO_2 balances. In such a view, dedicated ethanol from sugar cane production (i.e. not only from molasses but from the entire sugar juice) would be less sustainable than production form residues.
- EB recommends to pay more attention to benefits of local use of biomass, instead of directly importing biomass
- NW warns that especially the *rapid* expansion of monocultures such as soy beans has caused strong ecological and social problems (see appendix G for further details). This could imply to couple a maximum growth rate of ethanol production per year to sustainability criteria.
- JM emphasizes the need to include local stakeholders when formulating sustainability criteria for bio-ethanol. He makes a comparison with the RSPO, where the large majority of stakeholders were from importing countries. According to JM, this has led to the formulation of criteria for producers which are difficult to realize in practice.

Chapter 3 Current status of ethanol production in Brazil

3.1. Methodology

The goal of this study is, a.o.:

- To analyze the environmental, economical and social impacts of ethanol production from sugar cane in Brazil and to identify the key areas of concern.

- To analyze to which extend Brazilian social, economic and ecological boundary conditions, legislature and guidelines comply with Dutch and/or international standards.

- To quantify the impact of compliance with Dutch and/or international standards on the potential (quantity) and the costs (per unit) of ethanol from cane in Brazil.

First, the key areas of concern have been identified based on a literature review on sugar cane and ethanol production and based on a list of 127 sustainability issues that are relevant for the production and trade of bioenergy that have been identified by Lewandowski and Faaij (2004). In total 16 key areas of concern are discriminated:

- Water use
- Water pollution
- Land use, forest protection and biodiversity
- Soil erosion
- Fertilizer use
- Genetically modified organisms
- Sugar cane burning
- Greenhouse gas emission and energy balance
- Competition with food production
- Number of jobs
- Income distribution and land tenure
- Wages
- Working conditions
- Worker rights
- Child labor
- Social responsibility and benefits

Each area of concern includes several issues, because of the overlap between the scopes of the various issues. E.g. the issue of poverty reduction overlaps with the issue of wages and overlaps with the issue of access to health care services. Several criteria are excluded because these could not be operationalised into quantitative measures. For example, the criterion ‘Woman should not be discriminated and their rights have to be respected’ is, although very relevant, excluded for the analysis, because this criterion could not be translated into activities that have an impact on the management system (costs), or the availability of land (quantity) for sugar cane production and ethanol production. Note that this does not mean that these criteria are not important or that these criteria could not be a bottleneck for sustainable ethanol production and trade. Each area of concern is analyzed in a separate subsection in Section 3. In addition, the overall benefits of the Brazilian ethanol program (the Proálcool program) have been discussed (Section 3.3.9). That section is not so much of direct importance for the further development of a certification system for ethanol, but is included to indicate the social costs and benefits as evaluated and perceived by the Brazilian government/society. The approach applied for each section is based on the method developed by Smeets et al. (2005) and is depicted in Figure 3.1.

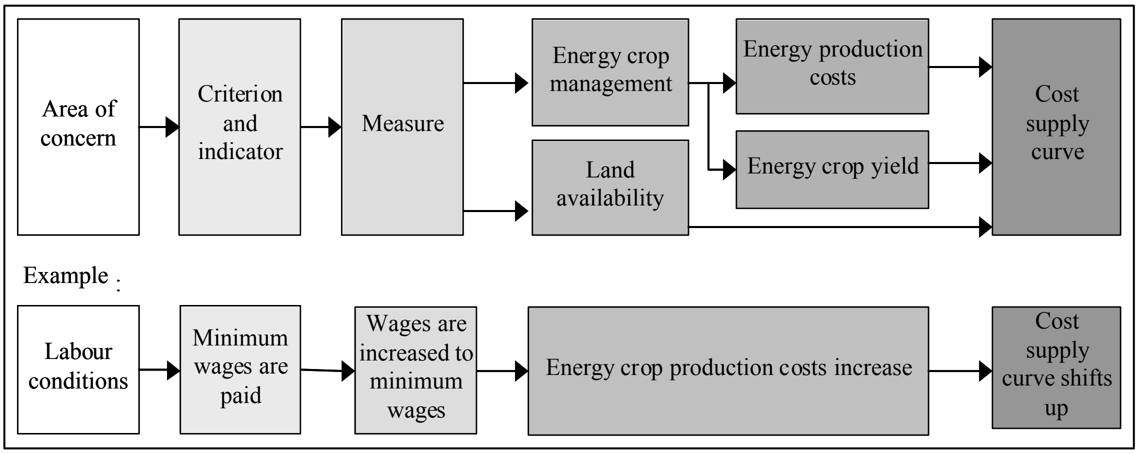

Figure 3.1. The procedure followed to analyze the impact of sustainability criteria on the cost supply curve of energy crop production (top) and an example for labor conditions (bottom). Source: (Smeets et al, 2006).

The approach shown in Figure 3.1 can be divided into six steps, see table 3.1.

Table 3.1. The six steps that have been undertaken to evaluate to what extend an area of concern is a bottleneck for certification.

1.	**Impact assessment**	Assessment of historic and/or present situation, including values for key indicators.
2.	**Brazilian legislation and standards**	Overview of the Brazilian legislation and standards whereby specific attention is given to law enforcement.
3.	**Dutch and/or international sustainability criteria, legislation and standards**	Overview of Dutch and/or international sustainability criteria, legislation and standards.
4.	**Implications for certification**	Analyses to what extend additional measures are required to meet Dutch and/or international sustainability criteria, legislation and standards (based on information from step 1, 2 and 3). In addition, potentially useful criteria and indicators and issues that require specific attention are briefly discussed. This section also includes an overview of measures and strategies that can be used to meet certain standards or legislation, e.g., changes in management or industrial processes.
5.	**Costs**	Assessment of the costs of meeting Dutch and/or international sustainability criteria, legislation and standards.
6.	**Conclusions**	Conclusion about to what extend a criterion is a bottleneck for ethanol production, taking into account the severity of the problem (step 1), the implications for certification (step 5, which is based on step 1 to 3) and the costs (step 6).

In step 1, the historic and present situation for each area of concern have been analyzed in detail based on a literature review and consultation with Brazilian partners. Second, specific attention is paid to Brazilian social, economic and ecological boundary conditions, legislature and guidelines. Third, an overview is given of the Dutch sustainability criteria as formulated by the commission Sustainable Production of Biomass ("Duurzame productie van biomassa" in Dutch, abbreviated as DPB or DPB commission in the remainder of this study) as well as various (inter)national sustainability criteria, legislation and standards. Fourth, the implications for certification are analyzed, meaning that the difference between the present situation and the desired situation based on Dutch and/or international targets is analyzed. Areas that require specific attention in a certification system are identified as well as criteria and indicators that can be useful when developing an ethanol certification system. This includes a summary of measures that can be used to reduce or avoid the problem under consideration. These measures may have an impact on the costs (per unit; as a result of changes in management of sugar cane or ethanol production) of ethanol from cane in Brazil, which is analyzed in step 5. Finally, in step 6 conclusions are presented about to what extend a criterion is a bottleneck for ethanol production, based on the results in the previous steps, with specific attention for uncertainties in the data. In all steps specific attention is given to what extend additional information and further research is required. For several criteria it was not possible to formulate clear conclusions because of a lack of data.

We would like to emphasize that this work is to a large extent a desktop study. While desirable to investigate, the following points were not included within the scope of this study:

- A Brazilian stakeholder consultation on the desired boundary conditions and criteria for sustainable ethanol, in relation to current national and state legislation, standards and practices, and to determine in how far criteria are measurable and verifiable. To this end, data should be collected from a number of local Brazilian stakeholders, such as Brazilian Agricultural Research Corporation EMBRAPA, the São Paulo Sugar Cane Agroindustry Union UNICA and Key NGO's, e.g. WWF Brazil and the Sustainable Agriculture Network (SAN), in cooperation with the Brazilian project partners
- An organizational model how impacts can be monitored via a workable track-and-trace system, directly applicable for intended imports of Brazilian bio-ethanol to the Netherlands
- Formulation of general conclusions and a strategy how the experience of this project can developed further into a more generic certification, labeling and support scheme for imported biomass and bio-energy.

We would also like to make a general point about the adequacy of environmental laws for the prevention of environmental degradation, both for the specific Brazilian situation and in general. It can be stated in general that even in developed countries with (very) strict environmental legislation, the quality of the environment is often still declining. Compliance with legislation is no guarantee that overall environmental degradation is fully avoided, as it may focus only on specific aspects of the environment. In Brazil (and specifically São Paulo), a large number of different environmental laws exist, many of them specifically designed for the sugar cane industry (both the agricultural and the industrial sector). These legislations are specifically based on and designed for the Brazilian situation, and thus also take into account what is economically and practically feasible at the short term. Furthermore, the law enforcement generally is weaker than in developed countries. So, despite many environmental laws, still (minor) general environmental degradation may occur. If the standards defined in these laws are met, the situation complies with many of the (minimum) criteria defined by the DPB commission for 2007. Whether these laws will be strong enough to meet the advanced criteria set by the DPB commission for 2011 (which amongst other require an active prevention of erosion and improvement of the quality of surface and ground water) is unclear, but also impossible to check, as more specific indicators still need to be developed.

3.2. General description of sugar cane and ethanol production processes in Brazil[3]

3.2.1 Geography

In 2005, Brazil was the world's largest cane, sugar and ethanol producer. Five million hectares of cane produced 26 million tonnes of sugar and nearly 16 million m3/year of ethanol, equal to an energy equivalent of 1.5 million barrels of oil per day (Oliverio, 2005). Nowadays, the Center-South region produces approximately 85% of the Brazilian cane. Within the region, the state of São Paulo is the leader, producing 60% of the national cane, and 60% of the nations sugar and ethanol (see figure 3.1). Because of the fertile soils, easy rolling landscapes, favorable climate and relatively good infrastructure, the region has long-lasting experiences in the sector. The nation counts approximately 400 cane processing industrial plants of which approximately 225 are located in the state of SP. Most and biggest units are found in the north west part of SP, around the city of Piracicaba, making this one of the world's densest sugar cane area of the world.

3.2.2 Technology

Brazilian sugar and bio-ethanol production process, is based on the same feedstock: sugarcane. Sugarcane contains high amounts of sucrose or reducible sugars which are expressed in the amount of total reducible sugars (TRS) per tonne cane (TC) [kg TRS/TC]. Sucrose is the most important feedstock in the hart of the industrial process; fermentation. The production process thus has two complete different aspects, sugar production by cultivating cane and industrial ethanol processing. Both processes will be described separately in the next section, to begin with the production of cane. The sections are mainly based on (Macedo & Cortez, 1999, Damen, 2000 and Braunbeck et al., 1999).

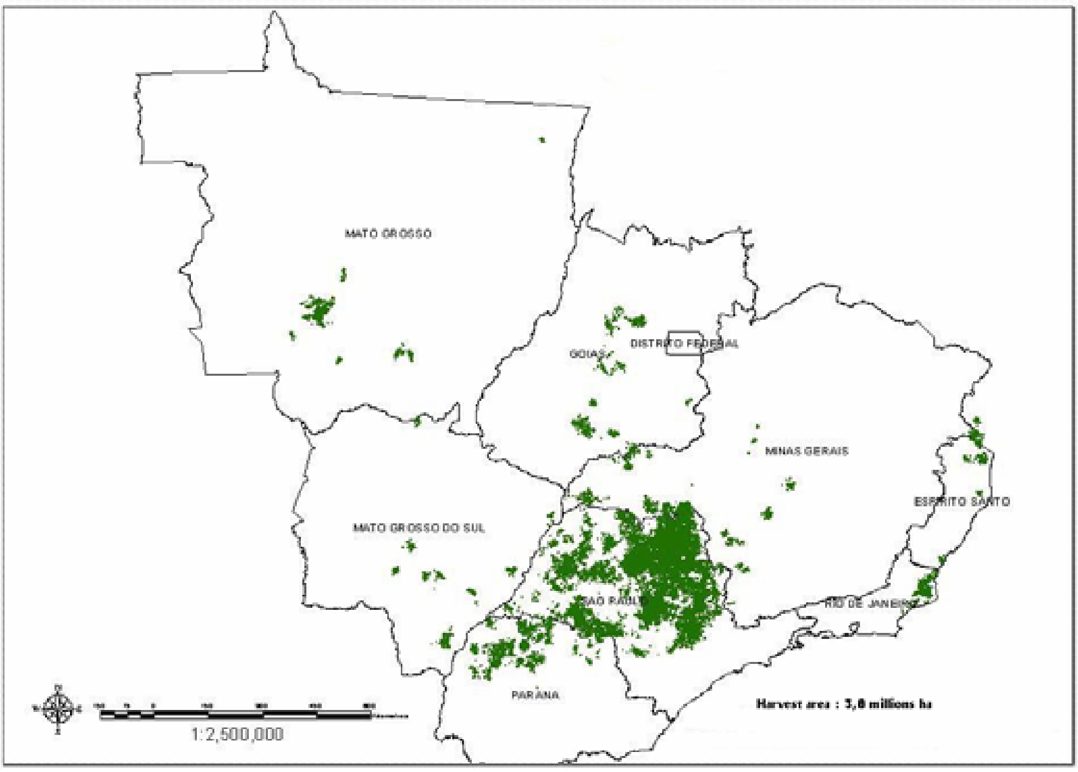

Figure 3.2 – Distribution of sugarcane cultivation in the Center-South region of Brazil (Moreira, 2005).

[3] This section was taken from van den Wall Bake (2006).

3.2.3 Agricultural process

Sugarcane cultivation in Brazil is based on a ratoon-system, which means that after the first cut the same plant is cut several times on a yearly basis. Harvesting season in the state of São Paulo is from May until November. Before planting in the first year, the soil is intensively prepared by, nowadays most mechanical, operations such as sub soiling, harrowing and application of mineral fertilizers. After this the soil is furrowed and phosphate-rich fertilizers are applied, seeds are distributed and the furrows are closed and fertilizers and herbicides are applied once again. The plant is furrowed and treated with artificial fertilizers or ´filter cake´[4] once or twice again during cultivation in the first year. After 12-18 months the cane is ready for the first cut. For this it is (still) common to burn down the cane in order to simplify manual harvesting[5]. Mechanical harvesting is applied by approximately 25% (CTC, 2004) of the cane in SP. Green cane harvesting is possible but the celluloid leaves have no purpose in the industry yet, so leaves are left on the field as organic fertilizer. After cutting and sometimes chopping cane stalks by a chopped cane harvester, the cane stalks are loaded in trucks and transported by trucks to the industrial plant. Burning and delays before processing such as loading and transport lead to significant losses of the amount of sucrose per tonne. Losses of 6-10 kg TRS within the first 72 hours is normal, which stresses the importance of quick harvesting, loading and transportation (CTC, 1988).
Then the process starts all over again excluding intensive soil treatments and planting. Depending on the rate of the declining yields[6], the same stock can be used. Yields decline with approximately 15 percent after the first harvest and 6-8 percent in the years that follow. Declining yields depend on treatment of the stock during maintenance and harvesting but are mainly determined by the combination of applied variety and type of soil (Braunbeck, 2005). During preparation for the next season, the soil is treated less intensively but fertilizers and herbicides are heavily used. A simplified overview of the production process of sugarcane is shown in Figure 3.3. Processes between brackets are only necessary at the beginning of the ratoon-system.

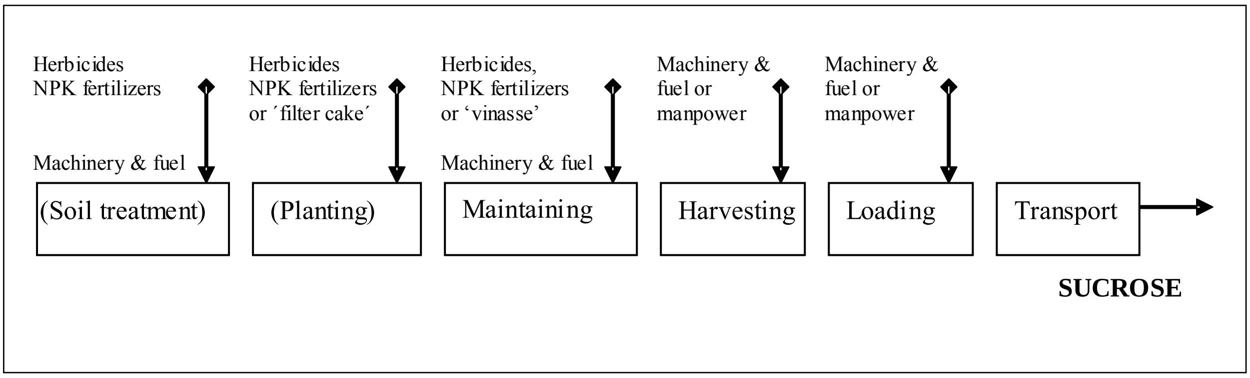

Figure 3.3 – Simplified overview of sugarcane production.

3.2.4 Industrial process of ethanol production

The simplified combined production process of sugar and ethanol from sugarcane is presented in Figure 3.4. The figure shows two kinds of ethanol, namely hydrated ethanol and anhydrous ethanol. Both are produced in large quantities, hydrated ethanol is used as a fuel for special adapted ethanol engines and anhydrous ethanol can be used to produce gasohol (mixtures of gasoline and ethanol).

[4] Filter cake is a rest product of sugar and ethanol production, it contains large amounts of nutrients, which are filtered out of the juice in the sedimentation process.
[5] The field is set on fire to burn the green residues such as leaves and kill dangerous animals in the field. After burning the leaves, harvest of the sugar-containing cane stalks takes place by relatively easy manual cutting. In case of mechanical harvesting, the cane is not burnt.
[6] The common unit for yield in the industry is [TC/ha/year], which is around 80-90 TC/ha/year in São Paulo. A more accurate unit for agricultural yields is tones of reducable sugar [TRS/ha/year].

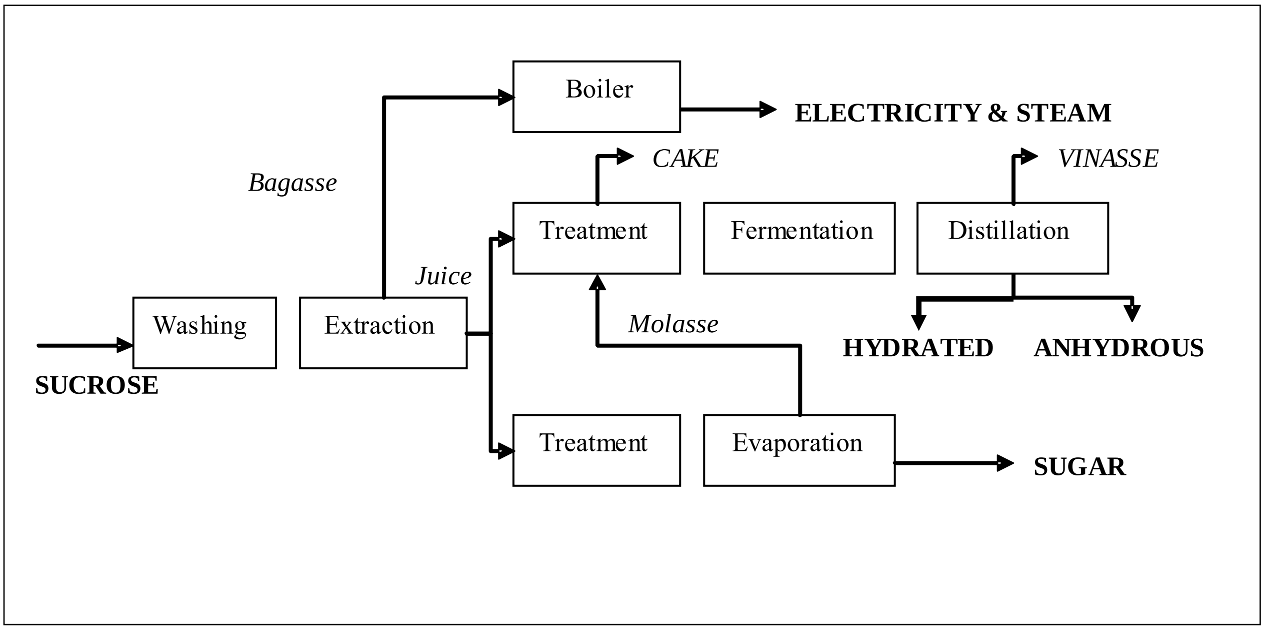

Figure 3.4. – Simplified overview of the industrial ethanol production process.

In summary, the cane is washed to remove organic material from the field and shredded into smaller pieces of 20-25 cm. After these pretreatments the feedstock is fed to and extracted by a set of 4-7 mill combinations into juice and bagasse (the fibre residue). The main objective of the milling process is to extract the largest possible amount of sucrose from the cane, a secondary, and increasingly important objective is the production of bagasse with a low moisture content as boiler fuel. The boilers supply enough electricity and steam for the process to be self-sufficient, in some cases even some electricity can be delivered to the grid. Next, the cane juice is filtered and treated by chemicals and pasteurized. Before increasing the concentration of sugar by evaporation, the juice is filtered once again. During this step, vinasse is produced, a fluid rich in organic compounds. The evaporation process increases the sugar concentration of the juice from 14-16°Brix up to 50-58°Brix. The syrup is then crystallized by either cooling crystallization or boiling crystallization. Crystallization leads to a mixture of clear crystals surrounded by molasses with a concentration of 91-93°Brix. Molasses are then removed by centrifugation, and the crystals are washed by addition of steam, after which the crystals are dried by an airflow. Molasses undergoes another pretreatment including pasteurization and repeated addition of lime, which leads to a sterilized molasse free of impurities, ready to be fermented. In the fermentation process sugars are transformed into ethanol by addition of yeast. Fermentation time varies from 4-12 hours, chemical efficiencies range from 80-90%, resulting in an alcohol content of 7-10° GL, called fermented wine. The wine is centrifuged in order to recover the yeast. Making use of the different boiling points the alcohol in the fermented wine is separated from the main resting solid components; yeast, non-fermentable sugars, minerals and gasses; mainly CO_2 and SO_2. The remaining product is hydrated ethanol with a concentration of 96°GL. Further dehydration up to the required 99,7°GL in order to produce anhydrous ethanol and is normally done by addition of cyclohexane.

3.3 Ecological impacts

3.3.1 Water use

Impact assessment

In general there is sufficient water to supply all foreseeable long-term water requirements in the Centre-South region of Brazil as a whole, but local water shortages can occur as a result of the occurrence of various water using and water polluting sectors (agriculture, industry) and/or cities and the uncontrolled use of water and uncontrolled dumping of wastewater. No detailed information is readily available about in which areas water shortages occur in the Centre-South and what the contribution is of sugar cane and ethanol production to these problems. Sugar cane production is mainly rain fed, which is generally not perceived as a problem, but the use of irrigation is increasing. The use of water use for the production of ethanol from cane is the main problem. More detailed information is presented below.

The production of sugar cane and ethanol requires water, which could lead to a depletion of fresh water resources. The water supply to water use ratio for Brazil as a whole was calculated at 1% in 1995, and this figure is projected to increase to 3-5% in 2075, dependant on the irrigation scenario (Berndes, 2002). Water use refers to the withdrawal of water for irrigation and the industry and households. A ratio of 25% or higher is generally an indicator of water stress. For comparison: the water supply to use ratio in Germany was calculated at 38% in 1995 and 112-138% in 2075. These figures indicate that Brazil has one of the lowest water supply to water use ratios in the world. However, regional water shortages occur. Brazil can be divided into eight major water basins, see figure 3.4 and table 3.2.

Table 3.2. The eight major water basins in Brazil. Source: (FAO, 2004).

Basin name	Main cane producing region (Yes/No)	Area (1000 km^2)	Precipitation (mm/y)	Evapotranspiration (mm/y)
1 Amazon in Brazil	No	3935	8736	4919
2 Tocantins-Araguaia	No	757	1257	884
3 North and Northeast	Yes	1029	1533	1240
4 San Francisco	Yes	634	581	491
5 East Atlantic	Yes	545	321	246
6 Paraná-Paraguai	Yes	1245	2140	1657
7 Uruguai	No	178	279	148
8 Southeast Atlantic	No	224	312	177
TOTAL		8547	15158	9761

Figure 3.5. The eight major river basins in Brazil. Source: (FAO, 2004).

The most important sugar cane producing regions in Brazil are situated in the North and Northeast basin, San Francisco basin, the East Atlantic basin and the Paraná-Paraguai basin (FAO, 2004). The focus in this paper is on sugar cane production in the south of Brazil, which relates mainly to the Paraná-Paraguai basin. According to the FAO, there is sufficient water in the Paraná-Paraguai basin as a whole to supply all foreseeable long-term water requirements from agriculture, households and industry (FAO, 2004). The same goes for most of the other water basins. However, local water shortages may occur as a result of the occurrence of various water using and water polluting sectors (agriculture, industry) and/or cities and/or in case there of unregulated use of water and unregulated dumping of wastewater. Some of these regions include sugar cane and ethanol producing regions, an example is the Piracicaba river basin in São Paulo (FAO, 2004).

To ensure an efficient use of fresh water resources, legislation is being implemented in some regions. This legislation includes the billing of water, for both the agriculture and the industry. In SP, a State Plan on Water Resources (Plano Estadual de Recursos Hidricos or PERH) was made that includes data on and projections of the water demand in SP. Table 3.3 shows the surface water availability and demand in São Paulo in 1990 and 2004-2007 in various water plans.

Table 3.3. The availability and demand of surface water in São Paulo. Sources: State Plan on Water Resources 1994-1995 and PERH, 2004-2007 in Macedo (2005).

		PERH-1990		PERH-2004-2007	
		1990		2003	
		m^3/s	%	m^3/s	%
Supply	Reference	2105		2020	
	Minimum available flow	888		893	
Demand	Urban	97	24	151	39
	Irrigation	154	44	102	26
	Industry – Total	112	32	137	35
	Industry – Mills	47	13	-	-
	Total	353	100	390	100

The pessimistic values projected for 2010 that were reported in the PERH-1990 were likely an overestimation of the water use for irrigation. Between 1990 and 2003 the demand for water from the industry increased by 22%, the demand for water from cities increased by 66%, the demand for water for irrigation decreased by 34%. These changes are partially a result of differences in definitions and also the use of water for irrigation is smaller than previously assumed. The increase in the use of water for the industry (including the sugar cane industry) is limited as a result of the implementation of new legislation that provides for billing of water use. The data also indicate that at a state level there is no water shortage.

For the production of sugar cane and ethanol two main types of water use can be distinguished:

- Water use for cane production. The evapotranspiration of sugar cane is estimated at ca. 8.0-12.0 mm/t cane and the total rainfall required by sugar cane is estimated at 1500-2500 mm/y, which should be uniformly spread across the growing cycle (Macedo, 2005). For comparison: the annual rainfall in São Paulo is roughly 1000-2500 mm/y. These figures indicate that water can be a limiting factor for sugar cane crop production under certain conditions in São Paulo. To what extend evapotranspiration from sugar cane production contributes to regional water shortages is unknown. This would require further an analysis of the complete water balance of a region, including local factors that determine the evapotranspiration rate (e.g., sugar cane yields, soil water holding capacity, slope, and rainfall). However, the use of rainfall for crop production is generally considered as acceptable. Problems occur particularly when irrigation is applied. However, irrigation for cane production is not economically feasible and not used in SP, with the exception of West SP. Currently, in this area only a small percentage of total sugar cane of São Paulo is produced, but the growing demand for sugar cane in the Centre-South of Brazil has led to the exploitation of dryer regions in the West of São Paulo (see also Figure 3.9). Experiments carried out by the Sugar Cane Technology Centre (CTC) showed that subsurface sprinkling is economically feasible under certain conditions.
- Water use for the conversion of cane to ethanol. Large quantities of water are used during the conversion of cane to ethanol. The use of water for the production of sugar and ethanol is shown in Appendix H. The total water use is calculated to be 21 m^3/t cane, of which 87% is used in four processes: cane washing, condenser/multijet in evaporation and vacuum, fermentation cooling and alcohol condenser cooling. Note that the water use for cane washing (5 m^3/t cane) is being reduced by the replacement of wet cane washing with dry cane washing. The net water use is much lower, because most of the water is recycled (see table 3.4).

Table 3.4. Water collection, consumption and release in 1990 and 1997 (in m^3/t cane). Source: Macedo, 2005.

	1990	1997	2005
Collection	5.6	5.07	1.83/1.23[a]
Release	3.8	4.15	n/a
Net Consumption	1.8	0.92	n/a

a 1.83 m^3/t cane is the average collection of all mills in São Paulo. When the mills with the highest water consumption are excluded (8% of all mills), than the remaining 92% of the mills has an average water collection rate of 1.23 m^3/t.

As a result of legislation and technological progress, the amount of water collected for ethanol production has decreased considerably during the previous years. It seems possible to reach a 1 m^3/t cane water collection and (close to) zero effluent release rates by further optimizing and reuse of water use and recycling (Macedo, 2005). The World Bank reports a target value for wastewater release of at least 1.3 m^3/t cane and an achievable rate of 0.9 m^3/t cane (WB, 1998).

Brazilian legislation and standards

In brief, there is an extensive legal framework related to water use in Brazil and São Paulo the framework has recently been expended and legislation is presently being implemented, of which the billing of water use and discharge is an important element, but no hard targets have been included that are directly related to the quality of the water in an area. However, information on these issues is scarce. A more detailed description of the legislation is given below.

Addition legislation has recently been implemented in Brazil to promote a more efficient use of water, based upon the “user-payer” and “pollutant-payer” principle: the user and polluter pay dependent on the amount and quality of the water collected and released. This principle is applied in all economic sectors in Brazil. There is yet no legislation for waters within SP, such as underground water, and rivers that die within the boundaries of SP. Note that water pollution is discussed in Section 3.3.2, but the legislation discussed here is relevant for both water use and water pollution. The main legal mechanisms for water billing are:

- São Paulo Constitution (1988). It provides that the use of water resources shall be billed and, the proceeds shall be used to maintain the quality and quantity of water.
- State Law Number 7,663 (1991). This law established the rules and regulations of the Water Resources Policy and of the Integrated of Water Resources Management System (SIGRH). This law established 22 Water Resource Management Units (UGHRI) for 20 river basins. There is also one Watershed Committee (CBH) for each water resource management unit. The committees include representatives of State government agencies (1/3), municipalities (1/3) and civil society (1/3). The various committees are represented in the State Water Resources Council. A State Water Resources Fund (FEHIDRO) was created that finances the activities set out by each CBH in their respective Watershed Plans.
- Federal Law 9,433 (1997) establishes the Establishes the National Water Resource Policy and the National Water Resources Management System. It is based on the following principles:
    - In case of shortages, priority in the use of water resources is assigned to human consumption and drinking water for livestock;
    - The management of water resources shall always allow for multiple water uses, such as irrigation, households and industry;
    - The river basin is the territorial unit for the implementation of the National Water Resources policy and the actions of National Water Resources Management System;

  The law established the following basic management tools:
    - Water resources plans dealing with river basins, on state and country level;
    - Classification of water bodies according to the main uses of their waters measured by concessions awarded for the use of water resources;
    - Fees for the use of water resources;
    - Compensation (royalties) for municipal districts for the use of water resources;
    - Water Resources Information System.

  This law also introduced a new institutional framework called the Water Resources Management System that consists of:
    - National Water Resources Council;
    - State and Federal District Water Resources Councils;
    - River Basin Committees;
    - Agencies at the Federal, State and Municipal Government levels whose respective spheres of competence are related to water resources management;
    - National and State Water Agencies.
- Committee for Integration of the Paraiba do Sul River Basin (CEIVAP) Decision 8 (2001). The CEIVAP provides guidance for the implementation of billing for the use of water resources from basins. The billing considers collection, consumption, effluents treated to total effluents ratio and the biochemical oxygen demand (BOD_5[7]) reduction level.
- São Paulo Bill 676 (2000) regulates the billing for the use of water in São Paulo State. The bill states that charges may vary according with the water source (superficial or underground); type, location and effective volume of use; conditions of water quality, availability and regularization in the basin; seasonal effects; and conservation measures. The maximum water charge in 2000 was set at US$ 0.006/m^3. The bill indicates that urban and industrial uses would be first charged and others uses (including agricultural) only after four years. As stated earlier, as there is little irrigation or no irrigation, agricultural use of water for sugarcane production in very small. On the other hand, the industrial use is important, or is important in some cases, and billing industrial consumption – including sugar manufacturing plants – of water is among the priorities.

A general problem is the weak law enforcement in Brazil and thus additional monitoring and control mechanisms may be required. Detailed information about law enforcement was however not readily available. Further, more in general, the price of water may not be sufficient to avoid degradation of fresh water resources[8].

[7] The BOD_5 is the quantity of oxygen in mg/l that is consumed by microorganisms at 20°C within a degradation time of five days.

[8] The water pricing system in the Paraiba do Sul river basin in São Paulo and Rio de Janeiro illustrates this, though there is no sugar cane cultivation in Rio de Janeiro . A water pricing methodology was agreed upon after debates and negotiations with stakeholders. The price was based on studies aimed at matching the basin's revenue expectations

Dutch and/or international sustainability criteria, legislation and standards

According to the DPB commission formulated criteria for 2007 in which it is required that special attention must be given to water use and treatment for bioenergy production, including a reporting requirement. The Water Protocol of the Global Reporting Initiative provides a framework for reporting on water issues and may serve as an example (GRI, 2003). In 2011 performance indicators should be developed. Potential performance indicators are the water collection rate and the effluent release rate. According to Macedo (2005) a water collection rate of 1.0 m^3/t cane and an effluent release rate of (close to) zero are achievable (Macedo, 2005). The World Bank reports a target value for wastewater release of at least 1.3 m^3/t cane and a achievable rate of 0.9 m^3/t cane (WB, 1998). Further, existing certification systems may also serve as an example, such as the EUREPGAP certification system for agricultural crops, which include criteria and indicators on water use (EurepGAP, 2005). Ideally, the water use should be kept equal or below the natural regeneration capacity. This requires a full-scale water balance for each hydrological unit (e.g., river basin, watershed), because water shortages are primarily relevant at the level of hydrological distinct units. However, such analysis falls outside the scope of this study but may be required when implementing a certification system, depending on the criteria included.

Implications for certification

Only in case of a regional overuse of fresh water reserves additional criteria, other than criteria related to monitoring, are required. The application of best practice technologies seems to limit the use of water to levels drastically compared to historic rates. A wide range of improvement strategies is available. The most important improvement strategies are: optimize water use, increase water recycling, reduce wet cane washing, and restrict irrigation. Water collection and water release rates can be used as indicators. However, ideally full water balances for each region are composed in which ecological parameters are included (e.g., species diversity). Specific attention may be given in a certification system to water optimization and recycling technologies and wet cane washing during ethanol production, since these technologies are crucial to reduce the water use. Also irrigation should receive special attention in any certification system, because of the (potentially) large impact of irrigation on water demand and supply. Most sugar cane production in the Center-South is rain-fed, but the use of irrigation is gradually increasing in the Center-West and Western part of SÃO PAULO.

Costs

No information is available about costs associated with the improvement strategies mentioned earlier.

Conclusions

The overuse of water resources seems a limited problem in general in São Paulo, particularly because of the relatively high rainfall. Yet, some local problems may occur. The use of best available technologies can reduce water to levels that are in line with international guidelines and principles (assuming no irrigation). However, additional criteria are required in case the total water demand in an area or water basin exceeds the supply. Ideally, in such cases additional criteria may be required that focus on the water quality and quantity

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intending to raise the necessary funds for implementing investment programs. The methodology requires monthly calculation of values for consumptive and effluent dilution uses, taking into account various factors such as the volume of the wastewater and the level of pollution. Simulations were carried out to evaluate the potential revenues and the economic impact of water charges on agriculture. Two important crops were taken as indicator crops: rice and sugar cane and only water quantity was considered. The application of the methodology resulted in an increase of production costs of 17% for rice and 13% for sugar cane (Braga *et al.*, 2005). This would increase the costs of ethanol by 9%, assuming that 60% of the ethanol costs come from sugar cane. Such a price increase was considered unacceptable (Braga *et al.*, 2005). Adjustments were required so as to enforce water charges to the agricultural sector without producing unacceptable financial impacts. It was assumed that the impact on the sector should not exceed 1% of the production costs. Therefore actual payments by the agriculturual sector are set at 5% of the originally proposed price of water. The impacts of these charges in the production costs would be of 0.86% on the rice crops and 0.60% on the sugar cane. Agricultural water pollution was excluded, mainly because of monitoring difficulties. In addition, it was decided that the agricultural water charge may not exceed 0.5% of the farmers' total production costs.

in an area or river basin as a whole. Based on the available information, we expect that this area of concern is hardly a bottleneck for certification of the ethanol production in São Paulo.

3.3.2 Water pollution

Impact assessment

The situation with respect to water pollution can be summarized as follows: water pollution is in the Center-South of Brazil is an important problem in some regions and water basins, particularly in places where different water polluting sectors are present. No detailed information is available about the level of water pollution in various regions and what the contribution is of cane and ethanol production. However, from general literature, main sources of water pollutin seem to be raw sewage, leaking land fills and industrial waste. Specifically regarding sugar cane, the two most important types of pollutants are organic pollutants (from ethanol production) and agro-chemicals (from cane production). In the past, some extreme cases of environmental degradation have been observed as a result of the unregulated water discharges, but these practices seem to have been abandoned. More detailed information is presented below.

For water pollution in general a similar situation goes as for water use: regional problems occur (e.g., in the Piracicaba River basin), though this seems to be mainly caused by raw sewage and industrial waste, and only to a lesser extent to sugar cane burning and leaching of fertilizers (Williams et al., 2001). The production of sugar cane and ethanol results in various waste streams that pollute fresh water resources. No information was found about the contribution of cane production and ethanol production to the problem, but anecdotal information suggests that there can be some impact in the main producing regions, mainly from agrochemicals (Pessoa et al., 2003) and wastewater from the production of ethanol. Below, water pollution is discussed in detail, whereby two pollution categories are distinguished: organic pollutants and inorganic pollutants.

Organic pollutants

Table 3.5 shows the most important wastewater flows from ethanol production, their pollution potential and commonly used treatment technologies.

Table 3.5. Wastewater flows from ethanol production, the pollution potential and treatment. Source: (Neto, E., 1996 in Macedo 2005).

	m^3/t cane	Pollution potential	Treatment	Remark
Cane washing	5	organic matter (180-500 mg/l BOD_5[a]). High concentration of solids.	Settling ponds and pH adjustment in case of reuse (closed circuit); settling ponds stabilization ponds (open circuit)	Tendency to be discontinued or replaced by dry cleaning systems
Barometric condenser	6	organic matter (10-40 mg/l BOD_5) and temperature ca. 50°C	Cooling pond (closed or open circuit) to bring T < 40°C;); recirculation and release	The circuits are being closed aiming zero leakage system
Fermented cooling	3	Temperature ca. 50°C	Cooling pond or tower (closed or open circuit); recirculation and release	The circuits are being closed aiming zero leakage system
Distillation condenser	4	Temperature ca. 50°C	Cooling pond (closed or open circuit)	The circuits are being closed aiming zero leakage system
Waste water	4	Grease, oil, acid, caustic and sugar (all in small quantities)	Dilution in other water streams, mix with vinasse	Dilution in other water streams, mix with vinasse

a The BOD is the main parameter of any treatment of waste waster polluted with biodegradable substances. The chemical oxygen demand (COD), on the other hand, is the standard for the content of oxidizable substances found in water, i.e. the method covers not only biologically active substances but also inert organic compounds. It is essential to use the COD method (evidence provided using potassium permanganate or potassium bichromate) as a fast method of determining the level of water pollution.

A crucial wastewater flow is the stillage of vinasse, which is a black liquid formed during the distillation process. Vinasse is produced in large volumes and has a high organic load (11 l/l ethanol with a BOD_5 of 175 g/l) and has a pH of 4-5. Vinasse is hot and therefore requires cooling. In the mountainous areas of northeastern Brazil, the pumping cost and the cost of land to store vinasse were prohibitive, and they were therefore released into rivers, resulting in the pollution of rivers (and fish kills) during each harvest. Presently, vinasse is used for ferti-irrigation of cane crops, together with wastewaters (floor washing, closed circuit purging, condensate remainders). Further, juice and water overflows may occur at plant breakdowns so that values of up to 18,000 mg BOD_5/l can occur (Sugarc Mark, 2006).

The amount of organic pollutants in wastewater can be reduced in many ways. The treatment processes for wastewater that can be carried out in sugar factories are largely determined by local factors. The management of the wastewater and circuit conditions inside the plant has a major effect on plant size and the level of degradation that can be achieved.

- Mechanical removal of suspended particles.
- Aerobic treatment. The simplest and by far the most desirable treatment method for the processing of organically polluted, concentrated sugar factory wastewater is its collection in a series of lagoons using an overflow system. The wastewater then purifies itself. The time required for adequate degradation of the wastewater in the lagoons is determined by the following factors:
  - The height of water level in the lagoon
  - The lagoon area
  - The soil below the lagoon and/or the sealing of the subsoil
  - The weather conditions
  - The external flows of water

  The lower the water level and the warmer the weather during the degradation processes, the faster the water in the lagoon is treated. If there is a high level of evaporation, the content of the wastewater is concentrated. If there are external flows of water and rainfall is high, the lagoon wastewater is diluted. In case of aerobic degradation fermentation and putrefaction occur, thus the possibility of odor nuisances, primarily due to the formation of hydrogen sulfide and butyric acid, cannot be ruled out. This can be overcome by selecting suitable locations and by adequate additional aeration. During the activated sludge process, oxygen is introduced into the water in the form of air via an aeration system. Small-scale continuous systems operate with a substantially higher micro-organism density and a higher oxygen supply, and achieve a degradation level of around 90%. Atmospheric pollution is clearly higher at 2 to 7 kg COD/m^3/day and the energy required for the air supply is around 3.5 kWh/m^3/day.
- Anaerobic treatment. Anaerobic treatment plants consist of large tanks (around 3.000 to 7.000 m^3) in which anaerobic bacteria degrade the organic pollutants to form biogas (approx. 75 to 85% methane). This is particularly effective where wastewater is heavily contaminated. The organic content is 80-85% decomposed, with the remaining degradation taking place aerobically in the aeration system. The benefits of this process are that the methane gas can be used directly as an energy source to heat the tanks and that the problems of odor can be overcome; an additional factor is that less space is required than in the case of lagoon systems.
- Recycling. Recycling is a crucial element of any wastewater reduction strategy: water management must be such that, once closed circuits are established, unpolluted or only slightly polluted water requiring no further treatment is discharged into the drains. Recycling is the application of vinasse to sugar cane growing areas. Filter cake may also be applied to sugar cane growing areas, but may also be used as feed considering its high protein content (14-18% on dry basis). The application of vinasse and filter cake to sugar cane areas is called ferti-irrigation. Ferti-irrigation use started in 1978. In the beginning, various environmental problems were encountered as a result of the high vinasse doses that were applied and the use of sacrifice area and infiltration furrow irrigation systems. Since then vinasse application rates have been gradually reduced. Further, tanker trucks were used for irrigation, but this technique has several disadvantages, such as soil compaction, the impossibility to apply in sugar cane areas, the low uniformity in distribution, high costs. Therefore sprinkler installations are increasingly being used, see table 3.6. Sprinkler irrigation is more expensive than standard tanker truck applications. All solids that can be settled must be removed to minimize malfunctions in the sprinkler irrigation installations. The load should be intermittent and the quantity must be limited (< 500 mm/vegetation period - individual doses not exceeding 80 mm) according to standards developed in Germany (GTZ, 1995). If the wastewater is first treated in lagoons to at least 180 mg BOD_5/l, drained areas can also be irrigated if the water table is suitably low. In

addition to wastewater treatment in the soil, the wastewater recycled for irrigation also acts as a fertilizer. At this moment, all vinasse is being recycled in Brazil.

Table 3.6. Vinasse application systems in São Paulo. Source: (Macedo, 2005).

Method	Share (%)
Standard tanker truck	6
Sprinkling (channel + direct mouting)	10
Sprinkling (channel + reel)	53
Sprinkling (truck + reel)	31

Inorganic pollutants

During the production of sugar cane and ethanol various inorganic substances are used that are potentially harmful for the environment. Three categories are discussed here: agrochemicals, disinfectants and clarifying agents.

Agrochemicals include a.o., herbicides, insecticides, fungicides, maturators, adhesive spreading agents and defoliants. An overview of the quantities of pesticides used in sugar cane and other crops is shown in table 3.7.

Table 3.7. Consumption of fungicides, insecticides, acaricides, agricultural defensives in 1999 and 2003 in Brazil (in kg active ingredient/ha/y). Source: (Macedo, 2005).

		Coffee	Sugar cane	Citric	Corn	Soybean
Fungicides	1999	1.38	0.00	8.94	0.00	0.00
	2003	0.66	0.00	3.56	0.01	0.16
Insecticides	1999	0.91	0.06	1.06	0.12	0.39
	2003	0.26	0.12	0.72	0.18	0.46
Acaricides	1999	0.00	0.05	16.00	0.00	0.01
	2003	0.07	0.00	10.78	0.00	0.01
Agricultural defensives	1999	0.06	0.03	0.28	0.05	0.52
	2003	0.14	0.04	1.97	0.09	0.51

The consumption of agrochemicals for sugar cane production is lower than in citric, corn, coffee and soybean cropping. Sugar cane uses more herbicides per hectare than coffee and maize, less than citric crops, and about the same amount as soybeans, however the values are not very different (Marzabal et al., 2004 in Macedo, 2005). Note that the average use of some pesticides varies significantly between years. The insecticide consumption in the US in 1991 was 0.38 kg/ha for corn and 0.26 kg/ha for soybean. Yet, the total amount of agrochemicals used for the production of sugar cane can be substantial, as a significant amount of the total area in São Paulo state is used for sugar cane production. In an evaluation by the Brazilian Agricultural Research Corporation (EMBRAPA) about the impact of sugar cane production on water quality, is classified as level 1, which means “no impact” (Rosetto, 2004; Macedo, 2005). No information was found about the reason for this classification

Disease and pest control, including the use of agrochemicals, is a crucial element in all cane production, both organic and conventional cane production; without disease and pest control severe yield losses occur. The development of resistant sugar cane varieties is a crucial aspect of disease and pest control and is one of the primary objectives of Brazil’s cane genetic improvement programs. Disease control is one of the main reasons for the replacement of a commercial variety of sugar cane. A total of 177 pathogens are known to cause sugar cane crop diseases worldwide, 40 of which have been reported in Brazil (Macedo, 2005). There are more than 500 commercial varieties of sugar cane. The top 20 occupy 80% of the total cane area. The leading variety occupies only 13%. The duration of use for each variety is becoming increasingly shorter, and at the same time, the number of varieties in use at any given time has been growing. Diversification of cane varieties is part of the pest and disease control strategy. However, active pest and disease control is essential and involves a combination of mechanical control (e.g., cane burning), biological control (using natural enemies), and chemical control. The main plagues and the conventionally used technologies to combat them are presented in Appendix H.

Weed control is a crucial aspect of sugar cane production, because yield losses range from 10 to more than 80% (Gravena et al., 2002, in Macedo, 2005), and therefore weed control has been the subject of extensive research. Weed control in sugar cane production in Brazil generally involves a combination of control mechanisms: mechanical (e.g., soil preparation, flooding, and burning), cultural (e.g., use of crop rotation and ground cover plants), biological (using natural enemies of weeds such as pests and diseases, although in Brazil this option has not been used), and chemical (using herbicides) weed control. A wide variety of chemicals is used, some of which are banned in other countries, such as 2,4-D and atrazine (De Armas and Monteiro, 2005, PAN, 2005). Preventive measures, such as the use of seedlings from areas that are free of pests and the cleaning of agricultural machines are also applied. However, the main weed control method is chemical. Herbicide resistant weeds are at this moment a very limited problem, but are increasingly becoming important. To combat these weeds, cane growers have been using crop rotation, mechanical control, use of different herbicides, and integrated control. Further, the type of harvesting is important for the weed control: the increase in mechanical harvesting without trash burning favors the development of species that used to be rare or unusual in sugar cane plantations on uncovered soil and consequently makes it difficult to eliminate the use of herbicides.

- Disinfectants (formaldehyde, various biocides). The intermediate products of the sugar industry are ideal nutrient media for a large number of microorganisms. The risk of microbial contamination is particularly high in extraction, where not even the most stringent technical hygiene measures and optimum process management can obviate the need to use disinfectants. Major disinfection operations can lead to heavy sugar losses and are therefore not economically viable. The substance most frequently used to disinfect extraction plants is formalin (approx. 35% aqueous solution of formaldehyde). It is added in batches at a concentration of around 0.02-0.04% in relation to the quantity of raw material processed. The formaldehyde concentration in the juice decreases constantly throughout the subsequent process stages. In the clear juice, levels are less than 1 mg/kg and in the white sugar the concentration is 0.10 mg/kg[9]. Traces of formaldehyde are also found in the condensates which are produced from evaporation and which are returned to the factory's water circuit. Formalin is controversial in the light of the carcinogenic effect attributed to it, but is still the preferred disinfectant in extraction. Alternative substances, e.g. thiocarbamate, quaternary ammonia compounds, cresol derivatives, hydrogen peroxide and the like, have all been tested over recent years. Their effectiveness as disinfectants when used in extraction plants is comparable to that of formalin. Thiocarbamate, cresol and hydrogen peroxide are also removed by the extraction water during the process, thus only traces can be found in the extracted slices. Quaternary ammonia compounds, by contrast, are irreversibly adsorbed or precipitated along with other organic substances during extract purification. Instead of disinfectants, repeated high-pressure steam disinfection at the points in the mill tandem most at risk can also be used, but this is only about 60% as effective as biocides. Further, steam treatment can only be effectively applied when the mill is not working, while chemical treatment can also be used during mill operation.
- Clarification agents containing lead (lead acetate solution) should no longer be used for the polarimetric sugar analysis of beet and cane extracts; instead the environmentally friendly reagents aluminium chloride or sulfate alone should be used.

Brazilian legislation and standards

The legislation related to water use that was discussed in Section 3.3.1 is obviously also relevant for water pollution. In addition to that, there is also legislation specifically aimed at water pollution, including emission standards. These emissions standards are not specifically for sugar and ethanol production, but the compliance of these standards are compulsory for all economic branches. The key laws and standards are:

- Federal Law 6.938 (1981) was created and defined the National Environment Policy. However, this law was applied only after the Constitution of 1988, with the creation of the Environment National System (SISNAMA) Law 8.08, in 1990. Thus the three public levels have started to work accordingly, under the coordination of the National Environment Council (CONAMA).

[9] For comparison, the acceptable daily intake (ADI) of formaline is 0.15 mg/kg bodyweight (WU, 2006). A person of 75 kg would need to consume over 100 kg sugar per day to reach this level.

- State Environmental Law 997 (1976). This law defines clearly the way of preventing and controlling environmental pollution. At that time only water, forestry and land codes were defined, all of them outdated and controlled through generic tools. Article 18 includes the Water Pollution Emission Standards, which state that emissions from any polluting source could be only released to any water body, under the following conditions:
  I pH: 5.0–9.0;
  II Temperature: ≤ 40ºC;
  III Suspended solids: maximum 1.0 ml/l in one hour, measured using an Imhoff Sediment Cone;
  IV Hexane soluble compounds: maximum 100 mg/l;
  V BOD_5: maximum 60 mg/l;
  VI Maximum concentrations of various substances (see further Appendix J).
  VII Maximum concentrations for other potential hazardous substances are to be established, case-by-case by CETESB;
- The use of herbicides is regulated by Law 7,802 of 1989 and further regulated by the Decree 98,816 of 1990. The legislation is complemented by Ordinances by the Brazilian Institute of the Environment and the Brazilian Sanitary Authority.
- Legislation on vinasse application, see further the section about fertilizer use.

No information was readily available about these two issues.

Legislation related to water pollution can be summarized as follows. Next to the legislation on water use (Section 3.2.2) the most important legislation relevant to water pollution deals with:
- Waste water emissions standards
- Agro-chemicals, i.e., which agro-chemicals are allowed

Further, there is legislation that is indirectly related to water pollution, such as legislation on vinasse application and legislation on nature protection, but these were excluded here. Existing legislation may be insufficiently enforced and/or strict to avoid further environmental degradation, but insufficient data is available to accurately quantify these impacts.

Dutch and/or international sustainability criteria, legislation and standards

Various criteria that are formulated by the DPB commission that are relevant to water pollution. In general, for 2007 compliance with (inter)national legislation is required according to the DPB commission. For the year 2011 additional criteria are required, for which additional performance indicators will be formulated. Various (inter)national legislation frameworks, certification and reporting systems can be used to develop indicators and criteria. Generally accepted performance indicators for organic pollutants are pH, total suspended solids (TSS) and biological oxygen demand (BOD) and also the temperature of wastewaters is important. More specific information is given below.

The DPB commission identified four criteria (criteria 6a to 6d in table 1) that are directly relevant to water pollution, which are:
- Waste management.
- Use of agro-chemicals, including fertilizers.
- Prevention of soil erosion and nutrient depletion. The criterion related to erosion is discussed in Section 3.2.4.
- Preservation of quality and quantity of surface water and ground water.

See in table 1 for details of the criteria. Compliance with local and national law is a minimum requirement for the year 2007. For the year 2011 additional criteria are required, for which additional performance indicators will be formulated.

To quantify organic water pollution three parameters are commonly used, which are:
- Biochemical oxygen demand (BOD) for determining the oxygen-consuming organic material.
- TSS (total suspended solids mg/l) for establishing the total quantity of suspended matter (primarily inorganic substances from cane and beet washing water).

- pH as extreme pH changes are harmful to water fauna.

These three parameters are also included in national legislation, but it is unknown to what extend the standards included are being met in reality. Stricter emission standards may be required in the future, whereby various national or international standards can be used as an example. For example, in Germany, GTZ composed minimum requirements for sugar production and associated industries, including alcohol and yeast production from molasses (GTZ, 1995), see table 3.8.

Table 3.8. The minimum requirements for emissions to water. Source: (GTZ, 1995).

	A mg/l random sample	COD mg/l mixed sample		BOD_5 mg/l mixed sample		TF - random sample
Seal and condensation	0.3	60	--	30	--	--
Other water	0.5	500	450	50	40	4

A = volume of suspended solids
TF = toxicity to fish, expressed as the minimum dilution factor of the wastewater at which all test fish survive under standardized conditions within 48 hours.

The BOD_5 emissions standard proposed by GTZ is directly comparable with the Brazilian standards. The BOD_5 requirement in Brazil is 60 mg/l compared to 30-50 mg/l in Germany. Further, the World Bank (WB) has published a Pollution Prevention Abatement Handbook (WB, 1998) that includes emission standards that are used in making decisions on WB assistance. The emission standards for BOD_5 is set at 50 mg/l, see table 3.9. The treatment of wastewater with a concentration of 5.000 mg BOD_5/1, as is usual in the sugar industry in Germany, requires a constant degradation efficiency of 99% or more to reach the emission limit of a BOD_5 of 30 mg/l. In sugar cane growing areas, complete biological purification (a BOD_5 of less than 30 mg/l) can be achieved within five or six months with good lagoon management and lagoon depth should not exceed 1.50 m in subtropical/tropical zones. This long-term process of degradation in lagoons could solve the wastewater problem for the sugar industry if sufficient lagoon area were available. The sugar cane processing industry generally has sufficient land area available and so uses the lagoon process almost without exception.

Table 3.9. Effluents from Sugar Manufacturing (mg/l, except for pH and temperature). Source (WB, 1998).

Parameters	Value
pH	6-9
BOD_5[a]	50
COD	250
TSS	50
Oil and grease	10
Total nitrogen (NH_4–N)	10
Total phosphorus	2
Temperature increase	≤ 3 °C[b]

Note: Effluent requirements are for direct discharge to surface waters.
a According to the World Bank, BOD reduction levels of over 95% are feasible.
b The effluent should result in a temperature increase of no more than 3° C at the edge of the zone where initial mixing and dilution take place. Where the zone is not defined, use 100 meters from the point of discharge.

According to the WB guidelines, the maximum levels should be achieved for at least 95% of the time that the plant or unit is operating, to be calculated as a proportion of annual operating hours. Biocides should not be present above detection levels or should be less than 0.05 mg/l. In general, the WB standard requires that sugar losses are below 10%. Further, the WB also states that the amount of wastewater can be reduced to 1.3 m^3/t cane and that plant operators should aim for a rate of 0.9 m^3/t cane (WB, 1998).Further, also the emission standards for the sugar cane industry published by the US Environmental Protection Agency (EPA) may serve as a basis to define emission standards. These emissions standards are based on the "best available technology economically achievable", values are shown in table 3.10.

Table 3.10. Emission standards for best available technologies. Source: EPA in (GTZ, 1995).

	BOD_5	A	pH
Raw sugar factory	(kg/t cane)	(kg/t cane)	(-)
max.daily value	0.10	0.24	
30-day			6.0-6.9
mean	0.05	0.08	
White sugar factory	(kg/t raw syrup)	(kg/t raw syrup)	(-)
max.daily value	0.18	0.11	
30-day			6.0-6.9
mean	0.09	0.035	
Liquid sugar factory	(kg/t raw syrup)	(kg/t raw syrup)	(-)
max.daily value	0.30	0.09	
30-day			6.0 - 6.9
mean	0.15	0.03	

A = volume of suspended solids

According to the EPA standards, the pH of the wastewater must be between 6.0 to 6.9, while the WB and Brazilian standards use a range of 6.0 to 9.0 and 5.0 to 9.0, respectively. Note that these differences may partially be caused by differences in the definition of the types of wastewaters. According to the Brazilian standards the maximum temperature of effluent water is 40ºC, while World Bank guidelines indicate a maximum increase in temperature of 3ºC. For suspended solids (TSS) there is also a difference between different guidelines. GTZ requires a TSS of 0.3-0.5 mg/l, while Brazilian standards are set at 1.0 mg/l. Note that a TSS load of <30 mg/l is technically feasible (UNEP, 1997).

For agro-chemicals compliance with local and national laws is required for the year 2007. For the year 2011 compliance with EU legislation is required. Note that at there are ongoing developments within the EU to harmonize the procedures used in different countries to determine if an agro-chemical should be allowed or not (EC, 1991). An agro-chemical is only allowed in case the active ingredient is on an EU list of approved ingredient, but the accession of each agro-chemical remains the responsibility of the different member states. In addition, various (inter)national standards and guidelines may also be helpful when formulating practically applicable criteria. Examples are: the Stockholm Convention on Persistent Organic Pollutants, the Basel Convention (Annexes I, II, III, VII), guidelines from the World Bank (WB), the Global Reporting Initiative reporting guidelines on water use and pollution. Also existing certification systems may be useful, such as EUREPGAP and the Forest Steward Council (FSC) criteria. FSC requires that that the following categories of chemical pesticides are prohibited in forests (this classification is based on the classification used by the World Health Organisation (WHO):

- WHO table 1, Class Ia, classified as "Extremely Hazardous"
- WHO table 2, Class Ib, classified as "Highly Hazardous"
- WHO table 3, Class II, "Moderately Hazardous"
- WHO table 4, Class III, "Slightly Hazardous"
- WHO table 5, Active ingredients unlikely to present acute hazard in normal use
- Chlorinated hydrocarbons, including aldrin, DDT, dieldrin and lindane.
- Other persistent, toxic or accumulative pesticides identified by their characteristics and defined thresholds.

Further analysis is required to investigate the differences between the legislation in Brazil/São Paulo and various handbooks, guidelines, and emissions standards in various other countries and particularly in the EU, as well as the practical and economic consequences of such criteria.

Implications for certification

Water pollution is a regional problem, so first it must be established if water pollution is a problem or not in a region, and how much is contributed by sugar cane and ethanol production. For the year 2007 specific attention must be given to what extend existing legislation is enforced and met. For the year 2011 additional criteria are required to meet certain sustainability criteria, because existing legislation does not fully meet various (inter)national standards and guidelines. This goes for the emission standards for organic pollutants (pH, TSS, BOD) and also for the use of agro-chemicals that are forbidden in other countries. Ideally the criteria should be set so that environmental degradation is avoided, but this requires the development of new performance indicators. Improvement strategies include the optimization of the management of ethanol production (best-available-technologies), increase the use of dry cleaning of sugar cane compared to wet cleaning, increase the use of water treatment technologies, increase the use of biological pest control, increase the use of pest and disease resistant varieties and pay attention to the selection of varieties best suited for the local conditions, replace the use of formaldehyde and biocides for disinfecting by steam disinfection or less harmful substitutes, replace the use of lead containing clarifying agents by non-lead containing clarifying agents.

Costs

No information is available about the costs to prevent water pollution, but aggregated costs are discussed in Section 5.

Conclusions

Water pollution is a serious problem in some regions in Sao Paulo state, though main pollution sources seem to be raw sewage, leaking land fills and industrial waste. The production of ethanol leads to significant amounts of wastewater, but this amount has been strongly reduced over the last years. In recent literature, we only found incidental reports of nutrient leaching and risk of pesticides form sugar cane cultivation reaching the ground water. Legislation is presently being implemented aimed at water pollution. For more strict sustainability criteria in the future, additional measures may be required, because existing legislation may be insufficiently enforced to prevent further environmental degradation. Data on these issues are however scarce. Further, the existing Brazilian emission standards are not always in line with various (inter)national standards and guidelines. On the other hand, a number of standards have been specifically set for the local Brazilian situation (e.g. the 60 mg/l BOD_5 requirement), and thus may be sufficient to prevent environmental degradation, In any case, a large number of measures can be applied to reduce emissions, but this may require substantial adjustments in technologies and management, but detailed information is not available. This area of concern is graded as a small-to-medium bottleneck for sustainable ethanol production.

3.3.3 Land use, forest protection and biodiversity

Impact assessment

The impact of the production on biodiversity can be summarized as follows (detailed information is presented in the remaining of this section): the direct impact of cane production on biodiversity is limited, because cane production replaces mainly pastures and/or food crop and sugar cane production takes place far from the major biomes in Brazil (Amazon Rain Forest, Cerrado, Atlantic Forest, Caatinga, Campos Sulinos and Pantanal). The amount of harvesting area in the Centre-South region increased from 2.8 Mha in 1993 to 4.2 Mha in 2003 and is expected to increase by some 50% to 2010 (Goldemberg, 2006). There are however no official land use scenarios for Brazil or for the state of São Paulo (SP). As a result, livestock production (and potentially also food crop production) is moving to the particularly the central part of Brazil, particularly at the borders of the present agricultural land, into cerrados, more than into forest areas. The cerrado is an important biome and biodiversity reserve. Thus, the direct impact from land use for cane production on biodiversity is limited, but the indirect impacts could be substantial. The indirect and positive biodiversity impacts of the replacement of fossil fuels by ethanol and the resulting avoided impacts of climatic changes are hereby ignored.

The production of ethanol could have a negative impact on biodiversity in various ways, either directly (e.g., through the conversion of undisturbed land to sugar cane production) or indirectly (e.g., through the pollution from agrochemical or through indirect impact on land use patterns). Positive impacts are also possible, e.g., the use ethanol reduces the emissions of greenhouse gasses and thus reduces biodiversity losses from greenhouse gas emissions. In this section the focus is on land use patterns, with specific attention for forests, because the land use patterns is a crucial parameter for biodiversity.

In Brazil, the main effort to set biodiversity protection priorities was developed within the Priorities Actions for Preservation of the Biodiversity of Brazilian Biomes project, coordinated by the Ministry of the Environment. The main biomes in Brazil are shown in table 3.11.

Table 3.11. Brazilian biomes: original area, current cover, and percentage contained in preservation units. Source: various Brazilian governmental sources in (Macedo, 2005).

Biome	Original coverage (% of the country)	Current cover (% of the original)	Protected area (% of the original)
Amazon Rain Forest	49	85	4.8
Cerrado	23	20	1.7
Atlantic Forest	13	7	0.7
Caatinga	10	32	0.7
Campos Sulinos	2.0	2.0	0.3
Pantanal	1.8	?	0.6

Further projects are being carried out that focus on the systematic integration of data on land use and biodiversity, although there are still significant gaps in knowledge.

The production of ethanol could lead to competition with the demand for land for other land use functions, e.g., nature conservation. However, most of the sugar cane production is located in areas away from important biomes like the Amazon Rain Forest, the Atlantic Forest and the Pantanal, see figure 6. Also, to double ethanol production in Brazil, the area required is just 2-3% of the land available for agriculture.

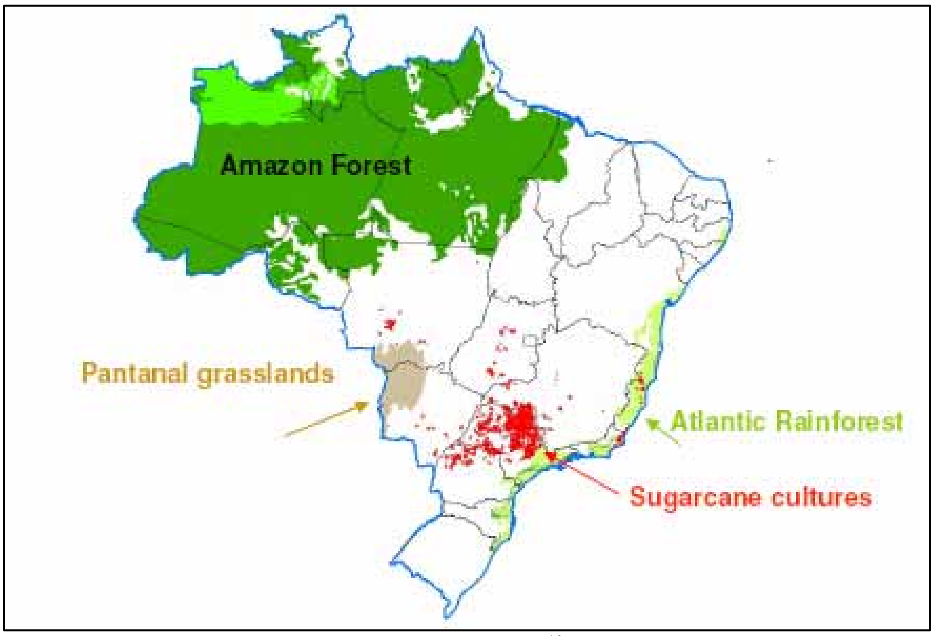

Figure 3.6. The location of sugar cane cultures[10] and important biomes. Source IGBE (vegetation) and CTC (sugar cane) in (Macedo, 2005).

Consequently, direct impacts from land use changes are likely limited. However, indirect impacts may occur. The sugar cane area in Brazil steadily increased from 1 Mha in 1955 to 5.3 Mha in 2003. In Brazil sugar cane production started in Northeast and about 15% of the production is still located there. However, sugar cane production in this region has been continuously reduced due to the low quality of soil (with impacts on yields and costs) and also due to the inadequate topography (lands of higher declivity). 4.2 Mha of the 5.3 Mha sugarcane in 2003 is in the Centre South region. São Paulo is the most important cane producing state, with an

[10] Excluding the North and North East, for which no data were available. Their contribution of the North and North East is ca. 15%.

area of 1.9 Mha in 1993 that increased to 2.8 Mha in 2003, equivalent to 13% of the total land area in São Paulo excl. infrastructure; and 32% of the area under crop production (Macedo, 2005). The rapid increase of the sugar cane area in São Paulo has different reasons. First, São Paulo has relatively favorable natural conditions for cane production. Sugar cane is a crop that requires soil of good quality and specific weather conditions (e.g., the winter period cannot be very cold, it is necessary to have a clear difference between summer and winter, dry periods with good solar radiation are required for sugar cane achieving its maturation). Another constraint is the rainfall pattern, as no irrigation is a condition for low cost of sugar cane production. In addition, as long as mechanical harvesting is considered, lands of low declivity are required (≤15%). For reasons given above, new sugar cane plantations in São Paulo are located in lands previously used for orange production and for cattle. Landowners expect larger revenues with sugar cane production and so many have decided to switch from orange production. For comparison, the annual net income per ha were R$ 1000 (U$ 487) for forestry, R$ 700 (U$ 350) for sugar cane, R$ 350 (U$ 170) for crops (bean, corn, soybean), and R$ 120 (U$ 58) for cattle farming (data for December 2005, source FGV, 2006). These numbers are likely to be the costs without management and taxes. Values for renting lands for sugar cane use were ranging from R$ 500 to R$ 1000 per ha per year during 2005, depending on their quality and location (Agricultural Economics Institute, 2006). The higher profit margins for farmers currently cause a shift from other crops to sugar cane in areas surrounding sugar mill plants.

It should be noticed that about 30-35% of sugarcane is produced by relatively small farmers who sell their production to the mills. Additionally, about another 30-35% of the sugar cane production is grown on land rented by the mills owners. In both cases, the short-term revenue perspective induces the decision. Cattle production is moving to the Central part of Brazil, where land is cheaper. The area of agricultural land has gradually increased during the previous decades, particularly at the borders of the present agricultural land, into pasture areas (including cerrados), more than forest areas (Macedo, 2005). Figure 3.7 displays the development of major crops in Brazil from 1930-2000. This expansion occurs mainly in the Centre West region (see table 3.12), as soils in this region are particularly suitable for sugar cane (see figure 3.8). Note that the dynamics of these land use patterns is high, as a result of changes in food commodity prices.

Table 3.12. The crop area in Brazil in million ha in 1994 and 2004. Source: (IBGE, 2004 Macedo, 2005).

	North - North East	South – South East	Centre West	Brazil
1994	16	29	8.0	53
2004	14	31	15	60
increase in %	-10	+7.3	+89	+14

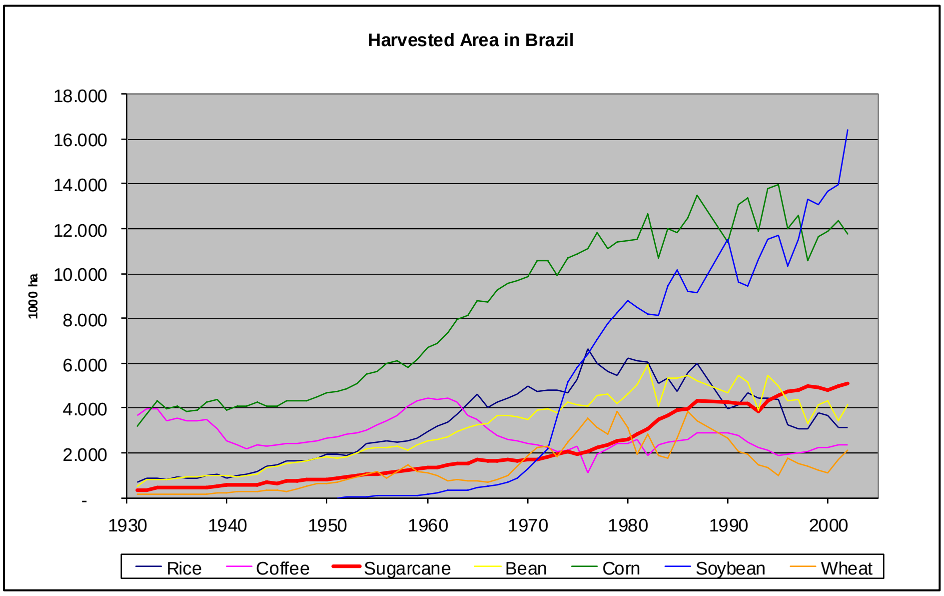

Figure 3.7. Development of major crops in Brazil from 1930-2000. Source: Brazilian Statistics Bureau, several years, in (Macedo 2005).

Impacts: possible future developments

Projections indicate that the area under sugar cane production will increase further in the future in particularly São Paulo, but also other parts of Brazil. The total land required for the enlargement of ethanol production until 2015 is estimated at 3.5-4.0 Mha for a total production of about 35 million liters of ethanol (Walter and Dolzan, 2006). The area of sugar cane production in Brazil is projected to increase by 50 % until 2010 (Goldemberg, 2006). The location of areas suitable for cane production is shown in figure 3.8. This figure shows land suitability for sugar cane plantation, with no irrigation, taking into account soil and weather adequacy. It is clear that at least about 50% of the Cerrado region is not adequate or has low suitability for sugar cane plantation. It can be seen in the figure that a small area in Brazil is highly suitable for sugar cane plantation (the Ribeirão Preto region) and that most of the area occupied with sugar cane in state of São Paulo has in fact just average conditions for this crop.

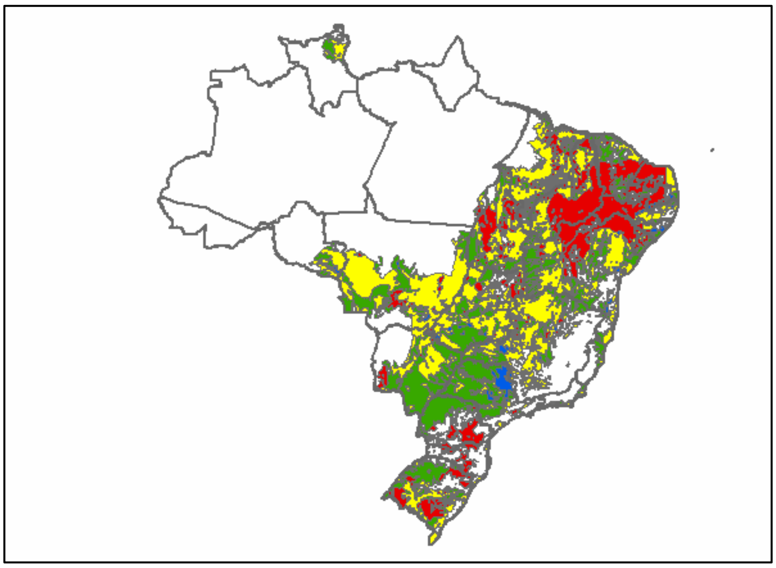

Figure 3.8. Land suitability for sugar cane plantation with no irrigation. Source: Source: CTC – Sugar cane Technology Centre (in Scaramucci and Cunha, 2005). Blue = high; green = average; yellow = low; red = inadequate.

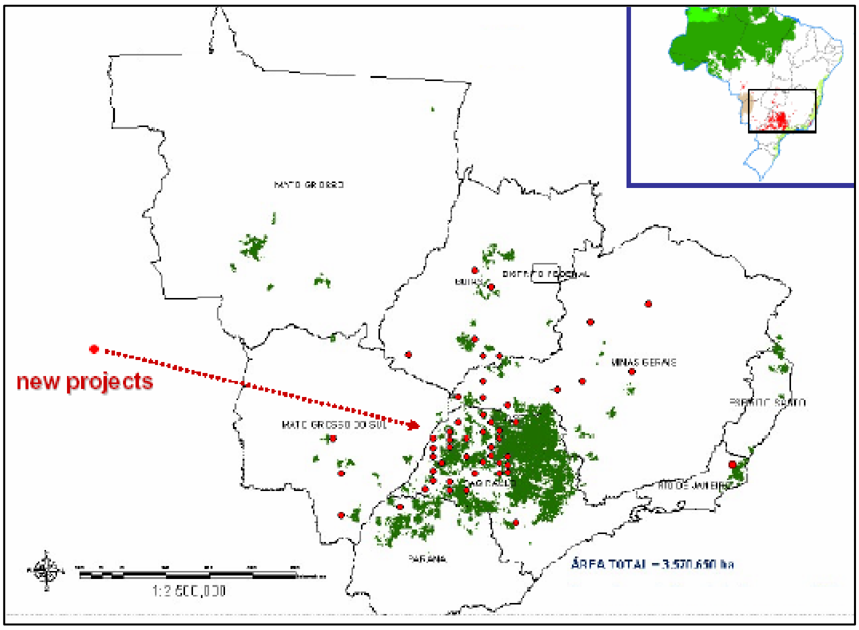

Figure 3.9. Map of new Sugar Mills under implementation (approximately 50), of which the large majority is planned in São Paulo, and a few other plants in Minas Gerais, Mato Grosso do Sul and Goiás. Source: (Macedo 2005).

Even considering that the lands in São Paulo are more expensive than in other parts of the country, the tendency is that about 50% of the 700-730 Mt cane predicted to be produced in 2015 would be produced in São Paulo. There are however no comprehensive official scenarios on land use for Brazil or for the state of São Paulo. Macedo and Nogueira (2005) state that there is no planning on land use regarding sugar cane production in Brazil[11]. There are, instead, studies by the Brazilian Government about land availability, land suitability for certain crops and potential environment impacts on agricultural activities (e.g., IBAMA, 2002). An expansion of the sugar cane area could result in a shift of land use functions to the border areas of agricultural expansion. The cerrados are often mentioned as an important source of agricultural land with favorable topography and climate for agriculture. Cerrados are a similar biome as the African savanna. The total area is estimated at 204 Mha (24% of the total area of Brazil). Presently, the cerrados are increasingly being used for cattle-breeding (ca. 50 Mha were in use in 2002) and agricultural production (mainly grains such as corn, soybeans, rice). The Brazilian Research for Agriculture Enterprise (EMBRAPA) estimates that of the 204 Mha, some 90 Mha are potentially available for crop production, of which 20 Mha are presently used for cattle grazing, see figure 3.10.

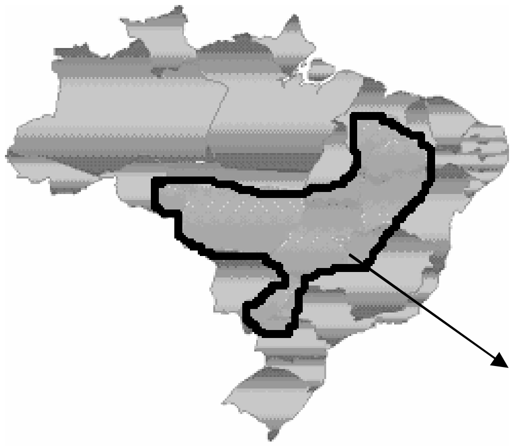

Figure 3.10. Available area for the enlargement of the agriculture Source: UNICA (2004).

Some scenarios suggest that the expansion of the area under crop production will continue at the expense of cerrados. The historic rate of conversion was ca. 3%/y and ca. 50% of the original cerrado has been converted into agricultural areas (mainly for soybeans production and cattle grazing) and urban areas. The cerrados are also seen as an important biodiversity resource: 10.000 plant species, 195 mammal species, 607 bird species, 225 reptile species, 186 amphibian species and 800 fresh water fish species (CI, 2006). Therefore, the cerrado are also included in Brazil's biodiversity protection targets. According to an Embrapa study, the impact of sugar cane production on mammals, birds, amphibians and invertebrates is rated for almost all impacts as level 1 (low) and level 2 (intermediate), and level 3 (medium impact) for reptiles. (Embrapa, 2003 in Macedo, 2005). In addition, deforestation for agricultural development may also continue during the coming decades (IMAGE-team, 2001), following a gradual process starting with partial deforestation, then conversion into pasture land and extensive farming, and followed by a shift to intensive farming.

In theory, the efficiency of agriculture can also be increased substantially, so that less land is required for food production and land can be freed for energy crop production. Smeets *et al.,* (2005, 2006) calculated that in theory up to half of the area agricultural land can be made available for energy crop production in Brazil in 2015, assuming high level of advancement of agricultural technology and an animal production system is which most animal feed comes from feed crops (instead of grazing as is presently the case). These results take into consideration the increase in food consumption and population to 2015. Further, pasture areas have very low densities compared to developed countries averages. There are large potentials for productivity improvements. In SP, cattle population has been raising, even with reduction of pasture land use over time, as shown in table 3.13.

[11] However, for the state of São Paulo, the Deputy Secretary for the Environment of São Paulo, Prof. Suani Coelho,has announced that she is interested in studying the perspectives of sugar cane expansion with the purpose of defining a land use regulation, if necessary.

Table 3.13. Cattle number and the area pasture in Brazil. Source: (Instituto de Economia Agrícola, in Goldemberg, 2006).

	2001	2005
Cattle (heads)	13,154,649	14,072,447
Pasture (hectares)	10,288,887	10,010,491
Density (heads/hectare)	1.28	1.41

Brazilian legislation and standards

However, there are various forest protection laws that directly affect the availability of land for sugar cane production. Riverside woods are specifically protected by both state and federal law, such as the Forest Code of 1965 (and its precursor of 1934), the Environmental Crime Law, rules on permits and licenses and recovery projects, tax legislation on rural properties. In addition to specific legislation, the legislation on Preservation Units is also relevant. The most important law is the Forest Code (Law 4.771/65, as amended by Law 7,803/89 and Provisional Measure no. 2,166-67). The Forest Code of 1965 requires each landowner to maintain a proportion of each property under natural vegetation as a legal forest reserve. Effective legal reserve requirements for rural properties are 80% in the Amazon region, 35% in the Amazonian Cerrado (savannas) and 20% in all other regions. That is in accordance to the proposal approved by the National Environment Council (Conama), which has the representation of all concerned sectors of society.

Many properties are out of compliance with the legal reserve obligation. Consequently, increased enforcement of the law has led to interest in policies that would permit trade of legal reserve obligations. Provisional regulation 2166-67 of 2001, the operative current rule, allows landholders to satisfy the requirement for one property through legal forest reserve located on another. In some cases, the off-site legal reserve may be owned by another party, opening the way to a market in legal reserve rights. Research suggests that a tradable legal reserve program could reduce the opportunity costs of protecting and regenerating a desired aggregate level of forest cover, when the trading scope extends beyond the strictly local area (e.g. municipality or micro-watershed) (Chomitz *et al.*, 2005). However, such a trading system also requires an advanced trading system in which the value of the (un)protected areas must be taken into account and also requires advanced control mechanisms. Thus, only under certain conditions such a trading system is beneficial.

In addition, the Forest Code designated permanent preservation areas (APP), which are:

1. Areas along rivers or water streams. The size of the area depends on the size of the water stream, e.g. 30 m for <10 m wide water streams, up to 500 m for >600 m wide water steams.
2. Areas around lagoons, lakes, or natural or artificial water reservoirs.
3. Areas at springs, yet intermittent, and at 'water holes', whatever the topographic situation, within a radius of at least 50 m.

These regulations exclude urban areas. Note that the existing legislation requires protection, but their restoration is mandatory, except for springs and there is also no definition of an acceptable use and uses as public utility and/or social interest are often mentioned for suppression of vegetation. São Paulo state legislation (Law 9,989 of 1998) requires that riverside woods are recovered by owners of rural properties, but this law was not regulated further.

In case permanent preservation areas overlap with sugar cane fields, the sugar cane fields are generally abandoned and left for natural recovery. This has begun particularly during the previous years. The recovery of degraded riverside woods by reforestation is limited to a portion of the total area. A survey held in São Paulo revealed that areas classified as APP's occupy 0.6% of the sugar cane area (Macedo, 2005), equal to 0.02 Mha. Thus, implementation of the APP legislation will hardly affect the existing area under cane production.

In the legislation discussed above, riverside woods are protected. However, their restoration is not mandatory, except for springs and there is also no definition of an acceptable use and uses as public utility and/or social interest are often mentioned for suppression of vegetation. São Paulo state legislation (Law 9,989 of 1998) requires that riverside woods are recovered by owners of rural properties, but this law was not regulated further.

Dutch and/or international sustainability criteria, legislation and standards

The DPB commission formulated various criteria that are relevant for land use, forest protection and biodiversity. Most criteria are indirectly related to these issues, such as the various criteria on environment (criteria 6 in table 1), but these are discussed in other sections. In addition, there is also a criterion formulate that is related to biodiversity. It states: '*no decline of protected areas or valuable ecosystems in 2007, also active protection of local ecosystems in 2011*' (Table 1). For the year 2007 this means that bioenergy crop production is not allowed near protected areas or high conservation value forests, because of leakage of nutrient and other activities that disturb nearby ecosystems[12]. A reporting obligation applies. For the year 2011 a management plan is required for the active protection of the local ecosystems. Further, although not specifically specified by the DPB commission, compliance with national legislation is also required.

In general, there is a lack of practical applicable criteria and indicators related to land use pattern and biodiversity. Most existing certification systems and guidelines focus on good management practices and the implementation of best available technologies (e.g., EUREPGAP), similar to criteria 6 in table 1. No certification systems were found that include targets on species diversity or on changes in land use. This also means that these systems may be inadequate to avoid damages to ecosystems and degradation and to protect valuable biomes. Possible indicators could be the price of land (a higher land prices indicates an increasing pressure on remaining land sources), the total agricultural area (using statistics or remote sensing), and the number of species in an area. Further research in this field is required.

Implications for certification

Compliance with national legislation (particularly the Forest Code) is a minimum requirement in any certification system. A disadvantage of this approach is that existing law may be inadequate to avoid environmental degradation and protect valuable biomes, especially because there is no comprehensive land use policy or biodiversity policy that includes hard biodiversity targets. The direct impacts of land use for sugar cane production on biodiversity are limited and require no or little action. Additional criteria and indicators are required to prevent indirect negative impacts on land use and consequently on biodiversity as a result of an expansion of the area sugar cane (particularly on the conversion of cerrado land to pasture and/or cropland). Practically applicable criteria and indicators are not available and need to be developed first. Possible indicators could be the price of land, the total area used for sugar cane production (using remote sensing; the total area sugar cane is 13% of the land in São Paulo in 2003), and the number of species in an area. Further research in this field is required. Improvement options include a restriction of the amount of ethanol produced within a region, increase yields of sugar cane production and/or conventional agriculture to reduce the demand for land, exclude sugar cane produced in areas close to valuable biomes.

Costs

No information is available about the costs to protect biodiversity, but the aggregated costs of organic sugar cane are discussed in Section 5.

Conclusions

The direct impacts of sugar cane production on land use/biodiversity are likely limited, since sugar cane production generally replaces conventional crop production and/or pastures, although detailed information about the impacts on biodiversity is not available. In general, only data on land use patterns are available. The indirect impacts from an increase of the area under sugar cane production are likely more severe. The most important indirect impact would be an expansion of the area agricultural land at the expense of cerrados. The cerrados are an important biodiversity reserve. These indirect impacts are difficult to quantify and there is a lack of practically applicable criteria and indicators. Considering the potential impact of indirect effects, this area of concern is categorized as a major bottleneck for a sustainable cane production, in case indirect impacts are included.

[12] In Table 1 an additional criteria is included that states that max. 5% of forest is allowed to be converted into plantations within 5 years. This criterion is specifically for bioenergy production from forestry and therefore excluded.

3.3.4 Soil erosion

Impact assessment

Soil erosion in sugar cane is generally limited compared to conventional agricultural crops such as corn and soybeans, although the exact difference is dependant on local conditions. However, soil losses for sugar cane may vary dramatically from 0.1 t/ha/y to 109 t/ha/y, depending on many factors, such as the declivity, the annual rain fall, the management and harvesting system, etc. (see appendix K for the details of the studies). Compared to pastures the soil erosion rates may be higher, because of pastures generally have a much lower soil erosion rate compared to annual crops (roughly a factor 20 or higher), but no data on soil erosion rates were available that confirm this statement in the case of sugar cane production in Brazil. More detailed information is given below.

Data provided by Quintiliano et al (1961) were extremely important for awaking a conscience towards the soil preservation and against erosion. At that time (50’s, 60´s), and even after 70´s and 80´s, erosion caused by different soil use techniques could be compared through Quintiliano data. However, from the middle of 80´s to the present, soil conservation issues have been rapidly growing as well as the techniques for soil management. Thus, some updated studies such as the one made by De Maria and Dechen (1998), may consider effects of no-tillage techniques and also conservation practices like contoured seeding, furrowing and ripping, use of absorption terraces, non burnt straw and others. These practices will lead to different figures than those presented by Quintiliano *et al.* Some crops may have developed better practices than other shifting the previous picture.

Other studies shows that during a 11 year test period, there was no significant effect of sugar cane production on the soil horizon thickness or physiochemical composition of the soil (CTC, 1993 in Macedo, 2005). The increase in mechanical harvesting (without trash burning) reduces soil erosion: this was determined from tests, where between 10-15 t dry matter sugar cane biomass/ha/y was left on the ground. This allowed the introduction of reduced soil preparation before replanting, as the trash protects the soil from the impact of rain drops and thus prevents soil erosion (Gandini et al., 1996 and Conde and Donzelli, 1997 in Macedo, 2005). The increase in the share of mechanical harvesting is also an explanation for the differences in soil erosion rates. Burnt straw, buried straw and straw on the surface result in soil erosion rates of 20.2 t/ha/y, 13.8 t/ha/y and 6.5 t/ha/y and runoff of 8, 5.8 and 2.5 % of rain fall, respectively (Macedo, 2005).

The usual practice for soil erosion control is bench terracing following the contour in order to prevent excessive runoff. However, conventional harvesting machines cannot operate on terraces and cannot cross them, thus reducing harvest efficiency by up to 40% compared with a field with no terraces. This efficiency decrease is due to excessive maneuvering (up to 50% of the time) to get to the next contoured sugar cane row or getting to neighboring terraces. Up to 25% of the sugar cane planted on terraces has to be harvested manually after the mechanical operation, raising logistic problems and increasing costs (Sparovek and Schnug, 2001). The advantages and lower costs of harvesting sugar cane mechanically on non-terraced and non-contoured fields make it difficult to justify terracing and contouring, and increase the interest in using tillage- and soil cover-based methods instead to control soil erosion. These tillage- and soil cover-based methods can be combined with surface drainage control methods such as drainage terraces and waterways (Sparovek and Schnug, 2001).

Brazilian legislation and standards

Erosion is described in several articles of the Law of Environmental Crimes (Milaré, 2004). Summarising them, two main classifications are possible:

1. Direct impact: any soil degradation or contamination is considered such as a "Crime of Pollution". Law 9605/98 , Article 54 , defines in general terms if a given polluter caused the degradation intentionally or not (dolosus or culposus), and also if the affected site (soil or subsoil) became temporally or indefinetely unsuitable for human use.

2. Indirect impact: pollution of water bodies, flora or fauna caused by erosion in or stemming from the affected site; Deforestation, or any other human activity stemming from the affected site causing indirectly erosion is also embraced by this law.

Beyond the aspects above, penalties will vary according to the nature, itensity and reversibility of the impact. Climate data on rainfall as well as technogies available to avoid erosion are considered to determine negligence or not and thus stating appropriate penalties.

There is also legislation that indirectly affects soil erosion, particularly the legislation regulating sugar cane burning and the one on permanent preservation areas as discussion in Sections 3.3.7 and 3.3.3, respectively. The most important one is the legislation on mechanical harvesting, which allows the use of cane residues to protect the soil and reduce soil erosion and this could reduce soil erosion rates substantially.

Dutch and/or international sustainability criteria, legislation and standards

The DPB requires an erosion management plan (2007). For the year 2011 new performance indicators will be developed. A practically applicable performance indicator is (obviously) the rate of soil erosion (in t/ha/y), whereby various erosion targets can be formulated:

- The natural rate of soil formation. The natural rate of soil formation (from chemical or physical weathering of rock particles into smaller pieces or into various chemical substances) is 1 t/ha/y (OTA, 1993), but figures of around 2 t/ha/y have also been found. For comparison: the average rate of soil erosion in the U.S.A. is 7.7 t/ha/y in 1997 (USDA, 2000). Note that for this reason it may not be realistic to require that soil erosion rates are reduced to the natural rate of soil formation[13].
- The erosion lifetime, i.e. the time necessary under the current agricultural practice to reach a depth of soil known as the minimum soil depth). The minimum top soil depth is defined as the depth in which the inputs (fertilizers, crop residues) and management technology (irrigation, improved genetic crop quality) were insufficient to prevent economic productivity loss. This implies that in a certain agricultural practice erosion is acceptable up to the point where the top soil layer is reduced to the minimum depth.
- The maximum allowed soil erosion rate according to (inter)national standards. For example, the United States Department of Agriculture (USDA) uses a maximum soil erosion rate of 2-11 t/ha/y (Pimentel *et al.*, 1995).

Erosion rates can be calculated using standard calculation methods (e.g., the Universal Soil Loss Equation, USLE) and data on soil profile, climate, slope gradient and length and management. Various international certification systems (e.g., FSC) also require soil erosion protection measures (e.g. buffer zones), but generally do not include targets on soil erosion rates in t/ha/y.

Implications for certification

Soil erosion can be a site-specific problem, so first it must be established if there is a risk of soil erosion or not. The management plan required in the DPB criteria for 2007 will most likely require additional efforts of cane farmers, because management plans are most likely not common practice presently (although we have no data on this). For the year 2011 new performance indicators are required, whereby the rate of soil erosion seems a logical choice. In any case, a certification system should be designed so that local circumstances can be included. Soil erosion control techniques include contour ploughing, the use of buffer zones, the terracing of steep slopes, the use of mechanical harvesting (without cane burning) instead of manual harvesting (with cane burning), the use of a cover crop, the use of a crop rotation system, strip cropping, reduced tillage. Various improvement strategies are available to prevent soil erosion. However, erosion cannot always be prevented and can thus be a limiting factor for cane production in case stringent maximum soil erosion rates are chosen.

[13] This is a general trend in modern agriculture. If no steps are taken to prevent erosion, sooner or later the minimum soil depth will be reached.

Costs

Data on the average costs of erosion prevention measures in the U.S.A. are estimated at 2.3 €/t reduced soil loss for a reduction of soil erosion from 17 t/ha/y to 1 t/ha/y (Pimentel *et al.*, 1995). Detailed data on the costs of the implementation of erosion control technologies in terms of man-hours, tractor hours per technology were not available and/or data specific for Brazil are not available. Assuming a soil erosion rate of 20 t/ha/y, which is among the highest soil erosion rates measured in cane production, the costs of ethanol would increase by 4% (assuming 6000 l ethanol/ha/y and an ethanol price of US$ 0.20/l). Note that this number is a very generic figure that may not be representative for cane production. The usual practice for soil erosion control is bench terracing following the contour in order to prevent excessive runoff. However, conventional harvesting machines cannot operate on terraces and cannot cross them, thus reducing harvest efficiency by up to 40% compared with a field with no terraces. Cost data were however not available.

Conclusions

Soil erosion during sugar cane production can be a site-specific problem. Soil erosion rates under sugar cane production are limited compared to conventional cropland, but are likely higher compared to pastures. Data on soil erosion rates under various land use types are however uncertain. Soil erosion can be prevented in various ways, although it cannot be avoided completely. Consequently, only in case very strict soil erosion rates are applied (which goes beyond the approach applied in existing certification systems and guidelines) soil erosion could be an important bottleneck for certification. As far as soil erosion can be prevented, the costs are likely in the order of magnitude of a few percent of the production costs of ethanol. We conclude that soil erosion can be regarded in general as having a medium impact factor on soil erosion.

3.3.5 Fertilizer use

Impact assessment

Fertilizer application rates are limited compared to conventional crop production and much lower compared to pastures. The use of fertilizers for sugar cane is not perceived as a problem. However, the use of mineral fertilizers is supplemented by the use of nutrient rich wastes (vinasse) from sugar and ethanol production. Particularly in previous times the overuse of vinasse led to serious environmental degradation (see also Section 3.3.1), but such practices have been reduced. No information was found about the present impact of vinasse applications in São Paulo or Brazil in the ecosystem; only site-specific impact assessments are available. Yet, the recently (2005) adopted legislation on vinasse application in São Paulo suggests that the present situation of vinasse application is not optimal. More information is given in the remaining of this section.

The use of fertilizers in cane production in Brazil is modest compared to other countries and to other crops (Macedo, 2005), but the overall use is obviously significant considering the total cane production, particularly in São Paulo. Table 3.14 shows the nutrient demand/uptake/removal and table 3.15 shows the recommended fertilizer application rates.

Table 3.14. Nutrient removal in sugar cane production. Source: (Malavolta, 1982).

	kg/t sugar cane					g/t sugar cane						
Nutrient	N	P_2O_5	K_2O	MgO	CaO	S	Fe	Mn	Zn	Cu	B	Mo
Quantity	0.8	0.30	1.32	0.50	0.42	0.25	31	11	4.5	2.0	2.0	0.01

Table 3.15. Recommended fertilizer application rates in São Paulo for sugar cane production. Sources: (Macedo, 2005).

Country/region	kg/ha		
	N	P_2O_5	K_2O
Plant	50	120	120
Ratoon	100	30	130

Lime is required if pH < 5, or gypsum if pH > 9.5. The use of mineral fertilizers is supplemented by the use of nutrient rich wastes from sugar and ethanol production (vinasse and filter cake; see also the section on water use and pollution). Vinasse is the residue from the distillation of the sugar cane juice, molasses and honey alcoholic fermentation process. The composition varies, dependant on the type, but generally vinasse has a high organic matter and potassium content and relatively poor nitrogen, calcium, phosphorus and magnesium content. A nutrient rich waste that at this moment is not used for fertilization is cane straw, which maybe used in the future.

Advantages of the application of vinasse include the reduced need for mineral fertilizers, a rise in pH, an increased cation exchange capacity, an increased availability of nutrients, improved soil structure, increased water retention and the development of soil micro-flora and –fauna (Macedo, 2005). Disadvantages are the risk of salinisation and nutrient leaching, although results obtained from tests so far indicate that there is no damaging impact on the soil or groundwater at doses lower than 300 m^3/ha (Macedo, 2005). However, this figure may not be used as a standard, because requires a site-specific evaluation of the nutrient balance. No information was available about a typical nutrient balance of a sugar cane plantation or ferti-irrigated field. The rate at which areas are covered by ferti-irrigation is highly variable, depending on topography and distribution of the mill's land. Research is ongoing to further optimize the nutrient recycling and there is a large (commercial) interest from the sugar cane industry considering the benefits. The form of "large-scale wastewater processing" most frequently used is overhead irrigation or, rarely, basin irrigation. The preconditions for this are level undrained areas, deep soils with no tendency to silting and a low water table (> 1.30 m). During the passage through the soil, the following processes take place:

- Mechanical filtration on the surface
- Absorption of the dissolved substances by bacteria in the soil
- Biological oxidation of filtered and adsorbed material by bacteria in the soil in the intervals between the individual doses of wastewater

For an overview of studies on the impact of vinasse applications, see Macedo (2005).

Brazilian legislation and standards

No legislation was found on the use of fertilizers, but there is detailed legislation in Brazil on the application, storage and processing of vinasse. The following legislation regarding vinasse is available:

- National Integration Ministry (MINTER) Ordinance 323 (1978) prohibited the release of vinasse in surface fountainheads, because of the negative impact of environmental impacts on the aquatic life and surrounding vegetation as a result of the high BOD and/or low pH and/or high temperature.
- National Environment Council (CONAMA) Resolution 0002 (1984) and 0001 (1986) required studies and determination of rules on the control of effluents from ethanol distilleries, both for new units and extensions.
- State Law 6,134 (1988), article 5 requires that wastes from industrial and other activities shall not contaminate underground waters.
- Environmental Protection Agency (CETESB) standards. In the state of São Paulo, potentially polluting emissions released by any sort of activities must comply with standards set by CETESB – which is the technical branch of Secretary of Environment of State of São Paulo. The Cetesb Technical Rule P4.231 (2005), sets:
    - Sensible areas in which vinasse use remains being prohibited;
    - Standards for vinasse storage according to the Rule NBR 7229 – ABNT;
    - All areas formerly used for vinasse disposal (sacrifice areas) should be immediately closed, and after that they should be assessed according to procedures of Cetesb no. 023/00/C/E. Results should be compared with standards set by Cetesb no. 014/01/E and a Directive from Ministry of Health 518/04.
    - For any area, it should be installed at least 4 monitoring wells according to the rule ABNT-NBR13.895 and CETESB-06.100, for checking standards of pH, hardness, sulfate, manganese, aluminium, iron, nitrate, nitrite, ammonia, Kjeldahl nitrogen[14], potassium, calcium, dissolved solids, conductivity and phenols; A legal responsible contracted by/ working for the sugar mill company will then undertake the monitoring, sending the samples for examination to an accredited lab, which will determine whether the samples meet Cetesb standards.

[14] Total Kjeldahl nitrogen is defined as the sum of free ammonia and organic nitrogen compounds.

  - In case of existing monitoring drains, they can substitute wells;
  - Use of geomembrane to make tanks and channels impermeable;
  - Every year, up to April 2nd a plan must be presented to the CETESB containing data on the vinasse utilization for the next campaign, containing the following aspect: the maximum amount of K_2O permitted to be use in one ha is 185 kg (depending on the potassium remaining in the soil), if it does not surpass 5 % of soil cation exchange capacity (CEC);
- A Funding programme named Procop – Pollution Control Programme - is available to help ethanol and sugar producers aiming at financing the expenditure needed for P4.231 compliance. The private bank Banespa (Santander) is offering resources at about 14% (per year) and 5 years to pay in amount up U$ 1 million/plant.

Dutch and/or international sustainability criteria, legislation and standards

The DPB commission formulated four criteria (criteria 6a to 6d in table 1) that are directly relevant to water pollution and thus also for fertilizer and vinasse use, which are:

- Waste management
- Use of agro-chemicals, including. fertilizers
- Prevention of soil erosion and nutrient depletion, see also section 3.3.4.
- Preservation of quality and quantity of surface water and ground water

See in table 2.1 for details of the criteria. Compliance with local and national law is a minimum requirement for the year 2007. For the year 2011 additional criteria are required, for which additional performance indicators will be formulated. Various (inter)national legislation frameworks, certification and reporting systems can be used to develop indicators and criteria. For vinasse potential indicators are pH, total suspended solids (TSS) and biological oxygen demand (BOD). No information was found on international sustainability criteria, legislation and standards related to fertilizer use and vinasse application rates.

Implications for certification

The issue of fertilizer use and its potential positive and negative impacts should be a key target for any certification system for ethanol. The minimum requirement is compliance with the national/regional legislation. This criterion may require additional measures, because the legislation on vinasse has only recently been implemented and also the enforcement may be weak. In addition, at this moment legislation in Brazil does not require a complete nutrient balance, which is crucial to evaluate the environmental impacts of vinasse applications. Thus, additional criteria may be required to prevent further environmental degradation, which is in line with the criteria of the DPB for 2011. Note that criteria regarding fertilizer and vinasse use overlap with the issues of water use and water pollution, whereby water recycling and the reuse of the suspended solids (which include the nutrients) is an important issue, and may therefore be analyzed together. See further Sections 3.3.1 and 3.3.2 on water use and water pollution, respectively. Key improvement strategies include the recycling of nutrients in wastewaters and optimal species selection.

Costs

No information is available about the costs to optimize the use of fertilizers and vinasse. However, the aggregated costs of organic sugar cane, which include some improvements) are discussed in Section 5.

Conclusions

The use of synthetic fertilizers is of little importance: the use is limited both in absolute terms as in relative terms (compared to conventional crop production). The use of vinasse as fertilizer (ferti-irrigation) is however an important source of environmental degradation, particularly in the past. The use of vinasse is closely related to the issues of water use and water pollution. Legislation has been recently been implemented aimed to avoid the negative impacts vinasse applications. Yet, additional requirements are desirable, considering the general poor law enforcement. Various well-established improvement strategies can be used to reduce the environmental impacts of energy crop production. We classify this issue as a medium bottleneck for ethanol production.

3.3.6 Genetically modified organisms

Impact assessment

Since 1997 the Sugar Cane Technology Centre (CTC) has been developing transgenic sugar cane varieties, including experimental planting. CTC has been involved in molecular biology research since 1990 when it headed the International Sugar Cane Biotechnology Consortium (ICSB in Portuguese) in which 17 institutions and 12 sugar cane producing countries are united. The CTC has received a bio-safety quality certificate from the Ministry of Science and Technology that allows it to undertake field experiments (Macedo, 2005).

In addition, Brazil has recently completed the Cane Genome project, in which some 40 thousand genes have been sequenced that are involved in plant development, in the production and the amount of sugar in the plant, in the resistance to disease and so on (Macedo, 2005). No specific information is available on the impact of GMO sugar cane on the ecosystem. The potential impact of GM-plants is subject of extensive research and debates, but the uncertainties are high and consequently there is no consensus. In general, the (potential) impact of GM-plants varies dependant on the exact genes that are altered or introduced. Some GM-bacteria and enzymes are widely used, and impacts seem generally accepted by the public.

Brazilian legislation

The use of GMO's has only recently been allowed in Brazil. Genetically modified organisms (GMO's) have been banned in Brazil for a long time, but illegal planting of GMO's has occurred on a wide scale: 8-22% of the soy bean area is planted with genetically modified seeds illegally imported from Argentina. As a result, the Brazilian government has now legalized the use of GM soybeans. It is expected that regulations regarding GMO's will be streamlined and that more GMO's will be approved in the future (Contini *et al.*, 2005, Fontes, 2003). Three ministries are responsible for the approval of planting experiments. Each of these has their own protocols and requirements, but the details have not been investigated. See Fontes (2003) for an overview and discussion of legislation.

Specifically regarding GMO's and sugar cane, according to the Brazilian law, the Technical Commission on Bio-Security – CTNBio – regulates the activities on GMO and is responsible for the required authorization for experiments and plantations on GMO. The CTNBio has given permission for the experiments at laboratory (for instance, there are thousands of plants at the CTC labs) but hasn't given authorization for the experiments at the field. In 2000 the CTC was able to start experiments at the field with GM-sugar cane, but CTNBio has stopped these activities due to a broad discussion in Brazil about GMO's.

In synthesis, as far as known to the authors, no GM-sugar cane species has been completely tested. After an eventual permission from CTNBio, another three years of field test will be required order to prove the plants effectiveness. (Walter and Dolzan, 2006). Commercial results may arise over the next five years (Macedo, 2005).

Dutch and/or international sustainability criteria, legislation and standards

The DPB requires for the year 2007 compliance with US safety regulations and for the year 2011 compliance requires compliance with EU safety regulations. Details of these safety regulations have not been analyzed here. However, various international certification systems (e.g., FSC) and non-governmental organizations (e.g., Greenpeace) reject the use of GMO's, except for traditional applications (e.g., the use of GM yeast in bread production). Yet, the application of GMO's must always be judged on a case-by-case basis, as basically goes for any GMO.

Implications for certification

The potential impact of GMSC on the ecosystem is subject of debate, but there is no consensus. The big uncertainties and wide range of modification that are possible do not (yet) allow the formulation of generally applicable criteria for GMO's that focus on the impact of GMO's on ecosystems. In general, GMO's must be evaluated on a case-by-case basis. Further, considering the limited amount of information on the impact of

GM-sugar cane, and the public opposition in particularly the EU, the use of GM-plants may be restricted, at least until more information is available. A similar approach is used in existing certification systems. The DPB commission proposed to take the safety regulations in the US (2007) and the EU (2011) as criteria. Potential strategies to reduce the impacts of GMO's include the long term monitoring of ecosystem impacts of the introduction of GMO's, increase R&D for conventional sugar cane breeding programmes, optimal use of existing technologies to prevent the need for GMO technologies.

Costs

No information is available about the costs or benefits of an introduction or a ban on GMO's.

Conclusions

At this moment, genetically modified sugar cane (GMSC) is being developed, but not yet being used. To what extend GMSC is a bottle neck for ethanol production is dependant on the criteria applied. A ban on GMSC is likely relatively easy to enforce, although the additional costs (= the benefits from GMSC that are not received) are unknown. In case GMSC are allowed than this could become a major bottleneck for certification, considering the large uncertainties surrounding the environmental impacts of GMO's.

3.3.7 Sugar cane burning

Impact assessment

Cane burning is the burning of the leaves and cane stalk tops of cane standing in the field. The goal is to reduce the costs of manual harvesting and the costs of transportation. The burning of cane has gradually decreased in SP, from 82% of the harvested area in 1997 to 63% of the harvested area in 2004. The shift from cane burning (and manual harvesting) to no cane burning (and mechanical harvesting) has both negative and positive impacts. The most important negative impact is the reduced employment. The most important positive impacts are the reduction of emissions that are potentially harmful for human health, the reduction of damage to infrastructure and forests, the reduction of soil erosion rates, and the reduction of greenhouse gas emissions from cane burning. More information is presented below.

Cane burning has various impacts:

- Air emissions. Cane burning results in emissions that are potentially damaging for human health: CO, CH_4, non-methane organic compounds and particle matter. Cane burning is also related to increased ozone levels in cities where sugar cane is produced. Many studies have been carried out during the 80's and '90's that focus on the impact of emissions from cane burning on human health. Some studies did not find a direct relationship between cane burning and damage to health (e.g. Sinks et al. 1993). On the other hand, a number of studies were performed in Brazil by the Experimental Atmospheric Pollution Laboratory (LPAE) of the Pathological Department from the University of São Paulo Medical School (FMUSP). Essentially, their main conclusions are: '*There was a significantly positive and dose dependent association between the number of inhalation treatments and the weight of sediment, which was used as a measurement to the particulate matter resulted by the sugar cane burning'* (Arbex et al., 2004), '*air pollution from biomass burning causes damage to the respiratory system, leading to an increase in respiratory hospital admissions. This effect is higher for children and the elderly, and it is similar to that observed in urban areas due to exposure to industrial and vehicle-emitted air pollutants*' (Cançado et al., 2006), and '*The health effect is determined not just by acute exposures to high pollution levels but also, and more importantly, by the length of time that people spend breathing polluted air chronically (…). However, the magnitude of chronic effects is not known'* (Bates et al,. 2003).

  In any case, it can be expected that any type of uncontrolled burning is potentially dangerous and should be avoided therefore. In table 3.16, the emission factors of cane burning are shown, based on various sources. Cane burning causes nuisance due to the emissions of particularly carbon particles, which are known as "carvãozinho" Further, the emission of especially methane (CH_4) from cane burning is a significant contributor to the overall emissions of greenhouse gasses during the production of ethanol, being responsible for, up to 20% of the total emissions, dependant on which CH_4 emission factor was used :

(EPA, 1995, IPCC, 2001, Jenkins, 1994, Macedo *et al.*, 2004). The IPCC recommends the use of generic values for the emissions from the burning of agricultural residues when specific data are not available. The conservative value proposed by the IPCC was also used in the study on greenhouse gas balance of ethanol production (Macedo *et al.*, 2004); (see further discussion in the section on greenhouse gas emission balance).

Table 3.16. Emissions from cane burning (in kg/dry t trash[1]). Sources: (EPA, 1995, IPCC, 2001, Jenkins, 1994, Macedo *et al.*, 2004).

Source	Particle matter	CO	CH_4	Non-methane organic components	N_2O
(EPA, 1995)	2.3-3.5	30-41	0.6-2.0	2-6	
(Jenkins, 1994)			0.32-0.59[2]		
(IPCC, 2001)			2.86		
(Macedo et al., 2004)					0.082

1. The amount of cane trash and tops is 8-48 t/ha/y in the US, dependant on the cultural practice. According to Macedo (2004) the amount of trash in Brazil is 0.14 dry t/t cane, with a yield of 82.4 t cane/ha/y, which equals 11.5 dry t trash/ha/y. Macedo (2004) assumed that 80% of the cane fields were burned with an efficiency of 90%.
2. The value of 0.32 kg/dry t is for spreading fire (this value is considered representative for and the value of 0.59 is for pile fire.

- Damage to infrastructure and forests. Cane burning results in risks for electrical systems, railways, highways, and forest reserves.
- Damage to the cane plantation. Cane burning can damage to the cell tissue of the cane stem, and thus increase the risk of infection, destruction of organic matter, damage to the soil structure due to increased drying, and increased risks of soil erosion.

When mechanical harvesting instead of manual harvesting is applied, cane burning is no longer required. Manual harvesting requires that cane fields are being burned; manual harvesting without cane burning is possible, but this is generally not economically feasible, because manual harvesting efficiency of green cane is roughly five times lower compared to manual harvesting of burnt cane. Note that workers are usually paid per unit of length/row, and not on harvested weight basis. Mechanical harvesting is based on unburned (green) cane harvesting. The percentage of cane fields that is burned has decreased during the recent years, as a result of legislation and technological improvements of mechanical harvesting systems. Additional reasons why mechanical harvesting is applied are to ensure a constant cane supply also in times when labor is scarce and to reduce harvesting costs. A limiting factor is the high investments costs associated with mechanical harvesting. As a result of all these factors, mechanical harvesting in São Paulo has increased steadily from ca. 18% of the harvested area in 1997 to 37% in 2004 (IDEA, 2002 and CTC, 2004 in Macedo, 2005). For comparison: in the Northeast region about 10% of the crop area is harvested mechanically. The fraction of raw (unburned) sugar cane in mechanical harvesting increased from 22% in 1997 to 65% in 2004 (IDEA, 2002 and CTC, 2004 in Macedo, 2005).

The increasing use of mechanical harvesting systems has encountered opposition from labor unions, because of the expected loss of jobs. A situation of full mechanical harvesting in São Paulo and 50% mechanical harvesting the rest of the country, 165000 jobs would be lost compared to a fully manual harvesting system (Macedo, 2005). The use of trash for energy generation may create some 12000 jobs in agriculture in case balers are being used to collect the biomass for energy generation. Alternatively, the cane can also be harvested including leaves and tops so that the residues are separated from the cane at the mill. The employment effect of the latter option is unknown, but probably limited. Another disadvantage of mechanical harvesting is the occurrence of some diseases and pests increases compared to a cane burning manual harvesting system. Mechanical harvesting may lead to an increase of the use of pesticides and insecticides or may lead to lower yields.

The legislation on cane burning takes these aspects into consideration: the law requires a gradual ban on cane burning (cane burning is planned to be phased out completely in São Paulo in 2030), and a program of professional requalification exists to those rural workers who used to harvest sugar cane and were replaced by the mechanical harvesting.

Brazilian legislation and standards

Legislation is implemented in São Paulo in which a sugar cane burning phasing out schedule is included, including detailed prescriptions how, where and when cane burning is allowed. Also a reporting requirement for cane produces is included in which cane producers are required to specify a cane burning reduction schedule. Cane burning is projected to be completely phased out in 2031. The legislation specifically takes into account the practical socio-economic consequences, i.e. the high capital costs associated with mechanical harvesting as well as employment effects. More information is given below.

The main norms pertaining to the issue of sugar cane harvesting burning practices set by federal and state requirements in the State of São Paulo are:

- State Law Number 6,171 (July 04, 1988), about the use, conservation and preservation of agriculture soil.
- State Law Number 8,241 (November 23, 1993) amending the State Law Number 6,171, about the use, conservation and preservation of agriculture soil.
- State Decree Number 42,056 (August 6, 1997), about burning sugar cane husk in harvesting. This decree establishes a series of places and circumstances where burning practices are totally forbidden, which are:
  - Within 1 km from urban centres;
  - In areas along electricity transmission and distribution lines, according to kW measurements;
  - In an area within 100 m from electric energy substations;
  - In an area within 25 m around telecommunication stations;
  - In an area of 1 km around public airports;
  - In an area of 50 m along state and federal highways and railways;
  - In an area of 100 m around public protection areas;
  - There should be a line of clear land of at least 10 m between sugar cane plantations and protected areas, and forest reserves.
- Joint Resolution Number 01/98 by the State Secretariats for Agriculture and for the Environment (June 04, 1998), which regulates the gradual elimination of burning sugar cane husk, and establishes deadlines:
  - Mandatory presentation of a phasing out program ("P.E.Q.") by every industry that uses sugar cane as a raw material, which should be signed by agronomists, as the responsible technicians;
  - Criteria for the establishment of phasing out programs;
  - Deadlines for gradual phasing out of burning practices, with the minimum percentage of areas to be included;
  - Requirement of annual reports relating to the gradual elimination of burning practices, with illustration maps;
  - The party responsible for conducting the burning shall: (a) inform neighbors about burning at least 48 hours before starting; (b) put signs on the roads, should it be the case; (c) organize security teams if control of fire should be needed.
  - Burning practices should take place at a time and under meteorological conditions that should allow better dispersion of pollutants and minimize security and public health risks, as well as inconveniences to the surrounding community;
  - Each program will last for two years, and should specify the quantity (in mass) of sugar cane husk to be burned by area.
- Federal Decree Number 2,661 (July, 8, 1998).
- State Law Number 11,241 (September 19, 2002). Both Federal Decree 2,661 and State Law 11,241 ask for a burning elimination schedule and specify prohibition areas as protection ranges near urban areas, highways, railways, airports, forest reserves and preservation units. In São Paulo the burning reduction schedule shown in table 3.17 is in force.

Table 3.17. Burning reduction schedule that is in place in São Paulo.

	Area where mechanical harvesting is possible (Soil tilt <12%)	Area where mechanical harvesting is not possible (Soil tilt >12%)
2002	20%	-
2006	30%	-
2011	50%	10%
2016	80%	20%
2021	100%	30%
2026	-	50%
2031	-	100%

Dutch and/or international sustainability criteria, legislation and standards

The DPB criteria do not contain criteria specifically for cane burning. A limited internet search did not reveal information about international sustainability criteria, legislation or standards, except for Australia and the US where no harvest programmes have recently been introduced. This implies cane burning is generally not considered as favorable, despite some positive aspects, although this comparison may not be correct: in Australia cane burning is also applied in case of mechanical harvesting, and thus there are no negative employment effects of a reduction of cane burning.

Implications for certification

Compliance with national legislation is a minimum in most existing certification systems. A general bottleneck is the enforcement of legislation and therefore it is advisable to check if cane producer meets the legal standards which can relatively easy be verified by checking if the required documents are available, e.g., cane burning permit, cane burning phasing out plan (P.E.Q.), and if these documents are approved by the authorities and meet the legal standards. Further, burnt and harvested cane(fields) can easily be distinguished from green and harvested cane (-fields). In addition, the fraction of the cane that is manually or mechanically harvested can also be used as a criterion and indicator. Note that a further reduction of cane burning is generally accompanied with a shift from manual harvesting to mechanical harvesting. Compensation may be desired for the negative employment effects, either through schooling and reallocation programmes or social benefits. Further, a bottleneck for mechanical harvesting is the high capital cost and mechanical harvesting is problematic on slopes with a gradient higher than 12%. The determination of the percentage should take into account the negative and positive aspects and the bottlenecks of a further reduction of cane burning, preferably through stakeholder consultation. For companies with large cane production areas, it seems reasonable to require a fraction similar as included in the cane burning phasing out schedule required by local/regional law.

Costs

Cane burning can be avoided by using mechanical harvesting systems, but this has a negative employment effect. The negative employment effect can be avoided if manual harvesting is applied. Such a system is presently not used in Brazil, because of the higher harvesting costs. Present manual harvesting rates are around 10 t/d. In green cane that is not burned, the harvesting capacity of a hand laborer decreases five-fold (Ripoli and Molina Jr, 1991). In the early 1990's, 21-24% of total cane costs (including land, capital costs, and all other fixed and variable costs) corresponded to labor costs, 60% of which is related to unskilled labor used in harvesting (Macedo, 1995). Sugar cane accounts for 60% of the net production costs of ethanol. Thus, manual green harvesting would increase the costs of ethanol by a factor 1.4.

Conclusions

The issue of cane burning is complex because a cane burning plus manual harvesting system has negative and positive impacts compared to a no cane burning plus mechanical harvesting system. Despite some positive impacts, legislation in Brazil requires a gradual ban on cane burning between now and 2031, which is in line with the trend in other sugar cane producing countries. In case cane burning is further restricted, then specific attention must be given to the balance of the negative and positive impacts. The most important negative impact of a employment effects resulting from the shift from manual cane harvesting (which includes cane burning) to mechanical cane harvesting (which excludes cane burning). The costs to fully compensate for the reduced employment as a result of mechanical harvesting increases the costs of ethanol by 40% and is thereby a significant bottleneck for certification.

3.3.8 Greenhouse gas emission and energy balance

Impact assessment

Only a few estimates of greenhouse gas emissions and energy balances of ethanol production were found in literature. One study is carried out by Macedo and co-workers (2004). Note that Macedo published various other studies as well, but we included only the most recent work. The second publication is from Oliveira and co-workers (Oliveira *et al.*, 2005). Table 3.18 shows the energy and greenhouse gas balance of ethanol production.

Table 3.18. The energy and greenhouse gas balance of ethanol production.

Source	Energy output : input		GHG emission (kg/m^3)	
Oliveira et al., 2005	worst cane 3.1	best case 3.9	worst cane 572	best case 461
Macedo et al., 2004	average case 8.3	best case 10.2	average case 389	best case 359

There is a significant difference between the results in these two studies. A more detailed analysis of the underlying data is shown in table 3.19.

Table 3.19. Energy inputs used for sugar cane production.	Macedo et al., 2004	Macedo et al., 2004		Oliveira et al., 2005
	GJ/ha	GJ/ha		GJ/ha
Agricultural operations	2.61	2.61	Diesel fuel, various operations	23
Transportation	2.95	2.51		
Fertilizers	4.57	4.36	Fertilizers	4.78
Lime, herbicides, pesticides, etc.	1.32	1.32	Lime, herbicides, insecticides	1.99
Seeds	0.40	0.38	Seed	3.35
Equipment	2.00	2.00		-
			Labor	2.86
Total	13.86	13.18	Total	35.98

The main difference is the use of diesel for agricultural operations, for which according to Oliveira and co-workers assumed a value of 23 GJ/ha, compared to 2.61 GJ/ha assumed by Macedo and co-workers. A further analysis revealed that the 23 GJ/ha refers to emergy and not to energy (see Ortega et al., (2003)). Emergy and energy are different concepts[15]. Also, from another recent paper form Ormetto and Ortega (2004), we were able to calculate the diesel consumption at 2.80 GJ/ha., i.e. only slightly higher than the values used by Macedo et al. 2004. Therefore, we have strong evidence that the value for diesel consumption used by Olivera et al. is erroneous, and we decided to exclude their results in our analysis.

[15] Emergy is a contraction of the term 'embodied energy'. However, emergy is also used to refer to the concept of energy memory as well as the sequestered energy and emergent property of energy use. There are various definitions of emergy: 1). emergy can be defined as the total solar equivalent available energy of one form that was used up directly and indirectly in the work of making a product or service 2). Emergy expresses the cost of a process or a product in solar energy equivalents. The basic idea is that solar energy is our ultimate energy source and by expressing the value of products in emergy units, it becomes possible to compare apples and pears. Source: http://en.wikipedia.org/wiki/Emergy

According to Macedo et al., (2004), the energy balance of ethanol is 8.3 (average) to 10.2 (best available technology). In terms of GHG emission reduction, ethanol from sugar cane is generally regarded the most efficient biofuel currently under commercial production (IEA, 2004, see figure 3.11). When compared to gasoline, the reduction of greenhouse gas emissions per kilometer is estimated to be between 85-90%.

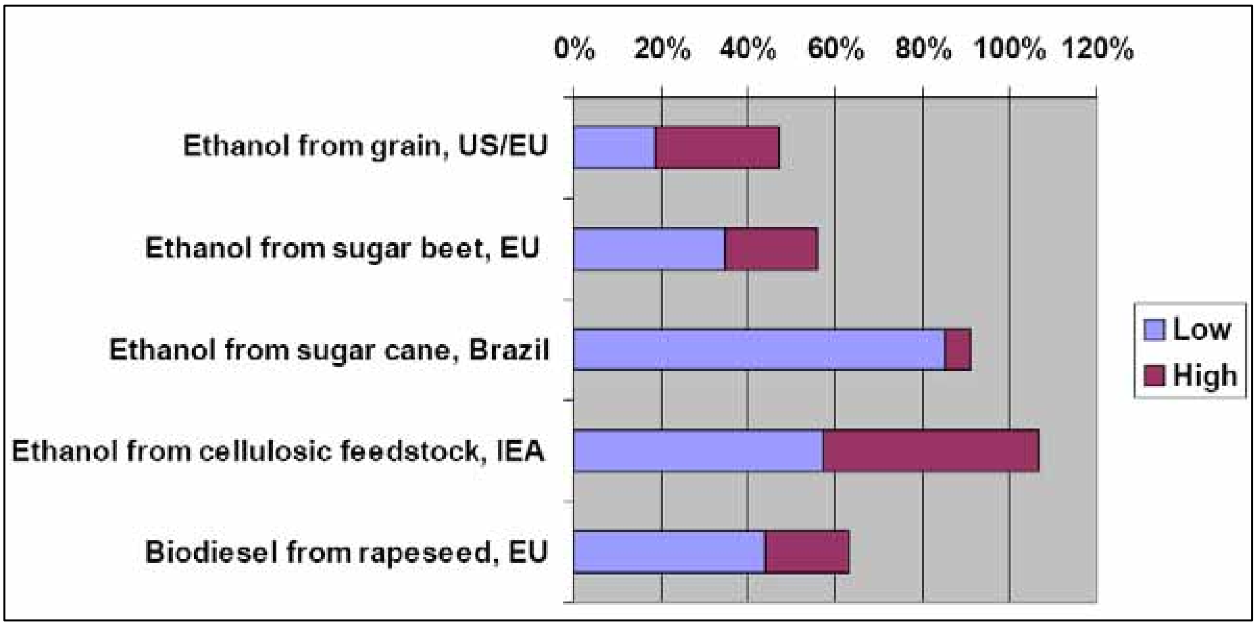

Figure 3.11. Reduction in well-to-wheel CO_2 equivalent GHG emissions per km, compared to gasoline (for ethanol) and diesel (for biodiesel). Source: IEA, 2004.

Regarding the future development of ethanol production, the conversion of bagasse into ethanol and/or electricity is crucial for the overall performance, and substantial increases are possible when this lignocellulosic feedstock can also be used for ethanol production. Macedo (2005) estimates that if a given mill should adopt a hydrolysis process t produce ethanol instead of surplus electricity, it could use 30% of the excess bagasse (improving the processes) and 50% of the can trash to produce around 34 additional liters per tonne of sugar cane. In addition, there are also substantial gains possible in the efficiency of electricity use and generation: the electricity used for distillery operations has been estimated at 12.9 kWh/tonne cane, with a best available technology rate of 9.6 kWh/tonne cane (Macedo, et al, 2004; Oliveira et al, 2005). For electricity generation the efficiency could be increased from 18 kWh/tonne cane presently, to 29.1 kWh/tonne cane maximum (Macedo, et al, 2004; Oliveira et al, 2005). The production of surplus electricity could in theory be increased from 5.3 kWh/tonne cane to 19 kWh/tonne cane. In addition, there are various other efficiency improvements possible in the cultivation of sugar cane and the logistic chain, see for more details Damen (2001). An assessment of the potential impacts on energy and greenhouse gas balance of the technological developments reported above goes beyond the scope of this study, but it can be concluded that there is a substantial potential for further efficiency increases.

Further, the soil carbon balance is an issue that must receive further attention. In Brazil, the evaluation of the emission of GHG for the 1990-1994 period indicates that change in land use and forests accounted for 75% of all GHG emissions, followed by energy (23%) (Macedo, 2005). In general, it can be said that the conversion of land from pastures to cropland leads to a significant loss of soil organic carbon (SOC). More specifically for the Brazilian situation, Silveira et al. (1999) found a decrease in SOC of 24% (over 20 years) when forest is turned into pasture land in Brazil leading to 47 tonne of carbon (tC) per ha for pasture land. This was followed by a decrease of 22% over 20 years when a sugarcane plantation is established on the pasture land, i.e. a SOC of 36.5 tC/ha on sugarcane plantations. So, if the additional land-use for sugar cane production leads (directly or indirectly) to conversion of pastures, the GHG emissions may be severe and could have a major impact on the overall GHG balance. This is also shown by Laurijssen (2006).

However, we emphasize that:

- little data are available to quantify soil carbon losses, and they depend on a large number of assumptions, e.g. the time frame to measure soil carbon loss, various carbon accounting systems, the definition of the reference system, etc. Thus, the numbers presented above should be seen as indications.
- it is very difficult to determine the indirect effects of further land use for sugar cane production (i.e. sugar cane replacing another crop like soy or citrus crops, which in turn causes additional soy plantations replacing pastures, which in turn may cause deforestation), and also not logical to attribute all these soil carbon losses to sugar cane.
- these effects have not yet been fully included for the GHG emissions reduction comparison by the IEA (2004), or for that matter for any other biofuel.

Quantifying these effects and their uncertainty clearly exceeds the scope of this research, but is deemed very important and strongly recommended for further research.

Brazilian legislation and standards

There is no legislation regarding this issue.

Dutch and/or international sustainability criteria, legislation and standards

The DPB criteria state that the net GHG emissions must be reduced by 30% in 2007 and by 50% in 2011 compared to the fossil fuel reference system. This is a general criteria relevant for biofuels and thus not specifically for ethanol from sugar cane from Brazil. The DPB criteria also state that GHG emission due to land use changes have to be taken into account.

Implications for certification

The criteria as formulated by the DPB commission require a net GHG emission reduction of 30% in 2007 and 50% in 2011 compared to the fossil fuel reference system. The emission reduction from the use of ethanol as a biofuel results in a GHG emission reduction of 80% or above. Thus, the criteria as formulated by the DPB do not require additional activities. However, additional targets may be desired, since several technological improvement options are available that could further increase the GHG balance and/or reduce the costs.

Conclusions

Compared to other biofuels ethanol has a very favorable GHG balance. Thus, it can be expected that criteria related to the GHG balance in general require no further action for the current situation, unless specific criteria for ethanol included. Specific criteria related to ethanol may be useful particularly to stimulate the efficient production of ethanol and/or to stimulate innovation. Examples of innovations are the conversion of bagasse to ethanol and the increase production of (surplus) electricity from bagasse. For new sugar cane plantations, direct and indirect GHG emissions due to land use change may have a (potentially large) impact on the GHG balances. However, to quantify these impacts is beyond the scope of this report.

3.4 Socio-economic criteria

3.4.1 Competition with food production[16]

Impact assessment

Despite the abundance of suitable soils and favorable climate for agriculture, the subsidies and other incentives given for sugar production and for fuel ethanol in the 70's and 80's caused a shift in land use patterns from food crops to sugar cane production. For example, the 362.000 ha of cane added in São Paulo between 1974 and 1979 occurred largely at the expense of food crops. The greatest impact was on maize and rice, of which the planted area declined by 35% (Saint, 1982 in ESMAP, 2005). According to ESMAP/Saint, the result was higher food prices that affected especially the poor, though it is unclear how this relationship was measured. The net value of sugar cane and ethanol production is thus reduced by the loss of value added on the crop being substituted (ESMAP, 2005), but no further information is available on the overall impact on the economy. However, positive indirect impacts through the generation of additional income have been not been taken into account and also no data were available about the magnitude of these indirect impacts. More recent analysis is not available. Further, research has shown that the efficiency of the Brazilian agriculture is well below what is (theoretically) agro-ecologically feasible (Smeets *et al.*, 2005). This implies that the impact of an increasing sugar cane production can be avoided in case gains in efficiency of food production are pursued.

In addition to the competition for land and other production factors between sugar cane production and food production, there is a direct link between ethanol production and sugar production, since many mills produce both sugar and ethanol. The ratio sugar to ethanol that is being produced is mainly dependant on the relative price of ethanol and sugar. However, since sugar accounts for only a small fraction of food consumption, this impact has not been discussed further in this study.

Brazilian legislation and standards

There is no legislation on this issue.

Dutch and/or international sustainability criteria, legislation and standards

The DPB criteria include a reporting requirement for the year 2007 and for the year 2011 new indicators will be developed. As far as we know, there are no existing certification systems or guidelines that provide help how this criterion can be operationalised.

Implications for certification

The indirect impact of sugar cane production on food supply could be included in a certification system by means of a reporting requirement. Criteria and indicators need to be developed; possible indicators are:

- Food consumption. Food consumption levels (in kcal/cap/day) and patterns can be monitored directly or derived from statistics or models.
- Food prices. Food prices can be used as a proxy for food availability, although food prices must also be viewed in relation to the income. Data on food prices are generally easily available.
- Land use patterns. Land use patterns can be monitored based on tabular statistics as well as remote sensing.

Further, various tools can be used to assess the impact of large scale ethanol production on these indicators. Examples are:

- Input-Output (I/O) analysis. I/O analysis can be used to calculate the indirect impacts on employment, GDP, income from the use of goods and services used for the production of ethanol.

[16] The issue of competition also goes for competition with local energy supply, medicines and building materials. Here we focus on food production, although the conclusions are also applicable for the competition with these other functions.

- Social Accounting Matrix analysis / Closed I/O analysis. This analysis is an extension of the standard Input-Output analysis, and allows the calculation of the indirect impacts of large-scale ethanol production on household income[17].
- General, spatially explicit equilibrium model. An equilibrium model can be used to calculate the impact of various parameters on food demand and supply can be modeled. The theoretical basis of such models is well developed and such models are widely used to forecast trends in food consumption (IFPRI, 2001).

A general bottleneck for the application of such models is the high data demand and consequently the implementation of such models generally requires a substantial amount of expert judgment. Further, most of these criteria are only applicable at a macro level, but not for individual producers. In case the supply of food is affected as a result of ethanol production, the supply of food can be restored by means of additional investments in agricultural technologies that increase the efficiency of food production, through subsidies on food production or directly by means of the provision of food coupons (or similar) to the people directly affected by food displacement (Moreira, 2006).

Costs

No information is available about the costs to meet criteria related to food security.

Conclusions

The production of sugar cane may lead to competition with food production, although insufficient data are available for impact assessment. Further, also positive impacts can be expected as a result of the economic benefits of sugar cane production. The overall impact is unknown and further research is required. However, considering the importance of food security, the lack of criteria and indicators and the complexity of the issue, we conclude that this criterion can be a significant bottleneck.

3.4.2 Number of jobs

Impact assessment

During the first five years of Proálcool, about 376.000 ha (or about 25% of the total sugar cane area) in the state of São Paulo was converted to sugar cane, displacing crops (36%) and pastures (64%). Because sugar cane is approximately seven times more labor-intensive than pastures, this resulted in a net gain of some 25.500 worker-years of employment consisting of a total of 40.500 worker-years generated minus 15.000 worker-years lost.

Presently, the unemployment rate in São Paulo is 11.5% and (un)employment is a key policy target in SP. The production of sugar cane/ethanol is an important source of employment in SP, both directly (employment in the sugar cane and ethanol production) and indirectly (employment in the industries that produce intermediate deliveries to the sugar cane and ethanol production sector).

The numbers of permanent and temporary workers in sugar cane production between 1992 and 2003 are shown in table 3.20. The total number of employees in the country fell by one-third during this period, in part on account of increasing reliance on mechanical harvesting. The percentage of temporary employees fluctuated, first declining and then increasing in recent years to about one-half of the total. Table 3.21 shows the formal direct jobs in the sugar cane production, sugar production and ethanol production.

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[17] Presently a study is carried out at Utrecht University in which direct and indirect employment effects are calculated for eucalyptus production in Argentina, using I/O analysis , Social Accounting Matrix / closed I/O analysis (Wicke, 2006).

Table 3.20. Number of workers in the sugar cane sector. Source (PNAD in Macedo, 2005).

	Permanent workers		Temporary workers		Total
Year	Number	Percent	Number	Percent	Number
1992	368,684	55	305,946	45	674,63
1993	373,903	61	242,766	39	616,669
1995	380,099	61	238,797	39	618,896
1996	378,273	59	260,873	41	639,146
1997	323,699	58	236,012	42	559,711
1998	322,601	71	133,368	29	455,969
1999	300,098	65	161,41	35	461,508
2001	222,418	54	192,671	46	415,089
2002	246,357	55	205	45	451,357
2003	229,981	51	218,902	49	448,883

Note: Data are not available for 1994 and 2000.

Table 3.21. Formal, direct jobs by region and industry in 2000 to 2002 (in 1000). Source: (RAIS data, Labor and Employment Ministry, in Macedo, 2005)

		2000	2001	2002
Sugar cane	N-NE	81	97	86
	C-S	276	303	281
	Total	357	400	368
Sugar	N-NE	143	186	175
	C-S	74	85	127
	Total	217	268	302
Ethanol	N-NE	26	22	28
	C-S	42	45	67
	Total	68	67	95
Total		643	736	765

The data show that regional differences are large. The number of jobs per product unit in the Centre-South region was still 3.5 times higher than in the North-Northeast. Further, the share of agriculture in the employment required for the production of ethanol has been decreasing during the period 2000-2002. This reflects both an increasing mechanization and the expansion of production. Thus, the contribution to the employment is large. In addition, there is also a large indirect and induced employment effects: in the late 1990's the direct employment in the sugar cane and ethanol production sectors was 650.000, and the indirect and induced employment was calculated to be 940.000 and 1.800.000 jobs. Further, including everyone working in the sugar cane sector in some capacity (including employers and non-paid workers), employees in the formal sector (those who possess formal working papers) were 59% in 2003, compared to 27% for those who did not possess working papers. The percentage of those employed in the formal sector was higher in the Centre-South (74%) than in the North-Northeast (49%), and highest in São Paulo (85%) (Macedo, 2005).

However, the results presented above exclude several other indirect impacts such as employment effects from the respending of income and replacement effects of cane production. An analysis of the first five years of Proálcool gives useful insights (Pereira 1983). An overall net job creation can be expected in case growing crops for biofuel production is an additional activity that does not displace other agricultural activities. In any other case, the net employment effects should take into account all direct, indirect and induced impacts of the sugar cane/ethanol production and the replaced agricultural activities. Data on the total net impacts were not available.

Brazilian legislation and standards

There is no specific legislation about employment levels. Yet, employment is (obviously) a key priority in Brazil. However, in much legislation employment is indirectly included. An example is the legislation on cane burning and the situation in the North East of Brazil, where the government specifically aims at reducing the rate of mechanization to avoid unemployment and consequently poverty.

Dutch and/or international sustainability criteria, legislation and standards

The DPB criteria require that no negative effects on the regional and national economy are observed (2007) and require for the year 2011 a contribution to wealth. Here, we assume that this criterion also goes specifically for employment. No other international sustainability criteria, legislation and standards were found regarding employment.

Implications for certification

The direct employment impacts can be calculated relatively easy, using standard financial and employment data. The indirect and induced impacts of ethanol production can be calculated using the tools presented in the previous section (Input-Output (I/O) analysis, Social Accounting Matrix analysis / Closed I/O analysis, spatially explicit equilibrium modeling). The applications of these tools allows the formulation of criteria related to employment, whereby a minimum requirement is that the net employment (including all direct, indirect and induced impacts) is not allowed to decrease. Net negative employment effects can be counteracted through schooling and reallocation programmes or social benefits

Costs

No information was found about the costs to prevent negative employment effects, although they are probably substantial taking into account the magnitude of indirect and induced employment effects and assuming that the costs are equal to the labor costs of the reduction of employment. Only the costs of compensation for unemployment as a result of a shift from manual to mechanical harvesting was calculated, see further chapter 4.

Conclusions

Employment is a key issue in São Paulo. Ethanol production is a major contributor the employment, both directly and indirectly. In case only the direct and indirect employment effects are considered than this area of concern will likely not be a limiting factor for ethanol production. However, in case the total net employment effects (including all direct, indirect and induced impacts) are included as criterion and indicator, than the situation becomes less clear. No data are available about the total net employment effects of ethanol production. Various tools can be used to calculate the total net employment effects, but these need to be developed. These tools allow the formulation of criteria whereby the net employment impact is taken as an indicator and criterion. Considering the complexity of this issue and the potentially large impacts and potentially high costs, we conclude this could be an important bottleneck for sustainable ethanol production.

3.4.3 Income distribution and land tenure

Impact assessment

Brazil has one of the highest Gini coefficients, which is a measure for the income distribution. The higher the Gini coefficient, the higher the differences in income within a country. The Gini coefficients of the sugar cane and ethanol production sector is lower compared to the national average and compared to various other sectors. Historic data suggest that existing legislation is insufficient and too weak to protect small farmers and to prevent disputes over land issues. Particularly the position of small farmers is problematic. During the 1970’s and 1980’s the expansion of sugar cane production exacerbated the land tenure conflict, although exact data and more recent data are not available. Currently, in São Paulo about 25% of sugar cane is produced by independent farmers. Detailed information is presented below.

Brazil has one of the world's highest Gini coefficients, which is a measure for the income distribution (the higher the Gini coefficient[18], the higher the differences in income). The Gini coefficient was 0.607 (1998) and 0.554 (2003), which is one of the highest in the world. For comparison: the Gini-coefficient in the Netherlands and the US is 0.32 (1994) and 0.41 (2000), respectively (WB, 2004). Notwithstanding the increase in income in Brazil, social inequalities have not been significantly reduced over the past 20 years. The Gini-coefficient in Brazil varies between various sectors, see table 3.22.

Table 3.22. Mean income in all jobs for people occupied, or engaged, in the sugar cane culture and similar industries in Brazil, 2003 (Macedo, 2005).

Statistic	Sugar cane crops	Sugar	Ethanol	Foods and beverages	Fuels	Chemicals
People (x1000)	789.4	126.0	67.0	1507.0	104.7	641.2
Mean age (years)	35.1	36.6	35.6	34.4	37.1	33.4
Mean education (years)	2.9	6.5	7.3	7.1	8.9	9.6
Mean income (R$/month)	446.6	821.3	849.9	575.0	1281.1	1074.6
Gini coefficient	0.493	0.423	0.393	0.490	0.476	0.531

The land tenure law in Brazil is generally weak, giving little protection to smallholder farmers. Smallholder farmers and landlords frequently clashed over land rights and landlords often recruited the help of the police, resulting in human rights violations. On the other hand, legislation is in place which allows the state to possess unproductive lands. These lands can be offered to poor people. Nevertheless, landless poor people trying to illegally occupy land can be evicted (Moreira, 2006). In this context, Proálcool in the 1970's and 1980's, which made sugar cane production attractive on account of large government subsidies, exacerbated the land tenure conflict. Some landlords took their land in hand or made false demarcation claims in order to plant sugar cane. Resistance by smallholder farmers sometimes took the form of trespassing and pulling down the sugar cane. Existing incentives for food production were not competitive with those of Proálcool, and many chose to sell out and move. According to reports, some farmers were forced off their land by legal or economic pressure, or by direct physical intimidation (Saint, 1982 in ESMAP, 2005). However, as it is not clear how this happened, it is difficult to judge whether these were incidents or occurred frequently.

For the whole of Brazil, Macedo and Nogueira (2005) state that about 30% of the sugar cane is produced by about 60,000 independent farmers. Specifically for São Paulo, there is a clear trend that the amount of land owned by independent farmers is declining. Veiga Filho and Ramos (2006) state that independent farmers have supplied, during the harvest 1999-2000, about 35% of the sugar cane in Sao Paulo and 30% in the Centre-South region. Comparing with data of the harvest 1995-1996 (when independent farmers supplied 45% of the sugar cane in Sao Paulo and 38% in Centre-South), and including using statistics analysis, the authors conclude that there are clear evidence that vertical integration in the sugar cane industry is in process. Macedo et al. (2005) state that currently in São Paulo about 25% of sugar cane is produced by independent, relatively small farmers who sell their production to the mills. The remaining part is produced on lands either owned or rented by the mills owners.

Brazilian legislation and standards

There is no specific legislation aimed at income (re)distribution, except for the general social security system and minimum wages. However, there state programs such as Bolsa escola and Bolsa familia supporting low-income rural and urban families (see also section 3.3.7). For land tenure and property rights there is (obviously) legislation in Brazil, but this was not analyzed in detail in this study, because of the complexity of the issue and because various studies indicated that law enforcement is a crucial problem.

[18] The Gini coefficient is a measure of inequality of a distribution, defined as the ratio of area between the Lorenz curve of the distribution and the curve of the uniform distribution, to the area under the uniform distribution. The Lorenz curve depicts the cumulative distribution of income. The Gini coefficient is often used to measure income inequality. It is a number between 0 and 1, where 0 corresponds to perfect equality (e.g. everyone has the same income) and 1 corresponds to perfect inequality (e.g. one person has all the income, and everyone else has zero income).

Dutch and/or international sustainability criteria, legislation and standards

The DPB commission formulated several criteria that are reported under the heading wealth and welfare, see Table 2.1. The one that is the most direct relevant is the criterion on property and use rights. For the year 2007 and 2011 three criteria are proposed based on existing certification systems. 1.) No land use without prior permission of sufficiently informed original users (RSPO, 2005, clause 2.3), 2.) Land use is accurately defined and this is officially recorded (FSC, 2006, principle 2) and 3.) Official property and use, including the customary land use rights of indigenous people must be acknowledged and respected (FSC, 2006, principle 3).

No further international sustainability criteria, legislation and standards are discussed here, although there are many that are (in)directly related to income distribution and land tenure.

Implications for certification

The Gini-coefficient can be included as a criteria/parameter in a certification system. Data on wages are generally available that allow the calculation of the Gini coefficient, because such data are generally included in the financial administration of an organization. Further research is required to develop practical indicators based upon the Gini-coefficient. Unacceptably differences in income can be avoided by increasing the wages of the worst paying jobs in the sector, which are the cane harvesters (manually).For land tenure, several criteria and indicators can be applied, following the approach used in existing certification systems such as FSC and RSPO and that focus on legal documents regarding land ownership and/or mechanisms that are used to resolve land ownership conflicts. Generally accepted tools to tackle land tenure conflicts are based on the verification of the legal documents relevant for land tenure and the development of procedures to deal with land tenure conflicts.

Costs

In theory, lowering the Gini coefficient can be achieved by increasing the lowest wages at the expense of the highest wages, but the latter may no be realistic. The lowest wages can be increased, which would lead to additional costs, as also further discussed in the next section on wages. No information is available to what extend the implementation related to land tenure conflicts lead to additional costs or a limitation of the area available for sugar cane production.

Conclusions

The differences in income are high in Brazil compared to other countries, although the difference is smaller in the sugar cane and ethanol production sectors compared to other sectors. In case strict criteria are applied than higher wages are required, which leads to limited additional costs of ethanol production: an increase of wages of cane harvesters by 50% increases the costs of ethanol by 4% (see chapter 4 for calculations). Land tenure conflicts are a potential problem, although no information was readily available about the extent of the problem for cane production areas. Various existing certification systems include criteria and indicators related to land tenure conflicts, whereby we found no prove that this is in practice a limiting factor. We conclude that both issues are a minor bottleneck for certification.

3.4.4 Wages

Impact assessment

In the late 1990s workers in sugar cane production in São Paulo were receiving, on average, wages that were 80 % higher than those of workers holding other agricultural jobs. Their incomes were also higher than 50 % of those in the service sector and 40% of those in industry (Macedo, 2005). Despite these positive aspects, wages levels may be insufficiently high to prevent poverty. This goes particularly for migrant workers, who are also required to pay unrealistically much for transportation and housing (Mendonça, 2006), but insufficient data are available to assess the magnitude of the problem. In general, wages in sugar cane and ethanol production are above the official minimum wage. However, minimum wages may be insufficient to avoid poverty, although data are uncertain since there is no official poverty line. Detailed information is presented below.

Earnings in the Centre-South were markedly higher than those in the North-Northeast for comparable levels of education, except those who had gone beyond high school in the sugar and ethanol industries, for which the earnings were higher in the North-Northeast region. Average earnings and years of schooling in 2003 in agriculture for different crops are given in table 3.23. In Brazil as a whole, sugar cane ranks third in income after soybeans and citrus. The North-Northeast region again stands out for having much lower levels of education among workers and lower monthly income (a breakdown of formal sector workers by education is presented in Appendix L). Table 3.23 is a comparison of mean income of workers in different agriculture activities. The difference among regions is because there are different opportunities. For instance, considering Brazil as a whole, a worker with just 2.9 years of formal studies is not able to earn much more than a minimum wage, but at the sugar cane sector, he can earn almost twice as much. It also possible to compare the figures with average wages paid in Brazil in 2003 and 2004. The average figure in Brazil, early 2003, was R$ 462.92/month and R$ 497.43/month, early 2004. On the other hand, at the agricultural sector the average wage was R$ 304.67/month, early 2003, and R$ 337.56/month, early 2004 (Parana, 2004).

Table 3.23. Mean income and years of education in agriculture, 2003. Source: (Macedo, 2005). For comparison, the nominal minimum wage level in Brazil during 2003 was R$ 200/month (compared to 350 R$ in April 2006), and the “required” minimum wage was around 1400 R$/month. (DIEESE, 2006)

Region	Crop	Rice	Banana	Coffee	Sugar cane	Citrus	Manioc	Corn	Soy bean
Brazil	Income[a]	318	348	358	447	489	218	214	1,044
	Education[b]	2.3	3.1	3.6	2.9	3.8	1.8	2.3	4.9
North-Northeast	Income[a]	191	262	223	283	289	211	133	378
	Education[b]	1.8	2.5	2.3	2.0	1.7	1.6	1.5	4.2
Centre-South	Income[a]	788	467	376	679	565	278	326	1,071
	Education[b]	4.4	4.0	3.8	4.0	4.6	3.0	3.2	4.9
São Paulo	Income[a]	—	452	635	797	584	—	620	864
	Education[b]	—	3.9	5.5	4.2	4.8	—	3.9	5.8

a R$/month
b Years

Although there have been concerns about the quality of new jobs created in the ethanol industry during the first 10 years of Proálcool, sugar cane workers in São Paulo in the late 1990s were receiving, on average, wages that were 80 % higher than those of workers holding other agricultural jobs. Their incomes were also higher than 50% of those in the service sector and 40% of those in industry (Macedo, 2005). As a result of the high wages, there has been a steady rise in agricultural mechanization for sugar cane production. In the North-Northeast region, wages are much lower. Special legislation required that 1% of the net sugar cane price and 2% of the net ethanol price be channeled into medical, dental, pharmaceutical, sanitary, and educational services for sugar cane workers (Moreira and Goldemberg, 1999 in ESMAP, 2005). A survey of jobs in the formal and informal sectors was conducted in 2003, and key income statistics are given in table 3.22.

There is a large regional difference in the earnings of sugar cane workers. The differences are much smaller in the sugar and ethanol industry. Sugar cane workers earn about 15% more than compared to the average income. The range in wages is however larger than the results presented in table 3.21 and 3.22, because of differences within each labor category. According to Pereira and Armand (Pereira and Armand, 1983 in ESMAP, 2005) the salary of the largest category of employees— seasonal agricultural workers—was slightly above the minimum wage level, but in some years it was lower. The most significant improvements appear to have taken place among semi-skilled industrial and agricultural workers such as lorry drivers, farm-machinery operators, and workers in vehicle and equipment maintenance. Because well-trained lorry drivers and farm-machine operators were in short supply, they tended to be given permanent employment even though there was much less work during the off-season. While the number of jobs was limited, these workers were earning wages substantially higher than those for similar jobs in large cities (ESMAP, 2005). Despite these positive aspect, problems remain particularly with respect to migratory workers (Mendonça, 2006). In São Paulo, the greater part of sugar cane cutting is done by migratory workers from the Northeast and from the Valley of

Jequinhonha in Minas Gerais. The Pastoral of Migrants estimates that 40.000 migratory workers work in São Paulo in the sugar cane harvest period. These workers often begin their activities in debt. One of the frequent debts encountered before beginning work is with transportation (usually clandestine, called "excursions") that costs on average R$200.00 per worker migrating from the Northeast to São Paulo. The migrant workers are seduced by "cats" or "coyotes" that are usually the owners of the buses that make the journey. Migrant workers are given housing and food at a much higher price than the average paid by the local population: R$400.00 per month, which is half of the wage of R$800.00, assuming an average of 10 tonnes per day and an average of R$2.60 (or one dollar) per tonne of cut cane. Further, cases were found where mills pay less than the workers have the right to earn. The Union of Rural Workers of Dobrada (São Paulo), for example, denounced cases in which workers received the equivalent of 10 t/d, when the quantity was actually 19 t/d (Mendonça, 2006).

Brazilian legislation and standards

The minimum wage increased from R$ 240 per month at the beginning of 2004 to 300 R$ per month at the beginning of 2006 (DIEESE, 2006). Wages in sugar cane and ethanol production are generally well above the minimum wage. This may however be insufficient to prevent poverty. Because of wide regional variations in salaries and in the cost of living, the government has no official poverty line. According to information from U.S. Department of State or U.S. Embassy reports indicates that in general the minimum wage in Brazil is insufficient to provide a decent standard of living for a worker (plus family) (USDS, 2006). The Interunion Department of Socioeconomic Studies and Statistics (DIEESE), created by a group of trade unions in 1955, provides studies and statistics on living conditions in Brazil and a monthly calculation of the "net minimum wage necessary", which is calculated at a. 1500 R$ for a family of four, compared to a net minimum wage of 300 R$ in 2006 (DIEESE, 2006).

Dutch and/or international sustainability criteria, legislation and standards

The DPB commission has formulated several criteria related to wealth and welfare, but no criteria specifically aimed at wages. However, compliance with national legislation (minimum wages) is a criterion in most certification systems.

Implications for certification

Wage levels can be used as a practical and easy to verify criterion and indicator. Compliance with legislation on minimum wages is a minimum requirement in most certification systems. But as explained earlier, the minimum wage may be insufficient to prevent poverty, but there is no consensus on a poverty line or a wage level that avoids poverty; further research is required. Therefore, wages can be increased to avoid poverty. Improvement strategies include an increase of wages, increase expenditures on e.g., health care, housing and social benefits.

Costs

If we assume that for a family of four the wages must increase by a factor 5, following the figures on "net minimum wage necessary" calculated by the Interunion Department of Socioeconomic Studies and Statistics (DIEESE, 2006), then the total costs of ethanol would increase by a factor 1.4. The factor five must be considered as a maximum and is probably unrealistically high. Therefore, we assume a wage increase of 50 % (and a corresponding increase in labor costs), which would increase the costs of ethanol by 4 %. In this calculation it was assumed that 21-24 % of total cane costs (including land, capital costs, and all other fixed and variable costs) corresponded to labor costs, 60 % of which is related to unskilled labor used in harvesting, of which the wages is increased (Macedo, 1995). Sugar cane accounts for 60 % of the net production costs of ethanol.

Conclusions

In general, wages in sugar cane production and ethanol production are above the minimum wage. Yet, these wages may still be insufficiently high to avoid poverty, although limited information is available about the level of wealth/welfare related to such wage levels. The main problems are related to cane cutters, which do most of the low-paid work related to ethanol production. Wage levels can be used as a practical and easy to verify criterion and indicator. The increase in ethanol costs from increasing wages is dependant on the assumed increase, but is limited to 4 % in case of a 50 % increase in labor costs of cane cutters. We conclude that this criterion is very important, but is likely not a bottleneck for certification, unless very high wage increases (>100 %) are required.

3.4.5 Working conditions

Impact assessment

The situation with respect to working conditions can be summarized as follows: the main problem with respect to working conditions is related to manual cane harvesting. A key problem is the high work load, whereby mechanical harvesting is presently used as a reference. Cases of slavery and deaths from overwork (cane cutting) have been reported, but these are likely worst-case examples. A more comprehensive overview of working conditions in cane harvesting is required. Detailed information is presented below.

The manual harvesting of sugar cane is often associated with poor working conditions. Below some worst-case examples are given. Note that these are only examples, and that these are not necessarily representative for the sector as a whole. The mechanized cutting of sugar cane has become a reference for the quantity cut by the workers. As a result the workload per worker increased from 6 t/d in the 80's, to 10 t/d in the 90's. Today, workers need to cut between 12-15 t/d in regions where machines are a reference for productivity. Increased mechanization creates new demands such as cutting sugar cane close to the ground (in order to take greater advantage of the concentration of sucrose) and a better trimmed sugar cane stalk. This increases the time required for cane cutting. Further, with the increasing mechanization of the harvesting, workers are increasingly being used in areas where conditions are not suitable for mechanized harvesting, such as areas where the terrain is not flat, the crops are planted irregularly, and the cane is of poorer quality (Mendonça, 2006). Because of targets for cane cutting, only a small number of women work in sugar cane cutting. For the women who still do this work, the situation is even worse because their daily workload is doubled. In addition to cutting sugar cane, they have to do most of the domestic work, as well as take care of their children. This means a much larger effort for women who, even with all the difficulties, are faced with brutal labor tasks. Some sugar mills also demanded that the women should be sterilized, so they cannot have children (Mendonça, 2006). Further, the Migrants' Pastoral of São Paulo registered 13 deaths of sugar cane workers, from excess of work and lack of an adequate diet (2003-2004) (Mendonça, 2006). These deaths happened after the workers fainted during the cutting of cane. Besides the deaths occurring in the cane fields, there are those that go unregistered, and that happen across a certain amount of time. Illnesses like cancer, provoked by the use of poisons, sugar cane soot, as well as respiratory illnesses, allergies, spinal column illnesses, linked to the impossibility of being treated due lack of income to purchase medicine. Further, the repetitive movements of cane cutting cause tendinitis and spinal column problems, loosening of the digits and spasms, provoked by the excessive loss of potassium. Frequent spasms followed by dizziness, headache and vomiting are called "birola". Many workers use medicines and drugs to alleviate the pain and stimulate their performance. Wounds caused by cane cutting, principally on the legs and the hands, are frequent. Companies rarely notify these work accidents and there is practically no control on the part of governmental organizations. Further, many sick or mutilated workers, despite being unable to work, do not qualify as disabled.

The paragraph above is largely based on a single literature reference (Mendonça, 2006), published by a Brazilian social NGO. While it is published recently and quotes a number of literature sources to support anecdotal information, it is a rather one-sided account of the situation, probably citing the worst-known cases only. As discussed below, sufficiently strict labor law are present in Brazil that (if enforced) should avoid situations as discussed above. Therefore, the worst labor conditions discussed above are likely exceptions. It is clear that in order to obtain an objective picture, more stakeholders need to be heard.

Brazilian legislation and standards

In general, there is extensive legislation regarding working conditions, working hours and safety regulations, which is broadly in line with international internationally recognized standards. However, a bottleneck is the inspection and enforcement of this legislation, as further discussed in detail below.

The Ministry of Labor sets occupational, health, and safety standards that are consistent with internationally recognized norms, nevertheless, the government devoted insufficient resources for adequate inspection and enforcement of these standards. Unsafe working conditions were prevalent throughout the country: during 2004 workplace accidents increased to 458,956 (from 390,180 in 2003), and deaths from accidents increased to 2,801 (from 2,582 in 2003). Employees or their unions may file claims related to worker safety with regional labor courts, although this was frequently a protracted process (USDS, 2006). Unfortunately, no data was available to analyze whether this trend was also visible specifically for the sugar cane and ethanol production sectors.

The law requires employers to establish internal committees for accident prevention in workplaces. It also protects employee members of these committees from being fired for their committee activities. Such firings did occur, however, and legal recourse usually require years for a resolution. The Public Ministry of Labor (MPT)--an independent agency responsible for prosecuting labor infractions - reported that numerous firms used computerized records to compile blacklists, identifying workers who had filed claims in labor courts (USDS, 2006). Individual workers did not have the legal right to remove themselves from the workplace when faced with hazardous working conditions, but workers could express such concerns to a company committee for an immediate investigation (USDS, 2006).

The law limits the workweek to 44 hours and specifies a weekly rest period of 24 consecutive hours, preferably on Sundays. The law also prohibits excessive compulsory overtime and stipulates that hours worked above the weekly limit must be compensated at time and a half pay; these provisions generally were enforced in the formal sector.

Dutch and/or international sustainability criteria, legislation and standards

The DPB commission requires compliance with Social Accountability 8000 and other treaties (not further specified) for the year 2007 and 2011. Various (inter)national standards and guidelines are available that include norms e.g., related to maximum concentrations of toxic substances or noise. Further, it can be expected that compliance with national legislation will be included as a minimum standard.

Implications for certification

Various criteria can be composed:

- Compliance with national legislation. This is a minimum criterion in many existing certification system. A bottleneck appears to be enforcement and/or the strictness of existing legislation.
- Management plan that contains detailed information on working conditions, working times and so on.
- Reporting requirement. Monitoring and reporting of accidents is required.

The criteria above are relatively easy to check, providing that criteria are formulated against which the criteria can be checked. For these reasons existing certification systems include a similar approach. See for example the EUREPGAP criteria. However, these criteria are no guarantee that the absolute level of water pollution does not lead to environmental degradation. Therefore, additional criteria may be required, such as:

- Compliance with other (inter)national standards and guidelines. For example, a list is available that contains detailed information about the maximum workplace concentrations (MAK values) or technical approximate concentrations (TRK) of substances used in sugar production that are applicable in Germany (mg/m^3) (GTZ, 1995). Also for noise standards are available. E.g., in Germany the noise emission guide values for sugar factories are (in Germany) 60 dB(A) in the daytime and 45 dB(A) at night. Noise nuisance is produced by the high-speed slicing equipment for sugar beet and in the whole area of mill extraction (sugar cane). Individual earmuffs are required. Cane sugar factories are generally located in the centre of the growing area, very rarely in the vicinity of sizeable residential areas. The design of factories is light and open (due to the climate); cane is received and conveyed to the mill in the open air (large quantities of dust generated). Noise emissions can be restricted by structural and acoustic measures, with housings provided around sources of noise and soundproofing. Where the noise from certain tasks or areas of the factory cannot be restricted or insulated, personnel shall be issued with appropriate individual protective gear. These include, in particular, tipping and bagging plants, cane handling and roller extraction, washing plants for the raw material and the centrifuge station. In the workshop area, they include mainly work at rotary machines with a diameter > 500 mm, sheet metal processing machines and drilling and punching machines. The acoustic power level in these areas is 80-130 dB(A). At values of > 85 dB(A), individual protective gear (ear plugs, ear muffs) must be worn. With acoustic pressure levels of > 115 dB(A), the combined use of both ear plugs and muffs is recommended.

Costs

No information is available about the costs of meeting criteria related to working conditions.

Conclusions

In general, the existing labor conditions are not in line with national and/or international standards, but insufficient data are available to draw a comprehensive picture of labor conditions and the wide range of issues. A key area of concern are the labor conditions during manual cane cutting, whereby law enforcement is a key bottleneck as well as the high work load. Some serious labor law violations have occurred (e.g., slavery), although these are likely exceptions. We conclude that labor conditions are likely in general a limited bottleneck for certification, although in some cases they could be a serious problem.

3.4.6 Worker rights

Impact assessment

Union organization is developed and plays a key role in employment relationships. For sugar cane, the specific aspects of employment relations in agriculture (specific unions) and industrial operations (unions of the food and chemical industries) are well defined, including the conclusion of collective agreements, which advanced during the last decade. Compared to the Brazilian 55% mean rate of formal jobs, the sugar cane industry's agricultural activities now have a rate of 68.5% (compared to 53.6% in 1992). In the Centre-South, the rate of formal jobs in sugar-cane production (agriculture) is 83%, reaching 88% in São Paulo (2003) (ESMAP, 2005).

However, problems exist particularly for migrant and temporary workers. Cane cutters risk their job when they fail to reach the goal of 10-12 t/d and the impossibility of returning home with nothing for the family, has made many workers "escape" or "disappear", migrating once again (mostly towards the Middle-West region) or searching for temporary work on the peripheries of urban centres. In São Paulo, a survey held among 50 sugar and ethanol companies showed that 75% of the workers were born in São Paulo State, thus the remaining 25% came from other states.

Cases of slave work in agriculture have increased in recent years. The ILO's annual report on forced labor estimated that there were 25 thousand slave laborers in the entire country, concentrated mainly in the states of Para and Mato Grosso[19]. Armed guards sometimes were used to retain escaped laborers, but the remoteness of

[19] Since 2003, in total 166 employers have been sanctioned. According to the Ministry of Labor's Mobile Inspection Group, the government released 1,547 slave laborers in 2005. On June 3, labor inspectors released 34 forced workers on a farm near Salvador, Bahia State. On June 14, labor inspectors released approximately 1,200 forced laborers at the Gameleira Distillery in Mato Grosso State. The distillery's owner, Eduardo Queiroz Monteiro, was fined US$ 630 thousand (R$ 1.45 million) in back-pay and was ordered to arrange relocations for the slave laborers. On May 19, 75 companies, 11 labor federations, and 13 civil society organizations signed an agreement with the labor ministry committing to ensure that their suppliers were not involved in slave labor. There were no reports on compliance. From January to November, the task force liberated 3,524 forced laborers in 163 different locations compared with 2,887 in all of 2004 (USDS, 2006). While these data clearly include cases from the ethanol industry (e.g. in Mato Grosso), no numbers were available for the sugar cane sector.

the location, confiscation of documents, and threats of legal action or physical harm usually were sufficient to prevent laborers from fleeing.

Brazilian legislation and standards

There is legislation on the issue of worker rights in Brazil that should prevent forced labor and allows workers to join unions. For example, the law provides that violators of forced or compulsory labor laws may be sentenced up to eight years in prison. The law also provides penalties for various crimes related to forced labor, such as recruiting or transporting workers or obliging them to incur debt as part of a forced labor scheme. The abolition of forced labor was hindered by failure to impose effective penalties, the impunity of those responsible, delays in judicial procedure, and the absence of coordination between the various government bodies. The law also allows the government, after compensating the landowner, to seize lands on which forced labor has been found and to distribute the property in the government's land reform program (USDS, 2006). There were few criminal prosecutions relating to forced labor because of the lack of a clear legal definition; local political pressure; weak coordination among the police, the judiciary, and prosecutors; the remoteness of areas in which forced labor was practiced; witnesses' fear of retaliation; and police failure to conduct criminal investigations when accompanying labor inspectors on raids. Since violators of forced labor laws enjoyed virtual impunity from criminal prosecution, the government used fines and other disincentives to penalize violators. The government withholds credit to farms using forced labor. No further information is available on other legislation or its effectiveness.

Dutch and/or international sustainability criteria, legislation and standards

The DPB formulated various criteria that are (in)directly related to worker rights and which are included in the section on welfare (see table 1), but these criteria are not analyzed further here. The International Labor Organization (ILO) also has formulated various standards and principles related to worker rights, but these have not been analyzed in detail here.

Implications for certification

It can be expected that the demand for worker rights is particularly relevant in cases where labor conditions are poor or wages are low. Thus, it can be expected that if the workers are satisfied with their wage and living conditions in general which is included in the other criteria, that the issue of worker rights is less of an issue. However, a specific group that deserves attention is the migrant and temporary workers, which are generally the group with the weakest position, but information is scarce.

Costs

No information was available about the costs to improve worker rights.

Conclusions

Some serious worker right violations have been observed, although Brazilian legislation in general seems sufficiently strict to prevent these violations. A key problem is the poor law enforcement. Note that the issue of worker rights is closely related to the issue of wages and working conditions. If these issue are accurately dealt with, than the need for additional criteria is limited. A general problem is the wide range of issues that can be included under this criterion and that data on the present situation is scarce. Further research is. However, based on the information we have so far, we conclude that worker rights in general are not so much of an issue compared to criteria that are directly related to welfare and wealth (e.g., wages). Therefore, we conclude that criteria specifically aimed at worker rights are likely a minor bottleneck for certification.

3.4.7 Child labor

Impact assessment

Child labor is widespread in Brazil. However, it seems that child labor within the sugar cane sectors in São Paulo is lower compared to other parts of the country, but probably some cases exist that should deserve attention. Information is however scarce and uncertain, as further discussed below.

According to the definition of the Work International Organization, child labor is related to the work done by people younger than 16 years old. According to a survey done by the Brazilian Institute of Geography and Statistics (an official institution), almost 5.5 million people younger than 18 years old were working in 2001 (5.1 million in 2003)[20], being 2.2 million people younger than 14 years old (IGBE, 2003). Approximately half of child laborers received no income, and 90% worked in the unregistered informal sector. Slightly more than half of child laborers worked in rural areas, and two-thirds were boys (USDS, 2006). The IBGE survey is known as PNAD (in a free translation, Sample of National Survey on Households). It seems that the range of situations is very wide, including both regularized and illegal cases, but with a very low share of regularized cases (Schwartzman and Schwartzman, 2004). A report of the Institute for Work and Society Studies identified 69 main rural and urban activities in which children worked. Common rural activities included: harvesting corn, manioc, and other crops; fishing; mining; raising livestock; and producing charcoal. The hidden and informal nature of child labor made children especially vulnerable to workplace accidents. For instance, children who produced charcoal, sisal, sugar cane, and footwear suffered from dismemberment, gastrointestinal disease, lacerations, blindness, and burns caused by applying pesticides with inadequate protection (USDS, 2006). Unfortunately, the frequency with which these diseases occur, is not known.

Based on PNAD's data for the year 2001, Schwartzman and Schwartzman (2004) state that 2.4 million people younger than 17 years old were working at the agriculture sector, being 22,876 people at the sugar cane branch (0.95% regarding the whole agriculture sector). For comparison, in 2002, the total number of workers active in the sugar cane, sugar and ethanol production was 764,593 (of which 2606 under age 18) compared to about 28.9 million people in the total agricultural sector in 2003 (OIT, 2006). Thus the percentage of people under 17 working in the sugar & ethanol sector was 3.0%, compared to an average of 8.3% in the entire agricultural sector (see also table 3.24). In concurrence with this, from the PNAD's data it can be concluded that the situation is worse in other agricultural activities, both in absolute and (mainly) in relative terms[21]. It should be mentioned that an expressive portion of child labor at the agriculture sector is concentrated in the poorest regions of the country (mainly Northeast), but also in the South (this is the region with the highest Human Development Index in the country) due to the tradition of familiar agriculture (Schwartzman and Schwartzman, 2004). It should also be mentioned that both official statistics and experts state that child labour in general still exists but has been declining over the last 20-25 years (IBGE, 2003,Satyarthi, 2006).

Table 3.24. Overview of workers in agriculture, and specifically in the sugar cane and ethanol production sector, and percentage of workers under 17. Source: Schwartzman and Schwartzman (2004) and (OIT, 2006).

	Nr of workers	Nr of workers under 17	Percentage
Total in agriculture	28,860,000	2,400,000	8.3%
Of which in sugar cane & ethanol	764,600	22,900	3.0%
Percentage	2.65%	0.95%	

The Brazilian Ministry of Work and Employment (MTE – Ministério do Trabalho e Emprego) does a regular survey on jobs and salaries through different economic sectors and regions (RAIS – Relação Anual de Informações Sociais). Based on the 2002 results, Moraes (2004) and Moraes (2005) have shown that in the

[20] In fact, there is a reduction on the numbers of child labour. In 1995, 7.8 million people younger than 18 years old were working in Brazil.

[21] Sugar cane production is one of the most important economic activities in Brazil. According to IBGE (2003), less important rural activities have more young workers involved in 2001: about 300 thousand with corn production, 270 thousand with manioc production, 185 thousand with vegetables production and 125 thousand with rice production.

sugar cane sector 2,606 workers were younger than 18 years old (0.34% of 764.6 thousand workers), being 24 younger than 14 years old. 64.4% of these 2,606 workers were working in the Centre-South region, a proportion that is lower than the proportion of sugar cane production through the country. Data basis of RAIS and PNAD are different and so the absolute numbers cannot be compared. A likely reason for this difference is that RAIS just considers formal employment, while PNDA's survey takes into account all jobs (formal or not).

Some social scientists working at Brazilian universities have written essays about child labor. These essays are based on PNAD's data (previously mentioned) of different years. Ferreira (2001), for instance, states that the practice of child labor is common in Brazil and that sugar cane sector is one of the economic activities most accused of this illegality. But the same author, mentioning a study by Schwartzman (1996), states that the practice of child labor in not generalized and that the worst cases at sugar cane fields (and also at the charcoal production) – both highlighted by the media in recent years – are specific cases. According to both authors, child labor is essentially an expression of poverty.

In the state of São Paulo, where sugar cane activity is more developed and more efficient than in other states, a significant share of sugar cane is mechanically harvested (on average, at least 25%). The worst job at the sugar cane field is manual harvesting. Mechanical harvesting is cheaper than manual harvesting and is essentially the investment constraint that is postponing full mechanization[22]. But mechanical harvesting was introduced in São Paulo mainly because of frequent strikes during the 1980s and early 1990s motivated by claim of better salaries. In general, the mills do not hire the workers directly, but they use an agent. As both the workers and the agents earn money in proportion of the daily production (tonnes of sugar cane harvested), the agents prefer to hire people between 20 and 30 years old, with good health condition.

Fernando Ribeiro, general-secretary of Unica, is mentioned in a report by Barros (2005). According to the text, Ribeiro recognizes that some mills do not respect the labor law in state of São Paulo (his state should be understood in a broad sense, as child labor is no specifically mentioned) and that there is still a long way to go. But Ribeiro states that the conditions are much better than before and many mills are engaged on social-responsibility programs.

Considering survey results regarding child labor, it seems that child labor at sugar cane branch in the state of São Paulo is lower than in other parts of the country, but probably some cases exist that should deserve attention. In general, working conditions in the Northeast region of Brazil are worse than in Centre-South. This is also true regarding sugar cane activity. The work conditions in São Paulo are better than in other states, but are not perfect.

This is also confirmed by José Roberto Novaes, from Federal University of Rio de Janeiro (Novaes, 2006). Regarding child labour at the sugar cane industry, and especially on the agricultural side, Novaes states that the problem is more important in Northeastern mills. He says that in Sao Paulo, to be competitive with mechanized harvesting, a worker should cut at least 10 tonnes of sugar cane per day and that 85% of the workers in harvesting are between 18 and 27 years old. According Novaes, a child cannot be competitive in harvesting and even when families need the financial support of their sons the best option is to let them work in other activities. Novaes also states that because of the same reason (i.e., only workers in good shape can have good performance) work conditions have improved during recent years. Due to the lack of economic opportunities, temporary workers move to São Paulo from the poorest North-eastern states (Piauí and Maranhão) and return to their places after the harvest period. In general they go to São Paulo without their families and do not earn enough money to bring them.

Brazilian legislation and standards

The (official) minimum working age is 16 years, and apprenticeships may begin at age 14. The law bans all minors under age 18 from work that constitutes a physical strain or from employment in nocturnal, unhealthy, dangerous, or morally harmful conditions, this clearly also includes sugar cane harvesting. However, the authorities rarely enforced additional legal restrictions intended to protect working minors under age 18. The

[22] In reality, there is another constraint: mechanical harvesting is not possible when the declivity is higher than 12%.

law requires parental permission for minors to work as apprentices, and apprentices must attend school through the primary grades. The national law is broadly in line with (inter)national standards, but law enforcement is a crucial bottleneck in Brazil. The Ministry of Labor and Employment (MLE) is responsible for inspecting worksites to enforce child labor laws; its regional offices has special groups to enforce child labor laws, principally by gathering data and developing plans for child labor inspection. Nonetheless, most inspections of children in the workplace were driven by complaints brought by workers, teachers, unions, NGOs, and the media. Labor inspectors continued to prioritize inspections in the informal sector, but they remained unable to enter private homes and farms, where much of the nation's child labor was found. In most cases, inspectors attempted to reach agreements and to have employers desist from labor law violations before levying fines of US$143 (400 reais) per violation. As a result, few employers were fined for employing children (USDS, 2006).

To prevent child labor and promote education, the government also continued to promote its family stipend program called “Bolsa Familia”, which provides approximately US$6 to US$40 (15 to 95 reais) monthly to low-income rural and urban families for each child (up to a total of three children per family) between the ages of 6 and 15 whose school attendance rate is at least 85%. Municipal governments have primary responsibility for day-to-day management of the program. In 2005, stipends were provided to over 8.7 million families in more than 5,560 municipalities. In addition to the federal program, an estimated 100 municipal governments operated stipend programs. The Pro-Child Institute, in São Paulo State, coordinated a labeling program to reduce instances of child labor in the footwear industry (USDS, 2006).

Dutch and/or international sustainability criteria, legislation and standards

The DPB commission formulated no criteria specifically related to child labor, but it can be expected that criteria related to child labor will be included in any certification system. The International Labor Organization (ILO) has child labor standards that are in line with most standards in the industrialized countries and Brazil.

Implications for certification

The Brazilian legislation on child labor is roughly in line with the Dutch and (inter)national guidelines and standards, but law enforcement is a major bottleneck. Therefore, when designing a certification system the focus must be on further strengthening of the reporting requirements.

Costs

The costs of a prevention of child labor have been calculated following the methodology developed by Smeets et al. (2005). Two types of additional costs are included for the prevention of child labor. First, parents are compensated for the loss of family income, which is added up to the labor costs. Second, parents are compensated for the costs of education, to ensure that children are able to go to school and are not sent to work elsewhere (see Smeets et al., 2005). The costs of ethanol are calculated to increase by 4%, assuming 2.1 child per family for which costs are included, one wage earner per family, a wage level of 797 R$/month; further input data are presented in Smeets et al. (2005).

Conclusions

Considering its importance, child labor is an issue that must be taken into account, despite the occurrence of child labor in the sugar cane production seems limited and despite there is sufficient legislation on this issue that is in line with international standards (e.g., standards of the International Labor Organization). Child labor is still present in various regions because law enforcement is generally weak. Therefore, additional criteria aimed at law enforcement may be required (reporting requirements, unexpected field visits). For reporting the Child Labor Protocol developed by the Global Reporting Initiative may serve as a basis (GRI, 2002). The (theoretical) costs to prevent child labor by means of compensating parents for the loss of family income from child labor and by means of compensating parents for the costs of education is calculated to increase the ethanol costs by 4%. Therefore, child labor is likely a minor bottleneck for certification.

3.4.8 Social responsibility and benefits

Impact assessment

The ethanol production sector in Brazil maintains more than 600 schools, 200 nursery centres and 300 day care units. Table 3.25 shows the frequency of benefits for a sample of São Paulo based sugar and ethanol companies (Barbosa, 2005).

Table 3.25. Benefits, sample of 47 mills in São Paulo, 2003 (%) Source:(Barbosa, 2005).

Health care	96
Dental care	94
Transportation	93
Collective life insurance	92
Meals	87
Pharmaceutical care	85
Hearing care	64
Funeral allowance	62
Christmas basket	59
Food basket	44
Credit cooperative	38
Club/association	36
Education allowance	36
Other	33
Food stamps	30
Private pension plans	24
Breakfast	21
Disease allowance	20
Loan/financing	15
Agreement with supermarkets	9
Subsidized sales	2
Consumption cooperative	0

The results show that more than 90% of the mills provide health and dental care, transportation and collective life insurance, and over 80% provide meals and pharmaceutical care. More than 84% have profit-sharing programs, accommodations and day-care units. However, for the low wage (temporary) laborers in cane cutting, these services may not be available.

However, the figures above provide no information on the absolute life conditions of the workers in the sugar cane and ethanol industry. Therefore, the industry adopted in 2002 the Social Balance Sheet concept (IBASE model) through UNICA (the Union of the São Paulo State Sugar-Cane Agro-Industry). A Social Balance Sheet is an overview of key parameters on education, health care, day-care units, food, safety and health, profit sharing profiles and so on. Some of the indicators of the IBASE Social Balance Sheet for 73 São Paulo-based companies are presented in table 3.26.

Table 3.26. Indicators in the IBASE Social Balance Sheet for 73 São Paulo based companies, 2003 (%).

Private pension plan	0.8
Health care	5.9
Education	0.9
Capacity building and professional development	1.0
Day-care units	0.3
Profit-sharing programs	6.7
Food	6.5
Occupational safety & health	2.3

The Social Balance Sheets can be used as a tool to monitor progress, but still provide little insight in the quality of life. Additional information can be derived from existing databases and studies, for example statistics of the World Bank, World Health Organization and the United Nations Development Program (UNDP) on human development indicators (see e.g., WB, 2004, UNDP, 2006).

Brazilian legislation and standards

According to Moreira and Goldemberg (1999), special legislation required that 1% of the net sugar cane price and 2% of the net ethanol price be channeled into medical, dental, pharmaceutical, sanitary, and educational services for sugar cane workers. No further information is available.

Dutch and/or international sustainability criteria, legislation and standards

The DPB commission formulated several criteria that are relevant to this issue (see the various criteria aggregated under the section welfare). However, the criteria are formulated too generic and the range of issues included is too large to be discussed in relation to the impact assessment or the Brazilian legislation and standards. Further research is required.

Implications for certification

The information collected is insufficient for a clear overview of which areas require further attention, particularly considering the large number of issues that is included. As already observed in some of the earlier sections, labor issues in general (e.g., wages, working conditions, health care) are key issues that deserve further attention considering the widespread poverty in Brazil. Despite this importance, Further, criteria and indicators need to be developed.

Costs

No information was available about the costs of social benefits, particularly since no detailed information is readily available about the costs of various social benefits. Only some highly aggregated, unspecified costs are available, but these were regarded insufficiently detailed to be of any use. Further research is required.

Conclusions

Insufficient information is available to determine which areas (e.g., education, health care, pensions) are not according to the desired level. Further research is required whereby the various areas should be analyzed separately. However, based on the limited information that was available, social responsibilities and benefits seem to be of less importance compared to the criteria related to e.g., wages, child labor etc.

3.4.9 Overall benefits

In this section the overall benefits of the Proálcool program are discussed. We acknowledge that this issue is particularly relevant for the national policy arena, but since this analysis includes information on the overall socio-economic benefits. The text below is derived from ESMAP (2005), with comments of Moreira (2006).

Even something that is not the least-cost option may make sense for society as a whole if social benefits exceed social costs, that is, if the net social benefits are positive. An assessment from a social perspective of a decade of Proálcool in Brazil from 1978 to 1987 (Rask 1995) showed that there were large regional and temporal differences (ESMAP, 2005). Rask (1995) used the methodology set forth by Little and Mirrlees for project appraisal for developing countries (Little and Mirrlees 1974). The analysis did not examine distributional and environmental benefits. The results showed that ethanol production in Brazil in 1978–1987 was economically viable only in the early 1980s, only in the Center-South region, and primarily in the mill/distillery complexes. The high social costs at the beginning and the end of the time period were not offset by the small net social gains in the early and mid-1980s. In particular, social costs in the North-Northeast area, where economic development was most needed, were extremely high. The findings indicated that the Brazilian economy had channeled more than US$3.6 billion (1987 U.S. dollars) in resources into the two northern states to support ethanol production. If production had been limited to the southern region of Brazil, the overall net social costs would have been significantly smaller. From a strictly economic efficiency perspective, the analysis indicated that Brazil paid a high price for ethanol. Over the time period studied, costs fell markedly, making, everything else being equal, the economics of ethanol production more favorable. The reasons appear to be two-fold: increasing efficiency, and falling real factor prices, in part as a result of the deep recession in Brazil. The most consistent factor price trend across the sugar cane producing states was falling real wages. Because sugar cane cultivation is labor-intensive and sugar cane costs represent a sizable portion of ethanol costs, falling agricultural labor costs would account for some of the overall decrease in unit costs of production. The time period studied overlapped with the Brazil Alcohol and Biomass Energy Development Project funded by the World Bank from 1981 to 1987. The main objective of the loan, amounting to more than US$200 million, was to support Proálcool to develop an economic, renewable liquid fuel energy source to substitute for imported gasoline. At the close of the project, an independent evaluation found the project unsustainable. The project was also faulted for its failure to reduce income inequalities through promotion of cassava-based distilleries in poorer areas of the country (World Bank 1990).

However, a number of things can be remarked on the analysis above: First of all, the analysis by Rank covers only a limited time frame of the Proálcool programme (1981-1987). Since the above analyses were carried out, the cost of ethanol production from sugar cane in Brazil has fallen further: ethanol producers were paid about US$0.40 per liter in 1987, and about US$0.30 in 2001 (Goldemberg and others 2004). Also, Brazil continued to save substantial amounts of by avoiding oil imports (e.g. 2,000 million US$ in 1996) (Moreira and Goldemberg, 1999). Furthermore, world oil prices have risen sharply in the last couple of years, up to 70 US$/barrel, compared to equivalent of 80 US$ of the oil crisis in 1980. The combined effect of lower ethanol production costs and sharply higher world oil prices would make the social cost-benefit analysis of sugar cane based ethanol production in the Center-South region of Brazil much more favorable today (ESMAP, 2005). At this moment the Brazil ethanol production is not subsidized and fully competitive with gasoline. With trends pointing at even lower production costs for ethanol (Van den Wall Bake, 2006), and current oil prices, Brazil is likely not only continue to save substantial amounts of foreign hard currency, but may also export increasing amount of ethanol. In this light, the investments in the 1980's could also be seen as "learning investments", of which the benefits can now be reaped.

Second, it is debatable whether the goals of the World Bank to produce ethanol at competitive prices and combat poverty at the same time are obtainable. Poverty and unequal income distribution are very old issues, hardly to be resolved with a loan of 200 million US$ (Macedo, 2006).

Chapter 4 Current cost of ethanol and additional costs for sustainable ethanol

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4.1 Historical and current cost developments

Technological innovations have enabled a nearly three-fold increase in the yield of ethanol produced from sugar cane in Brazil since 1975. About 2.000 liters of ethanol were produced per hectare of sugar cane in 1975. By 1999, the yield had increased to 5.000 liters, and to 5,900 liters of hydrous ethanol by 2004, or averaging an annual increase of 3.8 % over this period. The amount of harvesting area in the Centre-South region, where area expansion is occurring, increased from 2.8 Mha in 1993 to 4.2 Mha in 2003. Very little of this increase was from expansion into new, previously unused land; most was from crop substitution and turning pastureland into sugar cane fields. Between 1975 and 2000 in the state of São Paulo, which accounts for more than 60 % of the total cane production in the country, the sugar cane yield per hectare increased 33 %, cane's sugar content 8 %, sugar conversion for ethanol sugar cane 14 %, and fermentation productivity 130 % (m^3 of ethanol / m^3 of reactor * day) (Macedo 2005).

In Brazil, the cost of the feedstock for ethanol in mid-2005 fell within the range of US$0.13 to US$0.18 per liter (Nastari 2005a). The sugar cane yield increased from an average of 63 t/ha in 1990– 1991 to 66 t/ha in 2002–2003 in Brazil. In the Centre-South region of Brazil today, the annual yield is 82.4 t per *harvested* hectare, and assuming five harvests between replanting, this translates to an overall annual yield of 68.7 t/ha (ESMAP, 2005). However, recent Brazilian statistics provide a national average of 74 t/ha, and yields as high as 88 t/ha/year for São Paulo (Moreira, 2006; IAA, Planarsucar and CTC in Van den Wall Bake, 2006).

One estimate of the processing cost for manufacturing ethanol from sugar cane in Brazil is US$0.04 per liter of ethanol, not including capital cost recovery and feedstock cost; of this amount, 70 % is the variable cost, with the balance as fixed cost. In Brazil, a new mill/distillery complex with a capacity of 2.16 Mt/y costs about US$ 60 million (as of mid-2005). Assuming a tonne of sugar cane produces 80 liters of ethanol and half of the capacity is used for ethanol production, this plant can produce 86 million liters of ethanol a year operating at full capacity. An opportunity cost for capital of 8–10 % and a lifecycle of 20 years for the plant adds US$ 0.04 per liter to the cost of production at full plant utilization. In practice, plants do not run at full capacity. Taking the nation-wide average utilization rate of 86.5 % in 2004, capital cost recovery increases to US$ 0.05 per liter (ESMAP, 2005).

The cost of ethanol production in Brazil at the exchange rate prevailing in mid-2005 (R$ 2.40 = US$ 1.00) is in the neighborhood of US $0.25 per liter. Much lower figures have been reported in the past. For example, the U.S. Department of Agriculture (USDA) reported in 2003 that some analysts believed that the costs of producing ethanol in the Centre-South region of Brazil were about US$ 0.15 per liter (USDA 2003). The rise in the cost of ethanol production is primarily as a result of depreciation of the U.S. dollar against the Real, and does not mean that the ethanol industry in Brazil has become less competitive. It should be noted that the recent rise in the world price of gasoline is also in part due to depreciation of the U.S. dollar against other major currencies. The cost of ethanol production in the Centre-South of Brazil is estimated to be US$ 0.23 per liter, and 10–25% higher in the North-Northeast. When different fuel economies are taken into account, the range for the estimated cost of ethanol production—US$ 0.23–0.29 per liter— widens to US$ 0.29–0.41 per liter of gasoline equivalent (ESMAP, 2005).

In a study investigating international costs of biodiesel and bioethanol for the U.K. Department of Transport, AEA Technology found that, even after taking transportation costs into account, the cheapest option for ethanol in the United Kingdom both in 2002 and in 2020 would be to import it from Brazil.

For calculations in the next section,a default price of 0.25 US $ (0.21 €) was assumed.

4.2 Costs of compliance with sustainability criteria

At present, ethanol from sugar cane in Brazil is the cheapest biofuel in the world, and the price is competitive with fossil fuels (taking into account the recent increase in oil prices). However, the costs of ethanol meeting (advanced) sustainability criteria will be higher compared to standard ethanol as a result of the costs of compliance with criteria and the costs of certification. In this section the costs of compliance with various sustainability criteria are discussed. The costs of the certification procedure itself are discussed in Section 5.7.4. Note that the results presented below are based on a relatively rough assessment, thus the results are indicative and further research is required.

Environmental criteria

For most criteria discussed in chapter 3, no information was available about the impact on costs of compliance with these criteria. Only to meet criteria related to soil erosion and sugar cane burning the theoretical costs have been calculated:

- Soil erosion. Assuming a soil erosion rate of 20 t/ha/y that is reduced to 1 t/ha/y (the natural rate of soil formation), the costs of ethanol would increase by 4 % (see further Section 3.3.4).
- Sugar cane burning. In case the negative employments effects of a harvesting system without cane burning are fully compensated, the costs of ethanol will increase by 40% (see further Section 3.3.7).

For the other issues that were investigated in section 3.3, no information was found about the costs to meet certain sustainability criteria. On the other hand, we were able to obtain detailed information on three different cane production systems. These are:

- Conventional cane, the standard/usual cane production system, for old mills with operation license still to be renewed under The São Paulo State Regulation 47.397 of 2002.
- Green cane, which involves the adoption of Best Management Practices, including full legal compliance (social, technical, environmental), including the operation licensing previously mentioned (it may be eligible to IS0 14001 or a variation of Eurepgap).
- Organic cane, fully organic and certified production system. The data is mainly based on the São Fransisco Sugar Mill (see Balbo, 2000).

Table 4.1 shows detailed results. In the footnotes of Table 4.1, more details are given on the exact conditions for the green BMP and organic cane systems. Also, for criteria for organic cane production are presented in Appendix M. the organic cane production described below is meeting these criteria.

It is important to mention that an improvement can be expected in the Green Cane productivity in the future. It is possible to achieve the sustainability stage of the intermediate Green Cane in the short term while for Organic Cane, higher productivities and ecosystem rehabilitation takes longer time and it requires breaking paradigms in the rural sector that is even more difficult for extensive plantations like sugar cane.

Table 4.1. Detailed cost breakdown of conventional, green cane and organic cane (similar to the São Fransisco Sugar Mill).

	Foundation (R$ 1,00/ha) a			Annual Harvest (average of 6 cuts in R$ 1,00/ha) b		
Production Systems - c	Conventional	Green Cane	Organic	Conventional	Green Cane	Organic
Items	(traditional)	BMP	(certified)	(traditional)	BMP	(certified)
1. Foundation (average cost distributed per harvest)				665,61	792,05	1.103,19
2. Mechanised Operations	804,00	804,00	804,00	1.300,00	1.300,00	1.300,00
3. Manual Operations	395,00	592,50	790,00	50,00	250,00	450,00
4. Stems (seeding clones), Agrochemicals, Minerals	1.059,00	1.330,00	1.600,00	520,00	520,00	520,00
5. Managing Costs + Taxes	261,00	271,00	281,00	400,00	450,00	500,00
6. Green fertilisation			700,00			
7. New Legal Environmental Compliances / Certification Costs					51,95	70,65
8. Direct (running costs)	2.519,00	2.997,50	4.175,00	2.935,61	3.364,00	3.943,84
9. Capital Costs (habitat/ecosystem rehabilitation)	-				23,93	102,67
10. Total Costs	2.519,00	2.997,50	4.175,00	2.935,61	3.387,93	4.046,51
11. Cost Comparison (index 100 for conventional system)				100,00	115,41	137,84
12. Row Income (90/90/110 t/ha.yr)				3.060,00	3.060,00	3.740,00
13. Net Income				124,39	(327,93)	(306,51)
14. Impact/ t of sugar cane (index 100 for conventional system)				100,00	115,41	112,78
15. Percentage of cane on ethanol production cost				62,10	65,41	64,89
16. Impact / litre of ethanol (index 100 for conventional system)				100,00	110,08	108,29

Notes/sources:

a) Foundation " plant"- Sugar cane plantation establishment
b) Annual Harvest "ratoon" – cuts
c) Production Systems considered to be compared: conventional (as usual - for old mills with operation license still to be renewed under The State Regulation 47.397/2002); Green Cane – adoption of Best Management Practices, full legal compliance (social, technical, environmental), including the operation licensing previously mention (it may be eligible to IS0 14001 or a variation of Eurepgap); Organic – fully organic and certified system comparable to São Francisco Sugar Mill one – Native)
    1. Annual equivalent value obtained from the Foundation total costs and distributed per 6 harvests – cuts considering a discount rate of 15% /yr according to the Kaplan (1983) notation A = P/ (P/A, 15%, 6);
    2. Mechanized operations – source: Agrianual (2005);
    3. Manual operations – sources: Agrianual (2005), Embrapa (2005), Balbo (2000) e Souza (2005);
    4. Planting products according to each system of production – sources: Agrianual (2005), Embrapa (2005), Balbo (2000) e Souza (2005);
    5. Managing costs and taxes – Agrianual (2005);
    6. Green Fertilization – for organic system, nitrogen is provided by previous plantation of *Stilozobium aterrimum* through symbiotic fixation of N_2 (atmospheric nitrogen existent into the soil) – Souza (2005), Darolt and Skora Neto (2002)
    7. New legal compliances – overall licensing process including EIA/EIR (P/A, 15%, 20) and its renew costs each 2 years; certification costs for organic system at rate of 0,5 % of the row income – IEA (2000);
    8. Direct running costs – overall costs excluding capital costs;
    9. Capital costs – values obtained from AES-Tiete (2005) for establishment of native forests plus maintenance costs for 3 years considering 20% of Legal Reserve rehabilitation for Organic system and 3,9 % for Green Cane (average area remaining unprotected according to Barbosa in Macedo et al (2005). Annual equivalent value : A= P/ (P/A, 15%, 20) 15% discount rate in 20 yr.;
    10. Total costs are sent to the foundation costs also in yellow distributed in 6 harvest – cuts (see 1.);
    11. Cost comparison;
    12. Row income considers production of 90 t/ha for conventional and green cane systems and 110 t/ha for organic system (Balbo 2000) and a price of R$ 34/ton CIF sugar mill plant (exchange rate for Brazilian currency at that time was 1 U$ = 3,1262 R$ in June/2004 – source Agrianual (2005);
    13. Net income;
    14. Impact of each system compared with the raw sugar cane produced by the conventional one in percentage of additional costs for incorporating sustainability;
    15. Percentage of ethanol cost related to sugar cane row material cost established for the present year by Consecana – Sugar Cane Sectoral Council – for the conventional system. Source: Consecana (2006); for the other systems, values were corrected based on their own raw sugar cane prices (see item 14);
    16. Impact of each system compared with the ethanol produced by the conventional one in percentage of additional costs for incorporating sustainability.

The following aspects explain the increase in running costs when organic and conventional systems are compared:

- Fertilizer use. Instead of 500 kg of chemical fertilizer/ha/y, organic farms use 200 t of "green fertilizer"/ha/y. Beyond the sugar-cane residues left by the non-burning harvesting (20 t/ha), rotations with leguminous plants may provide about 50 t/ha each 3.5 months substituting fossil nitrogen (Balbo, 2000).
- Weeds control. Instead of using herbicides, the SF mill uses 1000 workers in 15000 ha for controlling weeds twice for each campaign. It means about 18 journeys/ha, about 46% more expensive than the chemical control (Balbo, 2000). Allelopathic compounds released mainly through roots exudation of companion plants and they are also powerful weed controllers, inhibiting seed germination and plant growing. Green sugar cane residues may also be some of these compounds able in some extent to help weeds control. Planting these companion/controllers plants is also an additional cost of an organic system.
- Pests and diseases control using pheromones, natural insecticides (neen, bio-oil, tobacco) and fungicides like sulphocalcic and sulphocupric solution; plant protectors like diatoms silicate powder, among others. Natural enemies have been successfully used even in the conventional system.
- Soil erosion is reduced by reduced/no tillage. Despite that no agrochemicals (fertilizers, herbicides, pesticides, fungicides) were used, the productivity increased from 90 t/ha/y for conventional cane to 110 t/ha/y for organic cane.
- Further, various environmental and social benefits have been realized. The area native forest increased from about 5 % in 1986 to 14 % in 2000. A reforestation programme was implemented planting about 70 thousand native trees per year. To recreate biodiversity islands in a relatively short time (reducing from 30 to 15 years) it was necessary to use organic fertilization also in the reforestation areas, which has economically intangible return and it is expensive. Since the beginning of the programme, 800.000 native trees have been planted. A nursery is established that produces 65.000 seedlings per year for multiple uses.
- Note however that yields also increased with organic production from 90 to 110 tonnes/ha. This causes organic sugar cane to be slightly cheaper than BMP sugar cane.

Next to addional environmental measures during the sugar cane production, we also differentiate two different ethanol production systems:

- Without environmental protection measures. Thus, no additional costs for environmental protection are included. The present ethanol production costs are taken as a proxy for this.
- With environmental protection measures. In general, the impact on the environment from the sugar extraction process and the processing of the by-products from it are manifold, but can be kept to a reasonable, and in part legally prescribed, minimum level by means of established methods and processes. In new beet sugar factories the proportion of costs required for installations to protect the environment stands at some 15-20% of the total investment costs, while the figure for cane sugar factories is 10 to 15% (GTZ, 1995). NEDALCO reported a value of 10% of the total investment costs for ethanol production in the Netherlands. Assuming that the costs of conversion of cane to ethanol increase by 20% as a result of additional investments aimed to reduce environmental impacts, the costs of ethanol would increase by 6%, assuming that approximately 60% of the costs of ethanol are feedstock costs.

Socio-economic criteria

For wages and child labor costs have been calculated; for other criteria no costs have been calculated, mainly as a result of a lack of data.

Additional costs resulting from compliance with criteria related to wages are dependant on the required wage level. The Interunion Department of Socioeconomic Studies and Statistics (DIEESE, 2006) calculated the "net minimum wage necessary" for a family of four at five times the minimum wage (see further Section 3.4.4). However, we consider an increase with a factor five an unrealistically and irresponsibly high increase that may disrupt the agricultural labor market. Therefore, we assume a wage increase of 50% (and a corresponding increase in labor costs), which would increase the costs of ethanol by 4%. It can be concluded that unless exceptionally high wage increases are assumed, substantial increases in the wages of low wage laborers have a limited impact on the costs of ethanol.

The costs to prevent child labor include two cost types. First, parents are compensated for the loss of family income, which is added up to the labor costs. Second, parents are compensated for the costs of education, to ensure that children are able to go to school and are not send to work elsewhere. The costs of ethanol are calculated to increase by 4% (see further Section 3.3.7). We conclude that such an increase in ethanol production costs is limited and that such costs are likely no bottleneck to meet sustainability criteria.

Total costs

Figure 4.1 shows an overview of the impact of compliance with selected sustainability criteria compared to the reference situation. A default price of 0.25 US $ or 0.21 € was assumed (based on the price level and exchange rate of mid 2005). Next to the reference situation, we formulated four other situations:

1. Adoption of Best Management Practices, including full legal compliance (social, technical, environmental) and the mechanical harvesting of green cane.
2. Compliance with all environmental criteria (as far as could be quantified), i.e. organic cane production and additional measures during the ethanol production process to (see above for specific details). Note that the costs related to soil erosion are excluded, since these are already included in the additional costs of green cane and organic cane.
3. Compliance with all social-economic criteria (as far as could be quantified). Note that we also included the manual harvesting of green cane. This could be on the one hand a measure to secure jobs, which would be lost with mechanical harvesting. However, manual harvest of green cane is extremely hard work, and it is doubtful whether this can be seen as acceptable working conditions.
4. Compliance with both environmental and social-economic criteria.

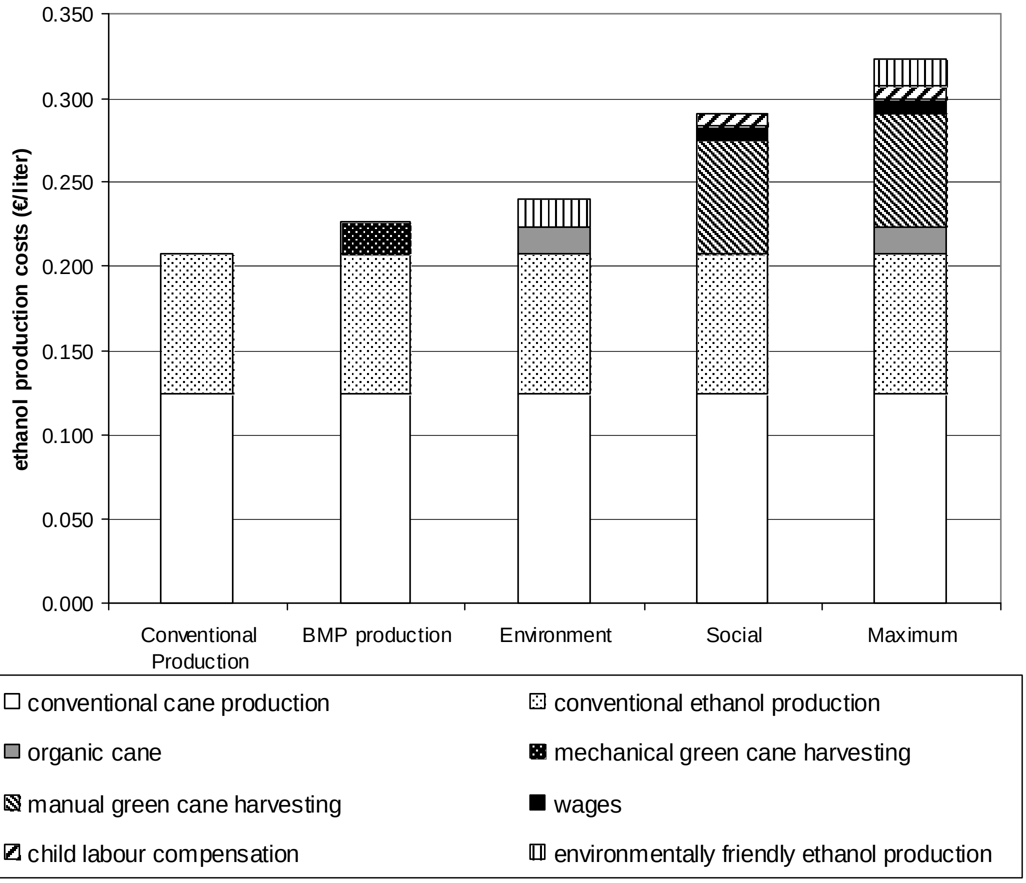

Figure 4.1. The costs of compliance with various sustainability criteria compared to the reference situation: current best management practices, additional environmental criteria, additional socio-economic criteria, and finally maximum compliance with all criteria.

The costs of compliance with the environmental and socio-economic criteria included in this study have been calculated to increase the costs of ethanol by about 0.12 €/l, which is equal to an increase of 56%. The bulk of the additional costs is related to environmental aspects and the manual green harvesting. As mentioned above, this is an arguable choice. If manual green harvesting is not included, additional costs would be about 0.05 €/l, an increase of only 24%.

These costs have to be considered as *indications* because of several reasons. On the one hand, most criteria have been excluded from the cost analysis as a result of a lack of data, and thus actual costs may still be higher. On the other hand, the situation described in the maximum compliance case will probably exceed a number of the minimum criteria set by the commission DPB by far, and thus may be too high (at least to meet the 2007 criteria). This is particularly relevant for the issue of wages (whereby we assumed an increase of the wages of cane cutters by 50%) and manual green harvesting (whereby we assumed full compensation of the negative employment effects of a shift from cane burning to no cane burning harvesting system).

As mentioned above, costs of organic cane production are actually relatively low due to the increased yield of 110 tonnes/ha at the Sao Francisco Sugar mill, compared to 90 tonnes under conventional production. However, the high organic yield was not achieved over night, but was achieved through a long process of learning-by-doing since the start of organic sugar production at the São Francisco mill in 1986 (Balbo, 2000). While further cost yield increases (and thus cost reductions) may be possible with organic farming, it is also clear that this process may take considerable time for other farms currently producing according to conventional methods, and thus initial cost for organic farming may be higher.

Chapter 5 Comparison of Dutch sustainability criteria and the current Brazilian situation

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In this chapter, based on chapters 2 and 3, for each criterion formulated by the commission DPB, first the compliance of *current* situation in Brazil (and especially in São Paulo) will be compared to the Dutch sustainability criteria, as far as investigated in this study. This includes an estimation of the severity / magnitude of specific problems, the existence of local legislation on the issue, and if applicable, an evaluation to what extent the legislation is enforced. Second, also the possible impact of *future developments* are discussed, especially the effects of land use change (LUC). An overview of this comparison is given in table 5.1. The chapter closes with an overview of the possibilities, bottlenecks and possible costs for certification of sustainable ethanol.

5.1 Greenhouse gas emissions

The Dutch viewpoint is that net GHG emissions should be reduced by 30% compared to a BAU scenario, and this level should increase to 50% in 2011. We assume that the reference scenario for the Netherlands is the partial substitution of (fossil) gasoline by blending anhydrous ethanol.

The literature reports GHG emission reduction potentials above 80%. These numbers do most likely not include transport of ethanol from Brazil to the Netherlands. However, previous studies show clearly that transport of biofuels with high-energy densities with bulk carriers have marginal influence on the overall energy balance (see e.g. Hamelinck, 2004). A point of attention would however be the local transport of ethanol from the production plants to the harbor. Concluding, under the *current* ethanol production practices in São Paulo state, both the 30% and 50% levels are very likely met.

However, regarding *further developments*, the effects of future changing land-use patterns would have to be taken into account, which go parallel with expansion of sugar cane area (and agricultural area in general). In this case, the soil carbon balance is an issue that must receive further attention. In general, it can be said that the conversion of land from pastures to cropland leads to a significant loss of carbon. So, for land already under (long) sugar cane cultivation, this issue is barely relevant, but if additional land-use for more sugar cane production leads (directly or indirectly) to conversion of pastures or other land types, the GHG emissions may be severe and could have a major impact on the overall GHG balance. Unfortunately, little data are available to quantify these effects. Also, it is very difficult to forecast the exact areas where additional sugar cane areas will be realized, and which indirect affects on further land use change this could induce (i.e. sugar cane replacing another cop like soy, which in turn causes additional soy plantations replacing pastures). Quantifying these effects and their uncertainty is deemed very important and strongly recommended for further research. Also, intensifying the use of existing agricultural crop area may (partially) reduce the need for additional land, but again, further research is required to quantify this. Finally, it must be stated that this issue is relevant for any biofuel produced from energy crops, not only for sugar cane.

On the other hand, further emission reductions may be achieved utilizing bagasse and especially cane trash (i.e. the sugar cane tops and leaves, currently largely burnt or left in the field) as lignocellulosic feedstock.

Concluding, on the long-term, even further GHG emission reductions in the direct production process are possible, but GHG due to land use change may also be significant. It was not possible within the frame of this project to estimate with certainty, whether these effects may cause GHG emission reductions to drop under 50%, though given the fact that further improvement of the GHG balance is also possible, we consider this possibility unlikely. Therefore, uncertainties for the latter are large.

5.2 Competition with food supply and other resources

The preliminary Dutch viewpoint is that availability of food, building materials, medicines and local energy supply should not be negatively influenced by production of biomass. However, it is emphasized that there are currently no indicators available to measure these criteria. Thus, be definition, it is unclear whether the Brazilian situation will meet the criteria or not.

In the analysis in chapter 3, only food supply was taken into account. Based on one account, the 362.000 ha of sugar cane added in São Paulo state between 1974 and 1979 occurred largely at the expense of food crops. The greatest impact was on maize and rice, of which the planted area declined by 35% (Saint, 1982 in ESMAP, 2005). According to ESMAP/Saint, the result was higher food prices that affected especially the poor, though it is unclear how this relationship was measured. However, this situation occurred about 30 years ago. It is unclear what the current situation in São Paulo is. For the whole of Brazil, the number of people who suffer from chronic undernourishment is not known accurately and is a subject of much debate. According to FAO's estimates, using methodology applied internationally, in 1998-2000, some 16.7 million Brazilians (about 10 percent of the population) were chronically undernourished (FAO, 2003). Most severe problems occur in the North-eastern region of Brazil. It is noteworthy that Brazil exports large amounts of food, e.g. soy, coffee and notably sugar (only about half of all sugar cane produced in Brazil is used for ethanol production). Thus, food supply is not so much depending on the actual production of food but on food distribution, income distribution and food prices. It is strongly recommended to carry out further research to both develop a general methodology and carry out a case study for Brazil.

In conclusion, the effects of current and future production of sugar cane on food supply are complex, difficult to measure, and closely intertwined with production of other crops, income distribution etc. While one source reported effects of sugar cane expansion on food prices thirty years ago, we did not find any information on the current situation. This holds also for the supply for fodder, building material etc.

5.3 Biodiversity

The Dutch sustainability criteria include no decline of protected areas or valuable ecosystems in 2007, and also active protection of local eco-systems from 2011 onwards. More specific rules are no new plantations near gazetted protected areas or high conservation value areas (reference year for ethanol is 2006), max. 5% conversion of forest to plantations within 5 years, and from 2011 onwards, an obligatory management plan for active protection of local ecosystems. The exact reporting protocol and performance indicators for the management plan still need to be developed. Regarding the indirect effects of LUC on biodiversity, this is only mentioned as an important aspect, but it is so far unclear how reporting on this topic will have to take place.

Regarding the *current situation* in São Paulo, it is very likely that most sugar cane plantations meet these criteria. A survey held in São Paulo revealed that areas classified as permanent preservation areas (APP's) occupy 0.6% of the sugar cane area. In such cases, increasingly over the last years these fields are abandoned and left for natural recovery. This indicates that the APP's (and compliance with local APP's law) is not likely to be a limiting factor for sugar cane production. Furthermore, within São Paulo, new sugar cane plantations are mainly located in lands previously used for orange production and for cattle. Thus, the direct effects on nature conservation areas are deemed minimal.

However, as discussed extensively in chapter 3.3.3, an expansion of the sugar cane area in the *future* may result in a shift of land use functions to the border areas of agricultural expansion. The cerrados are often mentioned as an important source of agricultural land with favorable topography and climate for agriculture. Cerrados are similar biome as the African savanna. The total area is estimated at 204 Mha (24% of the total area of Brazil). Presently, the cerrados are increasingly being used for cattle-breeding (ca. 50 Mha were in use in 2002) and agricultural production (mainly grains such as corn, soybeans, rice). The Brazilian Research for Agriculture Enterprise (EMBRAPA) estimates that of the 204 Mha, some 90 Mha are potentially available for crop production, of which 20 Mha are presently used for cattle grazing. Both in Brazil and in the Netherlands (see e.g. Appendices E, F & G), it is strongly disputed whether all cerrados should be considered nature area, or some part of it should be available to agriculture.

5.4. Wealth

The topic wealth refers to the influence of the activity (i.e. sugar cane growing and ethanol production) on the local economy. The level for 2007 is defined that no negative effects on regional and national economy should occur; from 2011 onwards an active contribution to the local economy is demanded. As no performance indicators have been developed so far, only a reporting obligation will be formulated, based on economic indicators of the Global reporting initiative. Economic performance indicators could include (Cramer et al. 2006):

- costs of purchased goods,
- materials and services,
- payments to (important) suppliers,
- contribution to local economy in terms of salaries, pensions and investments in human capital
- payment of taxes and amounts of subsidies received
- donations to the local community

Within the frame of this research, it was not possible to check whether any sugar cane plants currently participate in the Global Reporting Initiative, and how they score on these criteria. However, as shown in chapter 3, there is a large variety of benefits offered by ethanol plants to their employees (including pensions and various other benefits, see section 3.3.8). Thus, probably the specific contributions to local wealth may largely vary from plant to plant.

More in general terms for the entire industry, based on chapters 3.3.3 -3.3.4, we can summarize:

- The production of ethanol generates a large number of jobs in the São Paulo region, but the total number of full-time and seasonal directly employed jobs is declining (from 675,000 in 1992 to 450,000 in 2003).
- There are also large indirect and induced employment effects.
- Mean income in sugar cane is higher than the agricultural average, and only lower than income in citrus and soy bean cultivation.
- Wages in sugar cane and ethanol production are generally well above the minimum wage (i.e. comply with local law). However, migrant seasonal workers in sugar cane production require additional attention, as they sometimes receive lower payment than local workers. Some cases have been reported in which workers received the equivalent pay of 10 t/d, when the quantity was actually 19 t/d. Again, it is not clear to what extent these incidents occur, i.e. the situation may be different from plant to plant. Further study is required involving the local stakeholders.
- Finally, it should be remarked that the minimum wage may be insufficient to prevent poverty.

It would seem that production of sugar cane and ethanol in São Paulo in general at this moment plays an important role in the local economy, with wages similar or higher compared to other agricultural sectors. Note that this is a statement for the sugar cane industry as a whole in São Paulo, and not for individual producers.

5.5 Welfare

The Dutch sustainability criteria include the following categories: Labor conditions (i.e. compliance with Social Accountability 8000, Tripartite Declaration of Principles concerning Multinational Enterprises, and the ILO social policies), Human rights, Property and use rights, social conditions of local population and integrity (i.e. countering bribery). Within the frame of this research, it was not possible to compare the current situation in São Paulo with the specific treaties mentioned in the Dutch sustainability criteria. Below, the situation is described in more general terms.

Regarding the *current situation* in São Paulo:

- *On labor conditions and human rights*: working conditions are mainly severe for manual cane cutting. A number of incidents have recently been reported, including child labor, work related illnesses and even cases of deaths in the field. However, these are most likely the worst labor conditions that occur, which are based mainly on a single literature source. It is clear that in order to obtain an objective picture, more stakeholders need to be heard. More in general child labor (i.e. workers under the age of 17) does occur in the sugar cane sector, but on average to a lower extent than generally in agriculture (3% vs. 8.3%). Also, it seems the occurrence is lower in São Paulo than in other states. Again, the situation may be different for each mill. As for legislation, the Ministry of Labor sets occupational, health, and safety standards that are consistent with internationally recognized norms. Nevertheless, the government devoted insufficient resources for adequate inspection and enforcement of these standards.

- *On property and use rights*: The land tenure law in Brazil is generally weak, giving little protection to smallholder farmers. In the 1970 and 1980s, cases have been reported of farmers being forced off their land by legal or economic pressure, or by direct physical intimidation. However, as it is not clear how this happened, it is difficult to judge whether these were incidents or occurred frequently. Currently, in São Paulo about 30-35% of sugar cane is produced by relatively small farmers who sell their production to the mills. The remaining part is produced on lands rented for the mills owners. If there currently are any land conflicts in São Paulo state over sugar cane areas is unclear, and would need to be clarified with local stakeholders.

- *On social conditions of the local population*, very little is known of the effects of growing sugar cane on the social conditions of the local population.

- *On Integrity / countering bribery.* This was not investigated.

Some comments on *future developments*:

- For the next decade or so, most new sugar cane areas are planned within the state of São Paulo, mainly replacing pastures and other crops. Regarding property and use rights, two effects need to be investigated: 1) the direct effects, i.e. how the current property rights situation is in São Paulo for these areas; 2) The indirect effects: if e.g. cattle breeding is shifted towards new regions in other parts of Brazil, this may then result in new conflicts over land.
- Another trend in São Paulo is the increasing level of mechanical harvesting (from 18% in 1997 to 37% in 2004), which makes manual cane cutting obsolete. This will reduce the problems associated with manual cane cutting in terms of working conditions, but at the same time also would result in a net loss of jobs.

Summarizing, working conditions in the sugar cane plantations are severe, especially in cane harvesting procedure, and reports of ILO standards violations have been reported. National law is consistent with internationally recognized norms, but enforcement in general is weak. Again, the local situation may be different for each mill.

5.6. Environment

The Dutch environmental sustainability criteria are categorized as follows (including the performance indicators):
- Waste management (Compliance with local & national laws & GAP)
- Use of agro-chemicals (incl. Fertilizers) Compliance with local & national laws, from 2011 also with EU legislation
- Prevention of soil erosion and nutrient depletion (Erosion management plan, avoid plantations on marginal or vulnerable soils, or with high declivity, Monitoring soil quality, Nutrient balance)
- Preservation of quality and quantity of surface water and ground water (special attention for water use and pretreatment)
- Airborne emissions (Comply with national laws, 2011: Comply with EU laws)
- Use of GMOs (2007: Compliance with USA (safety) rules 2011: Compliance with European (safety) rules)

Below the current situation in São Paulo with respect to these criteria is discussed:
- *On waste management:* Water use in ethanol plants is substantial 21 m^3/t cane, but net water use is much lower, because most of the water is recycled. As a result of legislation and technological progress, the amount of water collected for ethanol production has decreased considerably during the previous years, to levels as low as an average of 1.23 m3/t cane for 92% of the mills in the São Paulo area. (Unica, 2005 in Macedo et al., 2005). It seems possible to reach a 1 m3/t cane water collection and (close to) zero effluent release rates by further optimizing and reuse of water use and recycling. The production of sugar cane and

ethanol results in various waste streams that pollute fresh water resources. A distinction was made in organic and inorganic pollutants. For both types of pollutants no information was available on the overall impact on the environment in São Paulo, but case studies suggest that water pollution in general is a serious problem in some areas (e.g., in the Piracicaba River basin). Strict legislation is in place specifying maximum levels of contaminants in waste water, and enforcement is relatively strict in São Paulo. Thus, compliance with local laws seems to be largely the case. Compliance with Good Agricultural practice was not scrutinized. Summarizing, water pollution can be a serious problem, but has been strongly reduced in the past, and may be even further reduced. Thus, the impact of this problem seems modest.

- *On use of agro-chemicals (incl. fertilizers):* The use of fertilizers in cane production in Brazil is modest compared to other countries and to other crops. The use of mineral fertilizers is supplemented by the use of nutrient rich wastes from sugar and ethanol production, thus nutrients are recycled to a large extent. Legislation on fertilizer use and especially Vinasse is in place and enforced relatively strongly.
- *On prevention of soil erosion and nutrient depletion:* Soil erosion in sugar cane is generally very limited compared to conventional agricultural crops such as corn and soy beans, although the exact difference is dependant on local conditions. No legislation was found directly aimed at soil erosion in Brazil, but there is legislation that indirectly affects soil erosion, such as the legislation regulating sugar cane burning and the one on permanent preservation areas. It is not clear to what extent erosion management plans are in place. It is clear that some sugar cane fields in São Paulo are on relatively steep slopes (as mechanical harvesting is not possible here).
- *On preservation of quality and quantity of surface water and ground water:* In general, the use of all available rainfall for crop production is generally considered as acceptable, which is the main practice for cane production in São Paulo. Problems generally occur when irrigation is applied. However, under the conditions found in São Paulo, irrigation for cane production is not economically feasible and not used, with the exception of West São Paulo. Yet, the growing demand for sugar cane in the Centre-South region in Brazil has led to the exploitation of regions having higher water deficits. Regions in which local water shortages occur include some of the sugar cane and ethanol producing regions, such as the Piracicaba river basin. To avoid local problems and to ensure an efficient use of fresh water resources, legislation is being implemented in some regions that include the billing of water, for both the agriculture and the industry. It is concluded that water can be a limiting factor for sugar cane crop production under certain conditions in São Paulo, but currently estimated to be a minor problem.
- *On Airborne emissions:* Cane burning results in emissions that are potentially damaging for human health. When mechanical harvesting instead of manual harvesting is applied, cane burning is not required, but it is more expensive to harvest green cane. Legislation in São Paulo to phase out burning is in place. For areas where mechanical harvesting is possible, currently only 70% of the total area may be burned, and full abolishment is scheduled until 2021. For areas-not suitable for mechanical harvesting, burning has to be terminated for 100% in 2031. As currently 37% of the area in São Paulo is harvested mechanically, compliance with legislature seems to be no problem. Also, compliance is checked using burning permits.
- *On use of GMOs*: Since 1997 the Sugar Cane Technology Centre (CTC) has been developing transgenic sugar cane varieties, including experimental planting. However, to our knowledge, no GMO- varieties are currently used in commercial sugar cane production. Genetically modified organisms (GMO's) have been banned in Brazil for a long time, but, the Brazilian government recently legalized the use of GM soybeans. It is expected that regulations regarding GMO's will be streamlined and that more GMO's will be approved in the future

Some comments on *future developments*:

Most of the sugar cane production in São Paulo is rain-fed, but the increasing use of long-term continuous irrigation (could lead to increasing environmental problems (salinisation, decreasing water tables). The further increasing use of mechanization may solve a number of environmental issues. Furthermore, it must be stated that sugar cane specific state laws (and their enforcement) are relatively strong in São Paulo compared to the rest of Brazil. Further expansion of ethanol production outside São Paulo could be expected to cause more environmental problems.

Table 5.1 Comparison of Dutch sustainability criteria and indicators, the current situation in São Paulo, and possible future developments in Brazil.

Criterion and level	Indicators for 2007 & 2011	Current Situation São Paulo				Possible future developments in Brazil	
		Compliance with NL criteria	Compliance with local legislation	Severity of Issue	Uncertainty & comments	Compliance with NL criteria	Uncertainty & comments
1. GHG balance , net emission reduction by >=30% in 2007 and >= 50% in 2011	• Use of developed methodology • Use of reference values for specific steps in logistic chain	Full, both 30% and 50%	Not applicable	Not applicable	Low uncertainty,	Probable	50% can easily be achieved, but high uncertainty regarding soil carbon, land use change (LUC) and further GHG emission reductions due to more efficient ethanol production
2. Competition with food supply, local energy supply, medicines and building materials Supply is not allowed to decrease	• Footnote a & b	Unknown	Not applicable	Medium/Large	Large uncertainty	Uncertain	Large uncertainty; both in data availability and methodological issues strongly depending on e.g. the speed of expansion of sugar cane, but also other cash crops, income distribution etc. and efficiency increases in land use
3. Biodiversity, No decline of protected areas or valuable ecosystems in 2007, also active protection of local eco-systems in 2011	• No new plantations near gazetted protected areas or high conservation value areas, reference year for ethanol is 2006 • max. 5% conversion of forest to plantations within 5 years • 2011:Additional obligatory management plan for active protection of local ecosystems • Footnote a & b	Probably most plantations in São Paulo	Partially: low compliance with legal reserve obligation, high compliance with permanent preservation areas	Medium	Low uncertainty	Very uncertain	Depend strongly on LUC (see above) and further specification of Dutch criteria. Organic production of sugar cane including reservation of land for biodiversity development could be promising to meet 2011 crteria.

Criterion and level	Indicators for 2007 & 2011	Current Situation São Paulo				Possible future developments in Brazil	
		Compliance with NL criteria	Compliance with local legislation	Severity of Issue	Uncertainty & comments	Compliance with NL criteria	Uncertainty & comments
4. Wealth, no negative effects on regional and national economy in 2007, and active contribution to increase of local wealth in 2011	• Footnote a & b, based on Economic Performance indicators of the global reporting initiative	To a large extent	Mainly yes, wages generally above minimum level, more critical for seasonal workers	Low for workers in ethanol plants, medium/high for workers in cane production	Large uncertainty	Uncertain	Large uncertainty, due to non-existent performance criteria & increasing mechanization (and effects on employment)
		Compliance with NL criteria	Compliance with local legislation	Severity of Issue	Uncertainty & comments	Compliance with NL criteria	Uncertainty & comments
5. Welfare, including							
5.a Labor conditions	• Compliance with ILO standards, social Accountability 8000 and other treaties	Only partially in cane harvesting	Partially	Large	Uncertainty of frequency of large violations	Same as 2007, situation in rest of Brazil probably worse than in São Paulo	Large
5.b Human rights	• Compliance with universal declaration of HR	Not fully, child labor observed incidentally	Little, no strong enforcement	Large	Large, unclear how frequent incidents are	Same as 2007, situation in rest of Brazil probably worse than in São Paulo	Large
5.c Property and use rights	• Three criteria from existing systems (RSPO 2.3, FSC 2, FSC 3)	Unknown	Local law weak, non-compliance known in the past, current situation unclear	Medium	Uncertainty of frequency of violations in sugar cane sector	Same as 2007, situation in rest of Brazil probably worse than in São Paulo	Large
5.d Social conditions of local population	• Footnote a & b	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown
5.e Integrity	Compliance with Business principles of countering bribery	Not investigated	Not investigated	Not investigated	Not investigated	Not investigated	Not investigated

Criterion and level	Indicators for 2007 & 2011	Current Situation São Paulo				Possible future developments in Brazil	
		Compliance with NL criteria	Compliance with local legislation	Severity of Issue	Uncertainty & comments	Compliance with NL criteria	Uncertainty & comments
6. Environment, including							
6.a Waste management	• Compliance with local & national laws • GAP	Yes, but unclear how many plants have GAP compliance	Yes, to large extent	Low/medium	Low	Depeniding on GAP compliance	With possible 100% recycling of waste water, this issue may be solved altogether in the future
6.b use of agro-chemicals (incl. Fertilizers)	• Compliance with local & national laws, from 2011 also with EU legislation	For 2007 yes, for 2011 uncertain	Largely yes	Low	Low	Partially, very likely organic production methods do comply	
6.c prevention of soil erosion and nutrient depletion	• Erosion management plan • Avoid plantations on marginal or vulnerable soils, or with high declivity • Monitoring soil quality • Nutrient balance • Footnote b	Unclear, but probably possible	No legislation on soil erosion,	Low/medium, strongly dependent on local situation	Low / medium	Strongly depends on development of NL criteria	
6.d Preservation of quality and quantity of surface water and ground water	• Footnote a & b, special attention for water use and treatment	Probable, depending on local situation	Yes	Mainly low/ some medium, dependent on local situation	Low	Unclear, but probably possible	Possible increase of irrigation critical
6.e Airborne emissions	• 2007: Comply with national laws, • 2011: Comply with EU laws	For 2007 Yes, for 2011, to large extent likely not	Yes	Medium	Low	Compliance with strict EU criteria possibly on medium term?	
6.f Use of GMOs	• 2007: Compliance with USA (safety) rules • 2011: Compliance with European (safety) rules	Yes	Yes	Currently not an issue	Low	Possible	Strongly depending on a) development of EU rules and b) whether or not GMOs cane is introduced in Brazil

a For 2007:For this criterion a reporting obligation applies. A protocol for reporting will be developed.
b For 2011 performance indicators will be developed for this criterion between 2007-2010.
Np not applicable

5.7 Overview of the possibilities and bottlenecks for certification of sustainable ethanol in Brazil.

As was discussed above, for many criteria, the situation may differ strongly from plant to plant. Certification of sugar cane and ethanol could be a method to check local circumstances and determine the compliance of individual plants with the sustainability criteria. Below, and overview is given of the current certification systems in operation in Brazil for forestry and agriculture (and specifically for sugar cane).

5.7.1 Currently applied forestry certification systems in Brazil:

According to Hoeflich (2005), about 2.8 (47.5%) of the 5.8 M ha of planted forest are already certified. The Forest Stewardship Council is the major certification system in Brazil for plantations and forests. FSC is both third party and fourth party certifier in Brazil, i.e. FSC sets standards for the certification of forests and plantations, and also provides standards to be used for other institutions (accredited or not). There are two models employed by the FSC: forestry certification and chain-of-custody certification. Up until 2005, about 2.3 Mha of plantations (mainly pine and eucalyptus) and about 1.3 Mha of native forests were certified (FCSF, 2006) .Furthermore, according to Imaflora/Smartwood, one of the major FSC and SAN certifiers in Brazil, about 25% of newly established plantations certified (in: Kwant, 2006). The other certification system containing similar but not identical standards is called CERFLOR, managed by INMETRO which is a member of the international institution PEFC – Programme of Endorsement Forest Certification Schemes, world largest certification scheme, composed by 27 national independent systems in five continents (Inmetro, 2006). The FSC-standards and Cerflor (through Inmetro) have accredited several third party certifiers such as: SGS, SKAL, BVQI, IMAFLORA, FSC-field etc., which may hold most of the 2.8 Mha of planted forests already certified. To our knowledge, no other forestry certification systems (such as the sustainable forestry initiative SFI or the Canadian Standards Organization CFA) were used in Brazil up until 2005 (FCRC, 2006).

5.7.2 Currently applied agricultural certification systems in Brazil

The most common certification system for agricultural products is Eurepgap. Eurepgap certification system brought up from the needs of 14 European food retailers (supermarkets). Thus, only Brazilian food producers which export to these retailers are required to have it. The Eurepgap label in Brazil is mainly used for coffee.

Fruits such as apple, mango, melon, papaya and grape exported have to comply with a Brazilian management system named PIF – Integrated Programme of Fruits, and they indeed do it. The PIF is nowadays accredited by Eurepgap. Furthermore, commercial fruit production in Brazil is close to hold 100% of PIF compliance. The 1.02 version of the EurepGAP Benchmarking System Procedure system Procedure have updated the previous version recognizing other farm technical and assurance schemes such as PIF. Other programs managed by Ministry of Agriculture and INMETRO- National Institute of Metrology have also been accredited by Eurepgap in Brazil such as Sisbov – Cattle Traceability System.

This new version has introduced some new requirements in terms of forage origin and certification postponing the certification of pig, poultry, dairy farms and cattle-sheep manufactures. According to SBS (2006) it is expected to May the certification of Sadia – the biggest poultry exporter in Brazil.

5.7.3 Existing systems for certification of sugar cane

Organic sugar: The great majority of certified sugar cane is related organic sugar production. According to Silva (2004), organic sugar cane production in 2002 was practiced on about 30 thousand ha, which in terms of São Paulo were around 10% of the overall planted area (or 7% of the total ar7ea under sugar cane in Brazil). Conventional systems have rarely been assessed by 3rd party certification bodies. Some of those few conventional plantations have been certified obtaining the ISO 14001 in all processes. This implies that all processes in the field and the plant are certified, as opposed to only the industrial process as it happens for most of conventional sugar and ethanol producers.

There are a number of institutions certifying the production of organic sugar in Brazil. A few major ones are:

- IBD – Instituto Biodinamico, accredited by IFOAM (International Federation of Organic Agriculture Movements) and Demeter. Major sugar cane mill certified by IBD are Usina da Barra (Cosan Group –

world largest ethanol producer) with project number SP-304; It is the largest certifier in Brazil, with 700 projects, 4500 producers and 300 thousand ha (all cultures);

- Ecocert – branch of the French Ecocert, one of the biggest European certifiers working in more than 50 countries. For internal market it works according to IN 007/09 (see below) and for Europe to CEE 09/91. It certifies the major organic sugar mills in Brazil - Usina São Francisco and Santo Antônio (Balbo Group – Native Label);
- FVO – Farm Verified Organic – from USA, was the first in the world to be accredited by IFOAM, working since 1980 in 11 countries.

IN 007/09 – the Normative Instruction 007/99, issued by the Ministry of Agriculture, establishes detailed rules on production, process, packing, distribution, identification and quality certification of the organic products in Brazil. Four of them are now highlighted: prohibited use of GMO, detailed steps for conversion and transition from the conventional to organic products/areas, designation of committees at state level, responsible for the implementation and for monitoring performance of the certifiers which must be non-profit entities.

Eurepgap: In São Paulo there are neither sugar cane plantations nor sugar mill (industry) certified by Eurepgap. There are two Eurepgap certifiers in São Paulo named WQS – World Quality Services and SBC – Brazilian Certification Services who have been Eurepgap certifiers for several years. Recently, two others, SBS and Planejar have joined them. WQS and SBC mentioned a system called informed IFA – Integrated Farm Assurance, in which sugar cane farm certification could be inserted, which is currently in use for sugar plantations certified in Cuba and in an African country. This also could provide a benchmark for certification in Brazil.

SAN-standards: Specifically for sugar cane, Imaflora developed a standard under the Sustainable Agricultural Network (see SAN, 2006, and appendix M). According to Imaflora, a multi-stakeholder process was followed to define this standard. The process was very successful in terms of participation, transparency and representation. The process achieved high political credibility in the country (Pinto, 2006). However, no sugarcane farm or sugar or ethanol mill was certified. The project failed for two reasons. First of all, Imaflora became a certifier and could not be the political driving force of the initiative. Nobody else took up this project after Imaflora left it. Second, there was no concrete economic incentive for certification of farmers or companies, especially for ethanol. Third, in practice it was hard to find mills that could have their own products certified and traded isolated from other sources. Imaflora expected incentives from the policy side, but did not receive support from national or state government. In the opinion of Luis Fernando Guedes Pinto, certification would work if there were very concrete markets for certified ethanol, or other incentives or pressure to do this.

5.7.4 Cost of certification

The cost of certification is strongly depending on (Junginger, 2006):

- The scale of production. For a production on above 10,000 ha, costs of monitoring sustainability criteria are very likely acceptable, for a size 20 ha, this is not possible. The difference in relative costs can vary over a factor of 50. For small producers, group certification is a recent trend which may enable the certification of small-scale producers.
- The costs are strongly depending on the amount and strictness of sustainability criteria, and the required experience of the experts. For example, the more specific criteria are formulated to measure biodiversity, the more experts will be required for a field visit to measure the compliance with these criteria.
- As a rule of thumb, an FSC-inspection may be about 5 times as expensive as a normal inspection based on ISO norms.

However, examples from Finnish forestry and organic food production in the USA and the Netherlands indicate that additional costs for certification (as percentage of the total production costs) lie between 0.1-1.2% depending on the scale of operation. Thus, the additional costs are probably marginal (especially as ethanol production in São Paulo is done on a large scale) and thus not prohibitive for the introduction of sustainability criteria.

Chapter 6 Discussion, conclusions and recommendations

6.1 Discussion

First of all, the large amount of uncertainty we encountered during data collection and evaluation needs to be discussed. There are different kinds of uncertainty involved:

1. In some cases, simply no data was available. In other cases data may be available but not accessible from the Netherlands.
2. In some cases, the exact magnitude of a problem was not known, e.g. the incidents reported on slave labor and land conflicts.
3. In many cases, impacts are largely indirect, e.g. caused by shifting land use. The most prominent example is the environmental and social impacts on the cerrado by increased cattle grazing and soy plantations (and the extent to which additional sugar cane plantations will add to this).
4. In some cases there is no methodology available to measure the (indirect) impacts, e.g. in the case of sugar cane influencing food availability and food prices.
5. In many cases the local situation may be significantly varying from plan to plant, e.g. whether sugar cane is grown on steep slopes or not, or which social benefits are given to workers at an ethanol plant, thus making it hard to draw general conclusions for the entire sector.

Given the fact that also many of the Dutch sustainability criteria and indicators need to be defined more narrowly, only in very few cases clear statements could be made whether or not the sustainability criteria are met, such as the (direct) GHG emission reduction, GMO cane and water use. On most other topics, potential problems with meeting the Dutch sustainability criteria have been identified, but the extent to which these issues occur may strongly vary from case to case. A hopeful indication is the fact that already nowadays a substantial amount of organic sugar is produced in São Paulo, indicating that sugar cane production with very little ecological impacts is feasible. Also, for many of the critical issues identified (e.g. child labor, wages) appropriate measures can be identified that can result in a positive score.

The costs of compliance with the environmental and socio-economic criteria included in this study have been calculated to increase the costs of ethanol by 0.12 €/l, which is equal to an increase of 56%. These costs have to be considered as indications because of several reasons. On the one hand, most criteria have been excluded from the cost analysis as a result of a lack of data, and thus actual costs may still be higher. On the other hand, the situation described in the maximum compliance case will probably exceed a number of the minimum criteria set by the commission DPB by far, and thus may be too high (at least to meet the 2007 criteria). The bulk of the additional costs is related to environmental aspects and the manual green harvesting. It is clear that with additional costs up to 56%, sustainable ethanol will most likely not be able to compete with ethanol produced according to current practices, and would probably require additional financial support. The bulk of the additional costs is related to environmental aspects and the manual green harvesting (whereby we assumed full compensation of the negative employment effects of a shift from cane burning to no cane burning harvesting system). As mentioned above, the latter is an arguable choice. If manual green harvesting is not included, additional costs would be about 0.05 €/l, an increase of only 24%.Given current oil and gasoline prices, such a price range would probably be less prohibitive. Cost of certification was not directly included in this calculation. However, as sugar cane and ethanol production are carried out at a large scale in Sao Paulo, additional costs for certification are expected to be minimal (e.g. well below 1%) though again this would depend on the number and severity of criteria.

A general observation made was that different sustainability criteria may conflict with each other. For example, burning of sugarcane causes environmental problems, but enables manual harvesting. Manual harvesting of green, unburnt sugarcane is very hard labor, and can be avoided by mechanization. Mechanization can also have advantages in terms of erosion prevention, however large-scale mechanization will likely result in large-scale job losses. Thus, it should only be implemented gradually, so that the workers can find work elsewhere. Another, less evident example could be the transport of ethanol. Inland transportation by boat instead of by truck may be preferable from an energy point of view, but further extension of canals / dredging of rivers may cause environmental damage. Clearly, these issues largely depend on the specific crop type and local circumstances. It is not clear how the Dutch sustainability framework will deal with these dilemmas.

A preliminary draft of this report was reviewed by Prof. Jose Roberto Moreira, CENBIO. Next to providing many useful additions and corrections, he also made a number of critical remarks on the Dutch sustainability criteria. His main point is the principal question whether one can demand from developing countries to fulfill criteria which are as strict as for developed countries. For example, the Dutch criteria demand from 2011 onwards that ethanol production should increase local wealth. Prof. Moreira emphasizes that ethanol has to compete with fossil fuels, and it cannot be expected that it solves all kinds of other ecological and social problems in Brazil at the same time. He notes that these are principally governmental tasks, and that the sugar cane industry already contributes to local wealth creation by paying wages and taxes.

Another main point is that sugar cane is currently only occupying a marginal share of the Brazilian (agricultural) land. While concerns over (indirect) impacts of additional sugar cane plantations are certainly valid, it must also be emphasized that there is still land available without directly threatening valuable ecosystems, Perhaps even more important, Brazil is intensifying its agriculture and meat production. As shown in section 3.3.3 / table 3.13, in Sao Paulo, cattle density per hectare of pasture has increased 10%, while growing in absolute terms by 7%. Further raising the productivity of agriculture and meat production is a key factor of keeping a neutral land balance, thus enabling compliance with criteria on biodiversity, food and fodder availability etc.

6.2 Conclusions and recommendations

While the current study contains many different types of uncertainties, no prohibitive reasons where identified why ethanol from São Paulo principally could not meet the Dutch sustainability standards set for 2007. In many impact categories, Brazilian ethanol from sugar cane scores average to (very) positive, see also table 6.1 for a summary. For a number of other criteria, problems are identified, but it also appears that these may differ strongly between the individual plants. Furthermore, for most of these issues, measures can be identified to improve performance (when needed).

For the future and the whole of Brazil, too many uncertainties remain to determine whether also additional criteria from 2011 onwards can be met. First of all, it is as yet unclear how additional land use for sugar cane may cause indirect / induced land-use, and how large the actual impacts will be on land use, biodiversity etc. Second, it is also uncertain whether and how the Dutch sustainability criteria will deal with these indirect impacts, as these criteria are not yet clearly defined.

However regarding the future developments, first of all, Brazil is currently intensifying its agriculture and meat production. Further raising the productivity of agriculture and meat production is a key factor of keeping a neutral land balance, thus enabling compliance with criteria on biodiversity, food and fodder availability etc. Second, a promising example is the organic sugar cane production, and in special the São Francisco sugar mill, where substantial ecological and social improvements compared to conventional sugar cane production have been achieved over a period of twenty years, including development of native forest area. This could be a case study for the development of additional sustainability criteria. However, it should also be clear that switching on a large scale to organic farming cannot be achieved within a short period of time.

Finally it is important to recognize that sustainability criteria lead to higher production costs - depending on the strictness of the sustainability criteria, we estimate additional ethanol costs of up to 56%, though in case mechanical green harvesting is applied, additional ethanol costs are estimated at 24%.While the latter may not necessarily be prohibitive given current oil prices, it is clear that some financial support is most likely needed to stimulate sustainable ethanol production.

A number of principal recommendations are made:

1. Additional data collection

As indicated in the discussion, a large part of the uncertainties stem from missing data, e.g. on occurrences of child labor specifically in the sugar cane sector, impacts of sugar cane on the social conditions of the local population. This data is most likely available, but it was not possible to collect all data within the time frame and the resources of this project. In a follow-up of this project, additional data could be collected.

2. Development of new methodologies

As discussed above, more research is required on carbon soil, biodiversity and food security. This not only implies the collection of new region-specific data, but also the development of effective indicators & thresholds to measure impacts, and valuation approaches on how to assess overall damages and benefits. A generic issue is the influence of land use dynamics. It should be emphasized that this field is much broader and complex that the development of sustainable biofuels alone.

3. Explore possibilities for certification

The situation for many different sustainability criteria may strongly differ from plant to plant and impacts generally cover a range. Certification similar to FSC certification of plantations and wood-processing plants seems feasible and advisable, and could lead to selection of specific producers/production areas.

There are several possibilities for certification. One possibility could be to introduce Eurepgap criteria for sugar cane. Eurepgap criteria could typically assure:

- The compliance of all legal apparatus on environmental themes, related on big scale enterprises (sugar cane plantations) e.g. licensing requires riparian vegetation recovery, wildlife corridors construction, compliance with emission standards, PRAD (Degraded Areas Recovery Plan); PGRS and PGRL – management plan for liquid and solid wastes, ARL – legal reserve area (20%), etc.
- The use of GMP (good manufacturing practices) and BMP (best management practices) in practice; e.g. mechanical harvesting of crude cane (non-burning); no tillage/minimum tillage; rotation crops.
- The compliance of Brazilian technical standards, rules and norms related to fertilizers, agrochemicals, e.g. use of the recommended dose of a given insecticide (also registered and authorized for sugar cane) as well as respecting the minimum time after harvesting prescribe in its guidelines;
- Continuity of the certified standards through periodic monitoring.

A third party certifier such as Eurepgap could boost the compliance ("private enforcement") of all aspects mentioned above. Thus, existing blanks such as lack of personnel, logistic and economic resources could be set aside once Eurepgap would be undertaking most of tasks. By checking the first party (self-declaration), requiring the appropriate licensing, doing the independent monitoring at field, most of potential gaps/risks, existing presently, could be covered.

With such criteria, the Dutch sustainability demands are likely to be met to a large extent. Taking it one step further are the production criteria for organic sugar cane, as even one step further would be the SAN-standards for organic sugar cane production, possibly extended with further social criteria and more specific criteria for processes in the ethanol production plant.

Clearly, such certification systems need to be developed either by or in close co-operation with the Brazilian stakeholders. Principal choices will also have to be made who is going to set up and carry out the certification, e.g. a Brazilian governmental body, an independent organization or roundtable, or the ethanol industry sector themselves.

4. Possible follow-up activities of this project

As discussed previously, a Brazilian stakeholder consultation on the desired boundary conditions and criteria for sustainable ethanol, in relation to current national and state legislation, standards and practices is strongly needed. This would also be very helpful to determine in case studies how far the Dutch sustainability criteria are measurable and verifiable. To this end, data should be collected from a number of local Brazilian stakeholders, such as Brazilian Agricultural Research Corporation EMBRAPA, the São Paulo Sugar Cane Agroindustry Union UNICA, other industrial stakeholders, key NGO's, e.g. WWF Brazil, the Sustainable Agriculture Network (SAN), but also local NGO's, governmental representatives, etc.

Also, it could be explored if on the short term organic sugar mills are planning to switch to ethanol production, i.e. whether such a pilot case could be supported from the Netherlands to demonstrate the possibilities of sustainable ethanol.

In this respect, an aspect which has not been highlighted in this report is the transport of ethanol to the Netherland. An organizational model needs to be developed, how impacts can be monitored via a workable track-and-trace system, directly applicable for intended imports of Brazilian bio-ethanol to the Netherlands.

Finally, a first attempt was made to calculate the additional production costs of sustainability criteria. Monetarization of the different impacts (both potentially positive and negative) is however necessary to a more detailed extent. Again, local field work would be required to get more accurate data and thus reliable results.

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Table 6.1. Summary of Dutch sustainability criteria and expected compliance in São Paulo and Brazil

Criterion and level	Indicators for 2007 & 2011	Compliance with NL criteria Sao Paulo	Compliance with NL criteria, whole of Brazil, future
1. GHG balance , net emission reduction by >=30% in 2007 and >= 50% in 2011	Use of developed methodology Use of reference values for specific steps in logistic chain	Full, both 30% and 50%	Probable
2. Competition with food & energy supply, and others		Unknown	Uncertain
3. Biodiversity, No decline of protected areas or valuable ecosystems in 2007, also active protection of local eco-systems in 2011	No new plantations near protected areas or high conservation value areas, reference year for ethanol is 2006, max. 5% conversion of forest to plantations within 5 years, 2011:Additional obligatory management plan for active protection of local ecosystems	Probably most plantations in São Paulo	Very uncertain
4. Wealth, no negative effects on regional and national economy in 2007, and active contribution to increase of local wealth in 2011	Based on Economic Performance indicators of the global reporting initiative	To a large extent	Uncertain
5. Welfare:			
5.a Labor conditions	Compliance with ILO standards, social Accountability 8000 and other treaties	Only partially in cane harvesting	Same as 2007, situation in rest of Brazil probably worse than in São Paulo
5.b Human rights	Compliance with universal declaration of HR	Not fully, child labor observed incidentally	Same as 2007, situation in rest of Brazil probably worse than in São Paulo
5.c Property and use rights	Three criteria from existing systems (RSPO 2.3, FSC 2, FSC 3)	Unknown	Same as 2007, situation in rest of Brazil probably worse than in São Paulo
5.d Social conditions of local population		Unknown	Unknown
5.e Integrity	Compliance with Business principles of countering bribery	Not investigated	Not investigated
6. Environment:			
6.a Waste management	Compliance with local & national laws Good agricultural practice	Unclear how many plants have GAP compliance	Depending on GAP compliance
6.b use of agro-chemicals (incl. Fertilizers)	Compliance with local & national laws, from 2011 also with EU legislation	For 2007 yes, for 2011 uncertain	Partially, very likely organic production methods do comply
6.c prevention of soil erosion and nutrient depletion	Erosion management plan, avoid plantations on marginal or vulnerable soils, or with high declivity, monitoring soil quality, nutrient balance	Unclear, but probably possible	Strongly depends on development of NL criteria
6.d Preservation of surface & ground water	Special attention for water use and treatment	Probable, depending on local situation	Unclear, but probably possible
6.e Airborne emissions	2007: Comply with national laws, 2011: Comply with EU laws	For 2007 yes, for 2011 to large extent likely not	Compliance with strict EU criteria possibly on medium term?
6.f Use of GMOs	2007: Compliance with USA (safety) rules, 2011: Compliance with European (safety) rules	Yes	Possible

References

AES-Tiete, 2005, Project Design Document Form for Afforestation and Reforestation Activities, available at www.aestiete.com.br

Agrianual, 2005, Fundação Nacional de Pesquisa, available at: www.fnp.com.br

Agricultural Economics Institute (Instituto de Economical Agricola), 2006, data on land rents, available at: www.iea.sp.gov.br.

Arbex, Marcos Abdo, José Eduardo Delfini Cançado; Luiz Alberto Amador Pereira; Alfésio Luís Ferreira Braga; Paulo Hilário do Nascimento Saldiva. Biomass burning and its effects on health. Jornal Brazileiro de Pneumologia. vol.30, no.2, São Paulo, March/April 2004.

Archer, G., 2006, Development of Carbon Certification & Sustainability Assurance for Biofuels in the UK, Presentation held at A Sustainable Path for Biofuels in the EU, 7th June 2006 Brussels, Belgium.

Balbo, L. 2000, Planeta Orgânico visita Usina São Francisco, available at: www.planetaorganico.com.br

Barbosa, M. L.: 2005, Internal Report, Unica, São Paulo, Brazil.

Bates, David V. Jane Koenig, Michael Brauer. Health and Air Quality 2002 – Phase 1 Methods for Estimating and Applying Relationships between Air Pollution and Health Effects. Final Report. British Columbia Lung Association. [RWDI Project: W02-304]. May 2003.

Bergsma, G., Harmelynck, B.G., 2005. Certificering van duurzaamheid van import van groene grondstoffen. Notitie. Delft, 31 maart 2005. CE / Eostra. P. 20.

Berndes, G., 2002, 'Bioenergy and water. The implications of large-scale bioenergy production for water use and supply', Global Environmental Change 12 (4), 253-271.

Braga, B. P. F., C. Strauss, F. Paiva: 2005, Water Charges: Paying for the Commons in Brazil, International Journal of Water Resources Development 21 (1), 119-132.

Braunbeck et al., 1999, Prospects for green harvesting and cane residue use in Brazil, Biomass and Bioenergy 17, p. 495-506.

Braunbeck O., 2006, Personal Communicatyion in van den Wall Bake (2006), 6-12-2005, Fac. Engenheria Agrícola, UNICAMP, Campinas, Brazil.

Cançado, José E.D, Paulo H.N. Saldiva, Luiz A.A. Pereira, Luciene B.L.S. Lara, Paulo Artaxo, Luiz A. Martinelli, Marcos A. Arbex, Antonella Zanobetti, and Alfesio L.F. Braga. The Impact of Sugar Cane–Burning Emissions on the Respiratory System of Children and the Elderly. Environmental Health Perspectives. VOLUME 114 NUMBER 5 May 2006, pages 725-729.

CE: 2006. Bergsma, G., et al. Resultaten Enquete duurzame Import biomassa.

Chomitz, K. M., T. S. Thomas and A. S. P. Brandao: 2005, 'The economic and environmental impact of trade in forest reserve obligations: a simulation analysis of options for dealing with habitat heterogeneity', Revista de Economia e Sociologia Rural 43 (4), 657-682.

CI: 2006: Biodiversity Hot Spots. Accessible via: http://www.biodiversityhotspots.org/xp/Hotspots/, Conservation International, Washington, D.C. U.S.A.

Consecana, 2006, Conselho dos Produtores de Cana-de-açúcar, Açúcar e Álcool do Estado de São Paulo, Circulares 2006, available at www.udop.com.br

Contini, E., M. J. A. Sampaio and A. F. D. Avila: 2005, 'The lack of clear GMO regulation: its impact on researchers and farmers in Brazil', International Journal of Biotechnology 7 (1/2/3).

Cramer, J., Wissema, E., Lammers, E. (+ en ander leden project groep Duurzame producite van biomassa), Faaij, A.., Hamelinck, C., Bergsma, G., van den Heuvel E., Junginger, M., Smeets, E.:2006, Criteria voor duurzame biomassa productie. Concept eindrapport, 5 Juli 2006, p 32.

CTC, 1988, Simposio de Avaliacao da Agroindustria da Cana-de-Açucar no Estado de Alagoas.

CTC, 2004. Internal benchmark report on 15 usinas in the state of São Paolo.

Damen, K., 2001, Future Prospects for Biofuel Production in Brazil, Master Thesis, Utrecht University. NWS E -2001-31, p. 68.

Damen, K. and a. Faaij: 2003, A Life cycle inventory of existing biomass import chains for “green” electricity production. Essent, Copernicus Institute for Sustainable Development – Utrecht University, NWS-E-2003-01, January 2003, Pp. 68.

Darolt M.R., and Skora Neto, F., 2002, Sistema de Plantio Direto em Agricultura Orgânica, available at: www.planetaorganico.com.br

De Armas, E. D. and R. T. R. Monteiro: 2005, 'Uso de agrotóxicos em cana-de-açúcar na bacia do Rio Corumbataí e o risco de poluição hídrica', Quím. Nova 28 (6), 975-982.

De Maria, I.C. and Dechen, S.:1998. Perdas por erosão do solo em cana-de-açú. STAB- Açúcar, alcool e subprodutos.v.17,n.2,p.20-21,1998.
DIEESE: 2006, Salário mínimo nominal e necessário. Accessible via: http://www.dieese.org.br/rel/rac/salminmar06.xml, Interunion Department of Socioeconomic Studies and Statistics.
EC, 2001. Council Directive 91/414/EEC of 15 July 1991 concerning the placing of plant protection products on the market. Available at: http://ec.europa.eu/food/plant/protection/evaluation/legal_en.htm.
EC, 2006. An EU strategy for biofuels. Communication from the commission, {SEC(2006) 142}, Brussels, 8.2.2006, p.29.
Embrapa (2005), Empresa Brasileira de Pesquisa Agropecuária, available at: www.embrapa.br
EPA: 1995, Compilation of Air Pollutant Emission Factors, Vol. 1 (Stationary Point and Area Sources) - AP - 42, United States Environmental Protection Agency, Triangle Research Park, N.C., U.S.A.
ESMAP: 2005, Potential for Biofuels for Transport in Developing Countries, ESMAP, Energy and Water Department, World Bank, Washington, D.C., U.S.A., p. 182.
EurepGAP – www.eurep.org
EurepGAP: 2005, Fruit and vegetables (various technical documents), Cologne, Germany.
FAO: 2003, Brazil: The hunger of the missed meal, FAO supports the Zero Hunger Project -- Interview with Andrew MacMillan. Available at: http://www.fao.org/english/newsroom/news/2003/13320-en.html
FAO: 2004, AQUASTAT country profiles - Brazil. Version 2000. United Nations Food Agricultural Organisation, Rome, Italy.
FCRC: 2006, Overview of wood and forestry related certification activities, available at: www.certifiedwoodsearch.org
FGV: 2006. data on profits per hectore for different types of agriculture, forestry and cattle farming, Fundação Getúlio Vargas, available at: www.fgv.br.
Fontes, E. M. G.: 2003, 'Legal and regulatory concerns about transgenic plants in Brazil', Journal of Invertebrate Pathology 83 (2), 100-103.
FSC, 2006. Forest Stewardship Council, FSC Principles & Criteria of Forest Stewardship, available at www.fsc.org
FSC Brazil: 2006. Data on FSC certified forests and plantations, FSC Brazil, available at: http://www.fsc.org.br/index.cfm?fuseaction=conteudo&IDsecao=180
Goldemberg, J., 2006. Sustainability of sugar cane ethanol in the state of Sao Paulo, Brazil. Personal written communication to K. Kwant, SenterNovem, June 2006.
GRI, 2002, Child Labour Protocol, Global Reporting Initiative, Amsterdam, 10.
GRI, 2003, Water Protocol, Global Reporting Initiative, Amsterdam, 48.
GTZ, 1995, Environmental Handbook Volume II - Agriculture, Mining-Energy, Trade-Industry, Deutsche Gesellschaft für Technische Zusammenarbeid, Eschborn, Germany, p. 736.
Hamelinck, C., van den Broek, R., Niermeijer, P., Jager, H., 2004. Biofuels certification. Ecofys, December 2004, p .36.
IBAMA – Instituto Brasileiro de Meio Ambiente e Recursos Naturais Renováveis. GEO Brasil 2002 – Perspectivas do Meio Ambiente no Brasil. Brasília, 2002. Available at http://www2.ibama.gov.br/~geobr/geo2002.htm
IEA, 2004. Biofuels for transport. An international perspective. International Energy Agency, Paris, France.
IFPRI, 2001, Global Food Projections to 2020. Emerging trends and alternative futures., International Food Policy Research Institute, Washington, DC, U.S.A.
IGBE, 2003, Pesquisa Nacional por Amostra de Domicílios - Trabalho Infantil 2001, Instituto Brazileiro de Geografia e Estatística, Rio de Janeiro, Brazil. See also: http://www.bbc.co.uk/portuguese/noticias/2003/030428_tperguntas.shtml
Satyarthi, K., Interview with BBC Brasil, 21 August 2006, see http://www.bbc.co.uk/portuguese/noticias/
IMAGE-team, 2001, The IMAGE 2.2 implementation of the SRES scenarios: a comprehensive analysis of emissions, climate change and impacts in the 21st century., National Institute for Public Health and the Environment, Bilthoven, The Netherlands.
Inmetro, 2006 – www.inmetro.gov.br
IPCC, 2001. Climate Change 2001: The Scientific Basis. Contribution of Working Group I to the Third Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge, United Kingdom and New York, NY, USA, Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp 881.

Jenkins, B., 1994, Cane smoke emissions study, University of California, Davis, CA, U.S.A.
Junginger, M. and A. Faaij, 2005. IEA Bioenergy task 40- Country report for the Netherlands, report NWS-E-2005-48, commissioned by IEA Bioenergy Task 40,unit Science, Technology and Society, Utrecht University, Utrecht, The Netherlands, July 2005, 34 pp.
Junginger, 2006. Comparison of cost of certification systems. Copernicus Institute, Utrecht University, unpublished.
Kaplan, S., 1983, Energy Economics – Quantitative Methods for Energy and Environmental Decisions. ISBN – 0-07-033286-X , 1983.
Kwant, K.: 2006, Personal communication on BEST mission Brazil, 9-13 april 2006. SenterNovem. The Netherlands.
Laurijssen, J, 2006. Trading biomass or GHG emission credits, MSc thesis, Copernicus Institute, Utrecht University, p. 79.
Lewandowski, I., A. Faaij: 2004. Steps towards the development of a certification system for sustainable biomass trade – analysis of existing approaches. Report prepared for NOVEM and Essent, Copernicus Institute for Sustainable Development – Utrecht University, NWS-E-2004-31, July 2004. Pp. 56 + Appendices
Macedo, I. and Cortez, L.A.B., Sugar-cane industrial processing in Brazil, reader UNICAMP, São Paulo, Brazil.
Macedo, I. d. C., M. R. L. V. Leal and J. E. A. R. Da Silva: 2004, Assessment of greenhouse gas emissions in the production and use of fuel ethanol in Brazil. Accessible via: http://www.unica.com.br/i_pages/files/pdf_ingles.pdf, Secretariat of the Environment of the State of São Paulo, Brazil.
Macedo, I. d. C.: 1995, Converting Biomass to Liquid Fuels:Making Ethanol from Sugar Cane in Brazil. Energy As An Instrument for Socio-Economic Development. J. Goldemberg and T. B. Johansson, United Nations Development Program, New York, USA.
Macedo, I. d. C. et al., 2005, Sugar cane's energy. Twelve studies on Brazilian sugar cane agribusiness and its sustainability, UNICA, pp. 237.
Macedo, IC, Nogueira, LAH, 2005, Biocombustíveis (Biofuels), Cadernos do Núcleo de Assuntos Estratégicos da Presidência da República. Number 2, January 2005, Brasília, 2005.
Malavolta, E., 1982, Mineral Nutrition and Fertilisation of Sugar cane, Ultrafertile S.A.
Mendonça, M. L., 2006, 'The WTO and the Destructive Effects of the Sugar cane Industry in Brazil. Accessible via: http://www.social.org.br/cartilhas/cartilha_rede_em_ingles.pdf (
Milaré, E., 2004, Direito do Ambiente: doutrina, jurisprudência, glossário.- 3.ed.rev.,atual. E ampl. - São Paulo.
Editora Revista dos Tribunais, 2004.
Moreira, J.R., 2005. The importance of Bio-Energy for the World Development and Sustainability. National Reference Center on Biomass. CENBIO/IEE-USP. Presentation given during IEA Task 30, 31 & 40 workshop in Campinas, Brazil, 30.11-2.12 2005. Available at: www.bioenergytrade.org
Moreira, 2006. Review of Jose Roberto Moreira on a draft of this report. CENBIO, May 2006.
Novaes, 2006, Federal University of Rio de Janeiro, Interview in Reporter Brasil, http://www.reporterbrasil.com.br/exibe.php?id=517
Oliveira, A. de: 1991. Reassessing the Brazilian alcohol program, Energy Policy 19, p. 47-55.
Oliveira, M. E. D., B. E. Vaughan and E. J. Rykiel: 2005, 'Ethanol as Fuel: Energy, Carbon Dioxide Balances, and Ecological Footprint', Bioscience 55 (7), 593-602.
Ometto, A.R., Roma, W. N. L., Ortega, E., 2004, Emergy life cycle assessment of fuel ethanol in Brazil.In Ortega, E. & Ulgiati, S. (editors): Proceedings of IV Biennial International Workshop “Advances in Energy Studies”. Unicamp, Campinas, SP, Brazil. June 16-19, 2004. Pages 389-399. Availabe at http://www.unicamp.br/fea/ortega/energy/Ometto-1.pdf
OIT, 2006. Orginacao Internalional de Trabalho. http://www.oitbrasil.org.br/
OTA, 1993, Potential environmental impacts of bioenergy crop production., US Congress Office of Technology Assessment, Washington, D.C., USA.
PAN, 2005, Pesticides Database. Accessible via: http://www.pesticideinfo.org/Search_Chemicals.jsp, Pesticide Action Network North America.
Paraná, 2004. Secretary of Work, Job and Social Promotion. Parana State Government. VARIAÇÃO DO SALÁRIO MÉDIO DOS ADMITIDOS NO BRAZIL, PARANÁ E REGIÃO METROPOLITANA DE CURITIBA. PRIMEIRO BIMESTRE DE 2004. April 2004.

PEFC – www.pefc.org
Pessoa, M.C.P.Y., Gomes, M.A.F., Neves, M.C., Cerdeira, A.L., De Souza, M.D., 2003, Identificação de áreas de exposição ao risco de contaminação de águas subterrâneas pelos herbicidas atrazina, diuron e tebutiuron, Pesticidas, R. Ecotoxicol. e Meio Ambiente, Curitiba, v.13, p.111-112, jan/dez. 2003.
Pimentel, D., C. Harvey, P. Resosudarmo, K. Sinclair, D. Kurz, M. McNair, S. Crist, L. Shpritz, L. Fitton, R. Saffouri and R. Blair: 1995, 'Environmental and Economic Costs of Soil Erosion and Conservation Benefits', Science 267 (3), 1117-1123.
Pinto, L., 2006. Personal communication on possibilites to certify sustainable sugar cane. Imaflora, 17 February 2006.
Quintiliano, J., A. Margues, J. Bertoni and G. B. Barreto, 1961, 'Perdas por erosão no estado de São Paulo', Brigantia 20 (2), 1143-1182.
Ripoli, T. C. and W. F. Molina Jr: 1991, 'Cultura canavieira: um desperdício energético', Maquinaria Agrícola (1), 2-3.
RSPO, 2005, Roundtable Sustainable Palm Oil, RSPO Principles and Criteria for Sustainable Palm Oil Production. Version 3. 22 September 2005, available at: www.rspo.org
Ryckmans, Y. Implementation strategy for large scale biomass imports. Presentation given at the T38/T40 workshop in Trondheim, Norway, April 2006, available at www.bioenergy trade.org.
SAN, 2006. general standards of the Sustainable agricultural Netwiork. Available at http://www.ra.org/programs/agriculture/certified-crops/standards.html
Schwartzman, S. and F. Schwartzman, 2004, 'O trabalho infantil no Brazil', Jornal do Brazil 27/12/1996.
Silva, R.M.H, 2004, Cadeia Produtiva da cana-de-açúcat no Brazil e determinantes para seu avanço, Universidade Estadual Paulista, GEEIN – Grupo de Estudos em Economia Industrial, 17 p. 2004
Scaramucci, JA, Cunha, MP. O agronegócio da cana-de-açúcar como vetor de desenvolvimento. Presentation at PROALCOOL – 30 anos. Available at www.cori.unicamp.br/foruns/ energia/evento11/Scaramucci.ppt
Silveira, A.M., Victoria, R.L., Ballesker, M.V., De Camargo, P.B., Martinelli, L.A., Cassia Picollo, M., 2006, SIMULAÇÃO DOS EFEITOS DAS MUDANÇAS DO USO DA TERRANA DINÂMICA DE CARBONO NO SOLO NA BACIA DO RIO PIRACICABA (Simulation of the effects of land use change in soil, carbon dynamics in the Piracicaba river basin, Sao Paulo State, Brazil. Available at www.embrapa.br , latest access: 25 March 2006.
Smeets, E., A. Faaij and I. Lewandowski: 2005, The impact sustainability criteria on the costs and potentials of bioenergy production. An exploration of the impact of the implementation of sustainability criteria on the costs and potential of bioenergy production applied for case studies in Brazil and Ukraine, Utrecht University, Utrecht, the Netherlands.
Smeets, E. M.W., A. P.C. Faaij and I.M. Lewandowski, 2006. The impact of sustainability criteria on the costs and potentials of bioenergy production - applied for case studies in Brazil and Ukraine. Submitted for publication in Biomass and Bioenergy.
Souza, J.L. (2005), Agricultura Orgânica – Tecnologia para Alimentos Saudáveis, available at: www.incaper.es.gov.br.
Sparovek, G. and E. Schnug: 2001, 'Soil tillage and precision agriculture: A theoretical case study for soil erosion control in Brazilian sugar cane production', Soil and Tillage Research 61 (1-2), 47-54.
Sugar mark, 2006. Cleaner Production waste reduction opportunities. Available at: http://www.ies.ac.zw/santren/Projects/cleanerproduction/triangle_limited.htm.
UNDP: 2006, Human Development Report (HDR), Unitend Natins Development Programme, available at: http://hdr.undp.org/statistics/data/
UNEP, 1997, Source Book of Alternative Technologies for Freshwater Augmentation in Latin America and the Caribbean, Organization of American States, Washington, D.C.,.
UNICA – União da Agroindústria Canavieira de São Paulo. Sugar and Ethanol from Brazil –Energy and Environmental Commodities. São Paulo, 2004.
USDA: 2000, National Resources Inventory (revised December 2000), Natural Resources Conservation Service, Washington, DC, and Statistical Laboratory, Iowa State University, Ames, Iowa, USA., 89.
USDS: 2006, Country Reports on Human Rights Practices – Brazil 2005, United States Department of State, Washington, D.C., U.S.A., Accessible via: http://www.state.gov/g/drl/rls/hrrpt/2005/61718.htm
Veiga Filho, AA, Ramos, P. The Brazilian National Alcohol Program and Evidente of Concentration in Sugar Cane Production and Processing. Informações Econômicas, v.36, n.7, july 2006. pp. 48-61.
Walter, A., and Dolzan, P., 2006, Personal communication on various topics, Campinas University, Campinas, Brazil, April-June 2006.

WB, 1998, Pollution Prevention and Abatement Handbook, World Bank, Washington, D.C., 471.
WB, 2004, World Development Indicators: 2004, World Bank, Washington D.C., U.S.A.
Wicke, B., 2006. The socio-economic impacts of large-scale land use change and export-oriented bio-energy production in Argentina: Quantifying the direct, indirect and induced impacts of agricultural intensification and bio-energy production with input-output analysis.Msc thesis, to be published. Supervisors, E. Smeets, A. Faaij, Copernicus Institute, Utrecht University, 2006.
Williams, M.R., Solange Filoso, Luiz A. Martinelli, Luciene B. Lara, and Plınio B. Camargo, Precipitation and River Water Chemistry of the Piracicaba River Basin, Southeast Brazil, J. Environ. Qual. 30:967–981 (2001).
WHO: 1998, The WHO Recommended Classification of Pesticides by Hazard and Guidelines to Classification 1998 - 1999, World Health Organisation, Geneva, Switserland, 61.
WU, 2006. Fact sheet on formaldehyde. Food-info site, maintained by Wageningen University, available at: http://www.food-info.net/nl/e/e240.htm

Appendix A Vragenlijst duurzaamheidscriteria bio-ethanol import uit Brazilië

Om de verschillende stakeholders te interviewen is een standaard vragenlijst gebruikt. De interviews zijn meestal telefonisch gevoerd, en zijn vervolgens schriftelijk uitgewerkt,waarbij de antwoorden zijn samengevat per onderdeel van het interview. Tenslotte zijn de uitgewerkte interviews ter controle aan de stakeholders voorgelegd. De interviewstructuur was als volgt:

1. Algemeen
2. Inventarisatie duurzaamheidscriteria Brazilië
3. Implementatie
4. Open gedeelte: visie stakeholder

1. Algemeen:

1.1 Het is in eerste instantie noodzakelijk om duurzaamheidseisen te stellen aan import van bio-ethanol?

1.2 Zo ja, zou dit alle voor energie en/of transportdoeleinden moeten gelden, of voor alle toepassingen (chemie, voedsel, etc.)?

1.3 In hoeverre zouden duurzaamheidseisen aan bioethanol moeten afhangen van de mate van subsidiering / accijnsvrijstelling?

1.4 In hoeverre zouden eventuele duurzaamheidscriteria voor geïmporteerde ethanol ook voor in Nederland geproduceerd ethanol moeten gelden?

2. Inventarisatie relevante duurzaamheidcriteria voor bioethanol uit Brazilië

Zijn dit relevante thema's? Zo ja, hoe zouden deze in duurzaamheidscriteria geformuleerd kunnen worden? En hoe zouden ze in de praktijk te monitoren zijn (vergelijking met Nederlandse situatie)

2.1 Algemene duurzaamheidscriteria

2.1.1 CO_2 en energie balans:

Moeten CO_2-en energiebalansen een onderdeel uitmaken van de duurzaamheidscriteria?
Zo nee, waarom niet, Zo ja, hoe moeten die gemeten worden:
a) "Well to Rotterdam", of te wel alleen: energie-inputs/ CO2 emissies per liter of GJ ethanol aangevoerd in Rotterdam
b) "Well to Wheel", rekening houdende met vermeden emissies van fossiele (transport)brandstoffen

Voor a) respectievelijk b): wat zouden redelijke getallen zijn voor bij voorbeeld de Output/ Input ratio voor energie of kg CO_2 / liter ethanol

2.1.2 Voedselvoorziening

Is een eis aan garantie dat biomassa-productie niet tot voedselschaarste leidt a) nodig b) wenselijk c) realiseerbaar?

2.1.3. Natuurbehoud / biodiversiteit

Mag ethanol productie (beperkt) leiden tot aantasting van waardevolle natuur, direct (cerrados) of indirect (regenwoud door leakage)

Welke mate van eisen is wenselijk? B.v.
Het verbouwen van biomassa mag niet ten koste gaan van waardevolle natuurgebieden
Actieve bescherming van het lokale ecosysteem
Actieve ontwikkeling van het lokale ecosysteem

Is dat in de praktijk te monitoren/ te meten?

2.1.4 Welvaart en welzijn

Moet ethanol productie Biomassa leiden tot een vooruitgang c.q. geen achteruitgang in de welvaart van ontwikkelingslanden?

2.2 Relevante ecologische en sociale duurzaamheidsaspecten bij de *teelt* van biomassa?

Tot nu toe geïdentificeerde aspecten:

- Sugar cane burning
- Water gebruik en vervuiling
- Landgebruik
- Bodem erosie
- Invloed op de bodemsamenstelling
- Gebruik van agro-chemicalien
- Ongedierte en onkruidbestrijding
- Gebruik van kunstmest / Vinasse-recycling
- Gebruik van GMOs op het veld
- Arbeidsomstandigheden (lokale wettelijke eisen / gangbare lonen, min. ILO normen, of Fair trade principes / strenger?)

Nog andere milieuzorgpunten?

2.3 Relevante ecologische en sociale duurzaamheidsaspecten bij de *productie van ethanol uit suikerriet in de fabriek*?

- Water use and water pollution, organic /inorganic pollutants, vinasse/recycling
- Gebruik van GMO's in het productieprocess
- Arbeidsomstandigheden (min. ILO normen, strenger?)

2.4 Transport

Nog specifieke duurzaamheidseisen voor transport (binnen Brazilië/naar Nederland)?

3. Implementatie

3.1 In hoeverre zouden duurzaamheidscriteria in fases ingevoerd moeten worden, c.q. geleidelijk aangescherpt moeten worden? Zijn meerdere niveaus duurzaamheidscriteria mogelijk/wenselijk?

3.2 Is (duurzaamheids)certificering van ethanol zinnig en haalbaar? (Vergelijking met FSC certificering van hout)

3.3 Zal extra duurzaamheidscriteria leiden tot (substantiële) extra kosten? Zo ja, indicatie hoe hoog (welke soort criteria geven vele extra kosten/juist niet)?

3.4 Hoeveel duurzaamheidscriteria zouden nodig zijn, om "duurzaamheid" te garanderen? Zouden 5 voldoen (soort. Indicator functie, als dat goed zit, zit de rest ook goed), of meer (b.v. >20)?

3.5 Hoeveel duurzaamheidscriteria zouden nodig praktisch hanteerbaar zijn? B.v. maximaal 5, of ook >20? Waar ziet U praktische problemen?

3.6 In hoeverre is het belangrijk, dat de criteria specifiek op bio-ethanol gericht zijn, of zou duurzaamheid van bio-ethanol onder een set algemene duurzaamheidscriteria voor alle biomassa geregeld kunnen worden?

4. Visie/ belangen van de stakeholder

4.1 Open vragen: hoe staat U tegenover het opzetten van duurzaamheidscriteria voor ethanol?

4.2 Heeft u nog extra suggesties voor duurzaamheidscriteria voor import van biomassa voor energie en transporttoepassing? Hebben we nog belangrijke aspecten gemist?

Appendix B Interview Nedalco

Telefonisch interview met Martin Weissmann (MW), business development manager biobrandstoffen bij Koninklijke Nedalco. Het interview is gevoerd op 25 April 2006 door Edward Smeets en Martin Junginger.

1. Algemeen

Duurzaamheidscriteria voor biomassa zijn principieel noodzakelijk, omdat er een politieke/maatschappelijke eis is, dat biomassa een aantal (duurzame) voordelen ten opzichte van de referentiesituatie. In principe zou de mate van subsidiering moeten afhangen van duurzaamheid van het product ten opzichte van de referentiesituatie: hoe duurzamer, des te meer financiële steun. Nedalco streeft naar een level playing field, dus duurzaamheidscriteria zouden zowel voor geïmporteerde biomassa als ook voor in Nederland geproduceerde biomassa moeten gelden.

2. Inventarisatie relevante duurzaamheidcriteria voor bioethanol uit Brazilië

CO_2 en energie-balans:

Ten eerste ligt het accent verkeerd: in principe zou niet het gebruik van ethanol, maar van aardolie beoordeeld moeten worden. Principieel zou elke biomassa-keten, die energetisch ook maar 1% beter scoort dan aardolie gesteund moeten worden. In de praktijk zal dit echter (ook op basis van maatschappelijke/politieke eisen) eerder op 40-50% kunnen liggen. Ter vergelijking: de door Nedalco geproduceerde ethanol op basis van restproducten levert op dit moment een primaire energiebesparing van 60-65% ten opzichte van fossiele brandstoffen op (resultaat van een nog niet openbare studie van CE). Berekening van deze getallen via LCA-methodolgie is complex. Bij vergelijking van verschiillende studieresulaten moet vooral gewaarborgd zijn, dat op dezelfde manier gealloceerd wordt.

Het is echter zeer gevaarlijk om enkel en alleen op maximalisering van de CO_2-reductie te sturen. Indien dat het geval is, zal het bedrijfsleven in Nederland massaal biomassa reststromen gaan verbranden, omdat hiermee de hoogste CO_2 reductie behaald kan worden. Echter, uit sommige restproducten kunnen veel hoogwaardigere brandstoffen gemaakt worden (zoals ethanol).

Voedselvoorziening & Natuurbehoud / biodiversiteit

MW geeft aan op deze gebieden geen expert te zijn. Hij benadrukt echter, dat het gebruik van non-food restproducten hierbij altijd beter is dan het gebruik van energiegewassen. Uiteindelijk blijft dit een theoretische discussie. Wel heeft MW de indruk dat het vooral gaat om verschuiving: suikerriet verdringt soja, dat op zijn plaats weer waardevolle natuurgebieden bedreigt.

Relevante ecologische en sociale duurzaamheidsaspecten bij de teelt van suikerriet en productie van ethanol?

Bij de teelt van suikerriet kan bij het afbranden van de cane zware luchtverontreiniging ontstaan. Ook zou bodemerosie een belangrijke rol kunnen spelen. Duurzaamheidscriteria voor deze onderwerpen zijn noodzakelijk.

Wat betreft de productie van ethanol moet Nedalco aan strenge milieueisen voldoen in Nederland, Nedalco participeert in het CO_2 benchmark convenant, en moet b.v. een biofilter gebruiken om vluchtige organische stoffen uit de emissies naar de lucht af te vangen (een uitgebreide lijst van milieueisen en maatregelen wordt later toegestuurd). MW is van mening, dat deze eisen in principe ook voor ethanol geproduceerd in het buitenland zou moeten gelden. De totale kosten van milieumaatregelen zijn significant, ca. 10% van de totale investeringen (getal moet nog worden bevestigd). Het uitrijden van afvalwater met een hoog percentage organische verbindingen als mest was in Nederland in het verleden geaccepteerd. Inmiddels wordt dit niet meer gedaan vanwege de (Nederlandse) mestproblematiek, en wordt het afvalwater als plakmiddel in de veevoerindustrie ingezet.

Wat arbeidsomstandigheden betreft zouden aan Brazilië Europese eisen gesteld kunnen worden. Bij Nedalco wordt een TPM management programma gehanteerd, waarin de arbeidsnormen hoger zijn dan in de ISO-standaards. Aangezien Brazilië qua industriële productie verder gevorderd is dan Europa zouden dergelijke standaards in het kader van een level-playing field voor Brazilië ook moeten gelden. Dergelijk strenge criteria zijn echter voor de 'least developed countries' op dit moment niet haalbaar. Voor de LDC/ACP landen zouden de normen lager moeten liggen, eventueel op een lokaal "best practice" niveau. Anders zou export naar de EU niet meer mogelijk zijn.

Een "gelijke monniken gelijke kappen"-principe zou een grote barrière voor de import uit deze landen zijn. MW adviseert om een voor Brazilië te bepalen, en dat als duurzaamheidscriterium te hanteren.

Gebruik van GMO's op het veld is volgens MW problematisch indien genen van de gemodificeerde planten kunnen 'ontsnappen', en door andere planten/dieren worden overgenomen. GMO's zijn bij de ethanolproductie vooral in de VS op basis van maïs al volop in gebruik. Gebruik van GMOs in een gesloten omgeving is niet problematisch. De ontwikkeling van 2de generatie biobrandstoffen is zelfs zeer sterk afhankelijk van het gebruik van bij voorbeeld gemodificeerde giststammen. Een punt van aandacht is wel de uitgewerkte gist, dat grotendeels uit hoogwaardig eiwit bestaat. Als dit eiwit niet inde voedselketen terecht mag komen (en b.v. verbrand moet worden) zou dit zware consequenties voor de rentabiliteit van de ethanolproductie hebben.

Transport

Binnen Brazilië wordt ethanol voor export vaak 400-500 km per truck naar de kust getransporteerd. Dit zou in Nederland per binnenschip gebeuren. Daarnaast moet dit transport door een natuurgebied plaatsvinden, wat de weerstand van lokale milieubeweging oproept.

Overige duurzaamheidscriteria

MW ziet twee zeer belangrijke criteria:
Ten eerste de technologie. Om op lange termijn duurzaam en goedkoop ethanol te kunnen produceren, is het nodig om 2de generatie technologie te gebruiken, waarbij de hele plant (dus niet allen suikers/zetmeel maar ook houtachtige biomassa) omgezet kan worden. Daarmee wordt het mondiale productiepotentieel een factor 5-6 groter, en zijn substantiële kostenreducties op de lange termijn mogelijk. Duurzaamheidscriteria dienen nadrukkelijk met de stimulering van technologie rekening te houden.

Ten tweede de grondstof. Gebruik van (non-food) restproducten als feedstock voor ethanolproductie (of andere inzet als biomassa) dient als duurzamer gezien te worden dan energieplantages zoals suikerriet, omdat hierbij geen concurrentie met voedselvoorziening optreed en geen extra land voor nodig is.

3. Implementatie

Implementatie van duurzaamheidscriteria zou zeker gefaseerd moeten gebeuren. Zeker aan het begin van een dergelijk systeem, zou een maximum van 5 criteria met basiseisen voldoende moeten zijn. Later zouden dan meer criteria opgenomen kunnen worden. Dat zou dus kunnen betekenen, dat bio-diesel op basis van plantaardige oliën op termijn 'niet duurzaam' wordt, omdat hier geen technologieverbeteringen meer mogelijk zijn. Op lange termijn zouden bij 2de generatietechnologieën flinke kostenreducties te behalen moeten zijn.

Het is van groot belang, dat er voor ethanol specifieke duurzaamheidscriteria opgesteld worden, zo dat ze niet één op één met bij voorbeeld resthout vergeleken worden. Daarbij speelt dus ook het referentiesysteem en de eindtoepassing een rol; resthout zal normaliter worden bijgestookt, en is dus de referentie de elektriciteitsopwekking, ethanol is een transportbrandstof en moet dus met gebruik van fossiele transportbrandstoffen vergeleken worden.

4. Visie/ belangen van de stakeholder

In Nederland en België wordt op dit moment alleen non-food restproducten voor ethanolproductie ingezet, en die is dus duurzamer dan Braziliaanse ethanol uit suikerriet (zie boven). Op lange termijn moet ook rekening gehouden worden met het biorefinery concept, waar uit biomassa eerst zoveel mogelijk hoogwaardige producten gemaakt wordt, en daarnaast elektriciteit en/of warmte.

De 5 meest belangrijke criteria zijn volgens MW :

1. Stimulering 2de generatie technologie
2. Gebruik van non-food feedstocks
3. Energiebalansen
4. (&5) beperking emissies naar water en lucht tijdens het productieproces.

Een extra suggestie is, om naar het Amerikaanse systeem voor het behalen van ethanol-quotas te kijken. Daarbij worden jaarlijks doelen gesteld. Voor het bereiken van de doelen wordt ook de inzet van moderne (2de generatie) technologie extra beloond.

Appendix C Interview Control Union

Telefonisch interview op 27.4.2006 met Johan Maris (JM), Control Union door Martin Junginger.

1. Algemeen

Duurzaamheidscriteria zijn nodig, gezien de schaal waarop biomassa geïmporteerd wordt / zal worden. Deze duurzaamheidscriteria zouden echter voor alle toepassingen moeten gelden, anders is er sprake van oneerlijke concurrentie tussen de verschillende toepassingen.

Om duurzaamheidscriteria te laten slagen, moet dit door een aantal grote spelers of de overheid getrokken worden, vanzelf zal dit niet gebeuren. Vanuit de overheid zou dit door een subsidie of een verplichting gedaan kunnen worden. Verder zouden criteria voor geïmporteerde ethanol ook voor in Nederland geproduceerd ethanol moeten gelden.

2. Relevante duurzaamheidcriteria voor bioethanol uit Brazilië

2.1 Algemene duurzaamheidscriteria

2.1.1 CO_2 en energie balans:

JM acht energie- of CO_2 balansen geen noodzakelijke duurzaamheidscriteria. Hooguit een 0-lijn (geen netto emissies) is zinnig.

2.1.2 Voedselvoorziening

Een eis dat biomassa productie niet tot voedselschaarste leidt is idealiter wel wenselijk maar in de praktijk onmogelijk realiseerbaar, zeker op het niveau van individueel te certificeren producenten. Er kan nooit bewezen worden, dat een individuele producent voedselschaarste veroorzaakt. Hooguit zou op landenbasis gekeken worden, hoe de algemene voedselvoorziening is.

2.1.3. Natuurbehoud / biodiversiteit

Biodiversiteit is in principe goed te meten. Bij FSC-certificering wordt eerst enen 0-meting uitgevoerd, waarbij een team van experts het aantal diersoorten telt in een gebied. De resultaten worden vervolgens ter goedkeuring aan de lokale stakeholders gepresenteerd. Het aantal species mag dan later nooit minder worden dan in deze referentiemeting. Dit soort metingen zijn echter enorm kostbaar, en b.v. op een schaal van enkele tientallen ha niet te betalen. Bij zeer grote bedrijven (b.v. >10,000 ha) is dit wel te doen. Op dit moment is het de algemene praktijk dat grote bedrijven een algemeen kwaliteitssysteem voor hun plantage ontwerpen, dat vervolgens ter goedkeuring aan de stakeholders wordt voorgelegd. Dit systeem werkt volgens JM ideaal.

De kosten voor monitoring zijn zeer afhankelijk van de schaalgrootte en van het management plan. Een vuistregel is dat een FSC-inspectie ongeveer vijf keer zo duur is als een normale inspectie.

2.1.4 Welvaart en welzijn

Wederom geldt dat dit wenselijke criteria zijn, maar in de praktijk moeilijk te monitoren.

2.2 Relevante ecologische en sociale duurzaamheidsaspecten bij de *teelt* van biomassa?

Wat betreft sociale normen is een voorbeeld de standrad die Cargill heeft ontwikkeld voor zin toeleveranciers. In het algemeen geldt dat alle grote multinationals niet willen dat tijdens het productieproces kinderarbeid of forced labour (slavernij) voorkomt. Fair trade principes gaan echter te ver, dit is een stap te ver voor commodities.

Wat betreft ecologische criteria is het een interessant feit, dat in Brazilië voor groeten of fruit, dat voor de export (naar Nederland) bestemd is, de Braziliaanse inspecteur de Nederlandse wet toe past. Zo mogen dan bij voorbeeld geen bestrijdingsmiddelen worden toegepast, die onder Eurepgap/Braziliaanse wet toegestaan zijn, maar niet in Nederland. Dit gebeurd door druk van de Nederlandse importeurs, die vrezen dat anders NGOs als Milieudefensie dit aankaarten.

2.4 Transport

Indien fysieke traceerbaarheid een (duurzaamheids-)eis is, moet er bij het laden en lossen een monster genomen worden. Een voorbeeld is palmolie. Tijdens het transport wordt de lading van een schip vaak meerdere keren(door-)verkocht. Vaak kan het dan aantrekkelijk zijn, om de lading op een tussengelegen plek te verkopen, en te vervangen door een minderwaardig product (b.v. vervuilde palmolie). Door de twee samples bij het laden en lossen te vergelijken ("fingerprints" te nemen), kunnen zulke ongeregeldheden vastgesteld worden. Dit is nu al algemene praktijk in de voedselsector, en de additionele kosten zijn vrij laag.
3. Implementatie en handhaving/controle mogelijkheden

Additionele vragen aan JH: Hoe zijn de volgende criteria in de praktijk te meten?

1. bodemerosie: in principe geldt dat je erosie moet voorkomen. Al je het meet, ben je in feite te laat. Een managementplan om erosie tegen te gaan is daarom belangrijker. De bottleneck is dan dat deze managementplannen in de praktijk gecontroleerd moeten worden. Dit werkt in het algemeen echter vrij goed.

2. nutriëntenbalans bodem: Deze zijn goed te meten, en dit gebeurt op dit moment ook bij voorbeeld binnen Eurepgap.

3. watervervuiling en watergebruik: is moeilijker meetbaar, om dat de kans bestaat, dat de vervuiling ook van omringende plantages/landgebruik afkomstig is.Het is nin principe te meten, maar het gebeurd op dit moment niet. In de huidige praktijk ligt de nadruk vooral op het afvalmanagement plan. Daarbij moet duidelijk zijn, wat met alle afval gebeurd, en of er potentieel waterverontreiniging optreed.

4. Agrochemicaliën: Bij biologische landbouw waar gewasbestrijdingsmiddelen verboden zijn, worden monsters genomen, en kunnen deze middelen (indien gebruikt) nagewezen worden. Dit gebeurt bij biologische landbouwproducten.

5. Biodiversiteit: Wordt op dit moment gemeten bij onder ander het FSC-systeem , maar b.v ook bij het Amerikaanse systeem "bird-friendly". In beide gevallen maakt een team van experts een 0-meting (zie ook hierboven). De vraag is, hoe zwaar de eisen zijn. Zo kan een ekele expert een algemeen niveau van biodiversiteit bepalen, maar er kan ook de aanwezigheid van b.v. vogelexperts vereist zijn. Dat maakt de zaak dan weer een stuk duurder, waardoor dit soort certificering alleen voor (zeer) grote plantages haalbar is. Eventueel kan groepscertificering een oplossing hiervoor zijn. Dit wordt momenteel al door FSC gedaan en door Eurepgap (Product marketing Organisation)

6. Arbeidsomstandigheden & kinderarbeid: Dit is het beste te controleren door *onaangekondigde* inspecties.

7. Respect locale bevolking, voedselvoorziening locale bevolking en conflicten omtrent landgebruik: Dit is alleen te achterhalen door lokaal met de stakeholders te gaan praten. Daarbij is er echter een spanningsveld, dat vele van de stakeholders van hun werkgever afhankelijk zijn. Daarnaast geldt ook weer, dat (onaangekondigde) inspecties cruciaal zijn, zodat de certificeerder zich zelf een beeld kan maken van de situatie.

Algemene vragen

Een geleidelijke invoering van (een beperkt aantal) duurzaamheidscriteria is zeker wenselijk. Je zou bij voorbeeld kunnen denken aan een systeem van majors(harde criteria, aan die in ieder geval voldaan moet worden) and minors (criteria, waaraan b.v. maar een bepaald percentage voldaan moet worden.). Het percentage van de minors zou dan in de loop der tijd verder verhoogd kunnen worden.

Certificering van ethanol is zeker haalbaar. Een beperkt aantal criteria is zeker wenselijk. Ter vergelijking: in de criteria van de Rainforest alliance staan 250 vragen, dat zijn er veel te veel om in de praktijk te kunnen controleren. Vijf a zes harde criteria zouden in de praktijk waarschijnlijk beter werken. De ervaring leert, dat de bedrijven die aan de hoofdcriteria voldoen, meestal ook goed aan de "minors" voldoen.

4. Visie/ belangen van de stakeholder

Bij het vaststellen van de RSPO criteria waren het overgrote deel van de betrokken stakeholders blank en uit importerende landen. In November 2005 zijn de criteria voor duurzame palmolie door de RSPO vastgesteld. De afgelopen maanden is gebleken, dat er bij de implementatie van de richtlijnen in de praktijk veel problemen optreden, omdat er onvoldoende rekening is gehouden met de producenten. Een voorbeeld is dat werknemers van bedrijven, die aan RSPO willen voldoen, nu hogere lonen eisen, hetgeen tot concurrentienadelen bij de bedrijven leidt. Tot nu toe zijn er dan ook nog geen pilots gevonden voor palmolie dat aan RSPO eisen voldoet. In het geval van palmolie hebben de producenten een alternatief als afzetmarkt (China) en als de criteria onhaalbaar zijn, zullen ze dus ook niet geïmplementeerd worden.

Een tweede aspect is, dat telkens maar een gedeelte duurzaam geproduceerd wordt, terwijl het (overgrote) deel onduurzame productie nog steeds doorgaat, Ook wordt er telkens weer een bepaald product gecertificeerd (b.v. ethanol). Volgens JM zou het veel beter zijn, om een bedrijf als een geheel te certificeren, voor alle producten dat het levert.

Tenslotte: certificering van ethanol is zinnig, maar de haalbaarheid hangt sterk af van de aspecten

- Financiële subsidie
- (Good)wil van de grote bedrijven
- Hoogte van de duurzaamheidseisen

Appendix D Interview Shell

Telefonisch interview op 28.4.2006 met Ewald Breunesse (EB), manager Energietransities bij Shell Nederland en voorzitter van de werkgroep biobrandstoffen van het Platform Duurzame Mobiliteit door Martin Junginger.

1. Algemeen

Duurzaamheidseisen voor ethanol zijn nodig, maar moeten ook gelden voor alle toepassingen, dus ook voor b.v. voedsel of chemie, en zowel voor geïmporteerde en in Nederland geproduceerde ethanol. Om dergelijke duurzaamheidscriteria in de praktijk te laten slagen, moeten echter grote spelers er zich aan committeren, b.v. grote multinationals of de Nederlandse regering. Aangezien Nederland maar een klein deel van de mondiale ethanolvraag dekt, zouden subsidies (of een verplichtstelling) noodzakelijk zijn voor het slagen.

2. Inventarisatie relevante duurzaamheidcriteria voor bioethanol uit Brazilië

2.1.1 CO_2 en energie balans:

Een CO_2 – eis is zeker een vereiste, idealiter op basis van well-to-wheel anlyses. Echter, aangezien het bijmengen van ethanol onafhankelijk is van de herkomst van de ethanol, zou ook een analyses van de CO_2 last tot aan b.v. de haven van Rotterdam kunnen voldoen. Een minimum niveau zou daarbij vastgesteld kunnen worde op basis van recente LCA-studies. Daarbij is wel van belang, dat men zich realiseert, dat de energie- en CO_2 balansen afhankelijk zijn van de gebruikte feedstock. Het is een keuze van de politiek om bij voorbaat al feedstocks uit te sluiten door de eisen te hoog te zetten. EB pleit ervoor om in eerste instantie de eisen zo te formuleren, dat met alle huidige feedstocks ethanol geproduceerd kan worden (tenzij ze netto energie verbruiken), en de eisen geleidelijk over de tijd aan te scherpen.

2.1.2 Voedselvoorziening

Een eis dat biomassa productie niet tot voedselschaarste leidt is wenselijk maar in de praktijk waarschijnlijk moeilijk realiseerbaar.

2.1.3. Natuurbehoud / biodiversiteit

De vraag of ethanol productie (beperkt) leiden tot aantasting van waardevolle natuur, direct (cerrados) of indirect (aantasting regenwoud door verschuiving) is sturend, in dat geval is het antwoord altijd nee. Het zou eerder volgens een FSC-principe moeten gaan, dat b.v. vanaf een bepaald jaar geen suikerriet mag verbouwd worden in een gebied, dat tijdens dat jaar nog tropisch bos (of ander waardevol natuurgebied) was.

2.1.4 Welvaart en welzijn

Geen achteruitgang is een minimum-eis, vooruitgang zou de voorkeur moeten hebben. De vraag is echter hoe men welvaart en welzijn formuleert: welvaart zal er (bij de huidige hoge olieprijzen) wel optreden, maar dat is niet automatisch welzijn. Ook het verdelingsvraagstuk van het inkomen is belangrijk.

2.2 & 2.3 Relevante ecologische en sociale duurzaamheidsaspecten bij de *teelt* van biomassa?

Alle genoemde aspecten zijn belangrijk. Wat betreft GMOs, gebruik in het veld is een aandachtspunt, maar niet automatisch een milieuprobleem, Shell zou hier niet principieel bezwaar tegen hebben.

2.4 Transport

Er moeten geen extra voorwaarden voor het transport van ethanol moeten komen, de (minimum) eisen die gelden voor andere sectoren kunnen ook voor ethanol gehanteerd worden.

3. Implementatie

Gefaseerde implementatie is zinnig, wel gezamenlijk met alle andere biomassastromen. Een aparte certificering van ethanol is niet wenselijk. EB kan geen uitspraak doen over de concrete hoogte van de kosten van eventuele duurzaamheidscriteria. Wel kan dit vergeleken worden met de ISO-certificering: het brengt in eerste instantie extra kosten met zich mee, maar daardoor dat het proces beter wordt, worden deze kosten ook weer terugverdiend. In het algemeen geldt, hoe minder criteria hoer beter, dan is de (kans op) implementatie groter. In principe moeten er algemene criteria voor biomassa komen, hooguit voor het CO_2 / energiecriterium zou een differentiatie afhankelijk van het type biomassa moeten plaatsvinden (b.v. tussen plantaardige oliën en ethanol).

4. Visie/ belangen van de stakeholder

In het algemeen maken duurzaamheidscriteria het werk voor Shell complexer, daarom staat Shell voorzichtig tegenover de implementatie. Het is belangrijk dat er een level playing field is, c.q. dat de duurzaamheidscriteria voor iedereen gelden. Zo is bij voorbeeld een vrees, dat onduurzame biomassa elders de EU binnenkomt, en dankzij het vrijverkeer van waren via de achterdeur alsnog naar Nederland geïmporteerd wordt.

Het is afhankelijk van de inhoud van de specifieke duurzaamheidscriteria of deze de ontwikkeling van tweede-generatie biobrandstoffen gaan belemmeren of juist gaan stimuleren. Volgens EB zal door het kunnen omzetten van lignocellulose grote hoeveelheden reststromen (b.v. stro) beschikbaar komen voor ethanolproductie. Indien er sprake is van energieplantages, lijken meerjarige gewassen efficiënter te zijn dan eenjarige gewassen. Het is de vraag of en hoe duurzaamheidscriteria hiermee rekening zullen houden.

Verder zou een verplicht gebruik (b.v. een verplicht percentage bij te mengen biobrandstof) op gespannen voet kunnen staan met een maar beperkt beschikbaar zijnde hoeveelheid duurzaam geproduceerde ethanol.

Ethanolproductie in Nederland is niet principieel duurzamer dan geïmporteerde ethanol. Aangezien de transport over grote afstand maar vrij weinig energie verbruikt, kan ethanol uit b.v. Brazilië duurzamer zijn dan ethanol geproduceerd in Nederland.

Tenslotte geeft EB aan, dat voor de reductie van CO_2-emissies het in eerste instantie niet uitmaakt, waar deze reductie ter wereld gebeurd, en dat het wel eens duurzamer zou kunnen zijn, om biomassa lokaal te gebruiken. Daarbij moet echter de kanttekeningen geplaatst worden, dat import van biomassa nog andere voordelen kent, zoals leveringszekerheid en betaalbaarheid (ten opzichte van de huidige olieprijs).

Appendix E Interview Cefetra

Telefonisch interview met Hugo Stam (HS), CEO Cefetra, door Martin Junginger op maandag 8 mei 2006.

1. Algemeen

Duurzaamheidseisen voor bioethanol zijn noodzakelijk, en zouden voor alle toepassingen moeten gelden (ook food & feedstock). In principe moet een basisniveau voor duurzaamheid zonder subsidies mogelijk zijn. Ook moeten dezelfde eisen gelden voor geïmporteerde ethanol en in Nederland geproduceerde ethanol.

2. Inventarisatie relevante duurzaamheidcriteria voor bioethanol uit Brazilië

In principe is een criterium voor CO_2 emissies noodzakelijk, maar HS laat het bepalen van de methode en eventuele hoogte van een criterium aan experts over.

Het veilig stellen van voedselvoorziening moet men zeker niet aan de markt over laten, en behoeft duidelijk sturing door de overheid. HS ziet een duidelijke link tussen de grootschaliger productie van biomassa en een mogelijke voedselschaarste. Hiervoor zou dus zeker een criterium opgesteld moeten worden.

Bij natuurbehoud / biodiversiteit gaat het volgens HS vooral om de precieze definitie van waardevolle natuurgebieden. HS is het eens met de definitie van tropisch regenwoud in het Amazonegebied, zoals vastgesteld door de Braziliaanse overheid. Hij heeft met de definitie van Greenpeace voor het “amazon basin”, waar ook veel land onder valt, wat wel voor landbouw gebruikt zou kunnen worden. HS benadrukt dat Brazilië een zeer groot land is, en dat er eigenlijk per provincie c.q. per type natuurgebied specifieke regels opgesteld zouden moeten worden voor natuurbehoud. Daarnaast is een belangrijk punt, in welk jaar een 0-meting gehouden wordt. Het kan volgens HS niet zo zijn, dat plantages, die op dit moment al bestaan, met terugwerkende kracht als niet-duurzaam worden bestempeld omdat ze op voormalig natuurgebeid staan.

Welvaart en welzijn is ook een belangrijk criterium. HS benadrukt dat het vaak gaat om discussies dat pastures geconverteerd worden b.v. suikerrietplantages. In deze discussie wordt vaak onderbelicht, dat dit een wissel is van extensieve naar intensieve landbouw, en dat daarbij veel meer banen (en dus werkgelegenheid ontstaan), zowel in de landbouw sector alsook de verwerkende industrie, logistiek etc. Wat betreft landownership benadrukt HS dat men niet te snel het verhaal van”de zielige indiaan”moet volgen, wiens land is onteigend, maar bereid moet zijn om per case te kijken wat er daadwerkelijk gebeurd.

Wat betreft andere relevante ecologische en sociale criteria:

- HS staat niet bij voorbaat negatief tegenover het gebruik van GMOs in het veld. Door GMOs kunnen veel hogere oogsten per hectare behaald worden, en zijn daarom voor de ontwikkeling van de landbouw belangrijk.
- Voor sociale normen moet minimaal ILO-normen gelden, dus geen forced labour of child labour. Specifiek in Brazilië moeten de arbeidsomstandigheden hiervoor dus verbeteren Sociale Fair-trade normen gaan volgens HS te ver voor een commodity als b.v. suiker of soja. Koffie of thee, waar fair trade principes voor een klein marktdeel toegepast worden, zijn kleinschaligere producten, waar toepassing van fair-trade criteria beter mogelijk is.
- Tenslotte merkt HS op, dat een algemene standaardisering van dit soort normen (b.v. Eurepgap-normen) voor de gehele landbouw wenselijk en nodig zijn, en niet slechts voor een enkel product.
- Voor transport van biomassa zijn geen extra duurzaamheidseisen noodzakelijk, locale normen voldoen.

3. Implementatie

HS ziet vooral het nut van een minimum duurzaamheidsniveau nu, en een concreet niveau dat binnen 3-5 jaar gerealiseerd moet worden. Een wenkend perspectief op 20 jaar termijn is weinig nuttig en ook niet wenselijk:

als men hiermee de Braziliaanse stakeholders benadert is dit te zweverig, en zullen de lokale producten je ook niet serieus nemen. Het zou beter zijn, om iedere 4-5 jaar weer nieuwe (strengere) normen te formuleren.

Kosten van certificering en auditing zijn volgens HS "peanuts", zeker voor grote bedrijven. Daarnaast is in de food sector gebleken, dat het invoeren van control points voor food safety de kosten voor de bedrijven uiteindelijk omlaag zijn gegaan, omdat men beter grip kreeg op het productieproces. In het specifieke geval van Brazilië zouden de ethanol/suikerfabrieken hun toeleveranciers dan moeten laten certificeren.

Volgorde van belang criteria: zoals in dit interview en de werkgroep genoemd zijn dit CO2, milieu en biodiversiteit, welvaart en welzijn en arbeidsomstandigheden.

HS is een grote voorstander om het aantal criteria beperkt te houden, liever 5 dan 20, anders is de implementatie moeilijker. Cruciaal is daarbij de drempelhoogte van de criteria: het moet geen wassen neus zijn, waarvoor alle producenten slagen, maart ze moeten ook niet dermate hoog zijn dat het feitelijk import blokkeren. Een systeem van majors and minors (waarbij aan alle majors voldaan moet worden, en een bepaald percentage van de minors) zou bij voorbeeld goed kunnen.

Het is van belang, dat duurzaamheidscriteria in het algemeen in ontwikkelingslanden op de agenda gezet worden. Hiervoor is het noodzakelijk, dat een aantal meta-standaards opgezet worden voor alle producten, en additioneel aanvullende productspecifieke eisen (zoals bij voorbeeld een CO2-balans).

4. Visie/ belangen van Cefetra

Cefetra staat zeer positief tegenover de discussie omterend duurzaamheidseisen. Een belangrijk discussie die gevoerd moet worden is de food-feed-fuel volgorde. Het kan volgens HS niet zo zijn dat fuel producten gesubsidieerd worden, waardoor productie van feed of zelfs food in het gedrang komt. Hiervoor zal dus ook bij de vaststelling van MEP-tarieven rekening gehouden moeten worden.

Cefetra is op dit moment zelf bezig om duurzaamheidscriteria op te stellen voor zijn toeleveranciers in Brazilië en Argentinië. Centraal staan daarbij het voldoen aan ILO-normen, en qua ecologische criteria voldoen aan de lokale wetten. In het algemeen staan de meeste toeleveranciers hier positief tegenover. Men realiseert zich goed dat dit een internationale trend is een geen geïsoleerde wens vanuit Nederland. Het is van groot belang om de "mentaliteit in de hele keten"te beïnvloeden. Een bedrijf moet principieel bereid zijn om duurzaam te produceren. Audits kunnen hier ter controle maar beperkt helpen, aangezien het toch maar momentopnames zijn, terwijl het juist gaat om de dagelijkse praktijk.

Nederlandse bedrijven zijn wat dat betreft welk koplopers. Vooral Amerikaanse bedrijven zijn veel meer volgers dan koplopers (met uitzondering van Walmart).

Tenslotte benadrukt HS nog een ander punt: het is van groot economisch belang voor de EU om zoveel mogelijk waarde toe te voegen aan een product binnen de EU. Vanuit dit oogpunt is import van ethanol (een eindproduct) minder wenselijk dan de import van intermediates, zoals bij voorbeeld granen. Dit standpunt is echter niet direct gerelateerd aan duurzaamheidseisen.

Appendix F Interview Stichting Natuur en Milieu

Interview met Hans Jager (HJ) , Stichting Natuur en Milieu, op 11 Mei 2006 door Martin Junginger.

1. Algemeen

Duurzaamheidscriteria voor biomassa zijn principieel noodzakelijk. Duurzaamheidscriteria moeten gelden voor zowel ethanol geproduceerd in Nederland alsook geïmporteerde ethanol. Subsidiering van duurzame ethanol door de overheid is wenselijk, omdat dit onder klimaatbeleid valt.

2. Inventarisatie relevante duurzaamheidcriteria voor bioethanol uit Brazilië

Voor de algemene standpunten voor biomassateelt en duurzaamheidscriteria wordt verwezen naar de publicatie: Biomassa, Risico's en kansen. (SNM e.a. , april 2006).

CO_2 en energie balans:

HJ benadrukt dat vaak de CO2 emissies verwaarloosd worden, die bij conversie van bij voorbeeld pastures naar sugarcane uit de bodem vrij komen. Duidelijk is dat dit een enorme impact kan hebben op de CO_2-balans van ethanol. SNM ondersteund het gebruik van ethanol enkel en alleen, als deze een significante CO2-emissiereductie ten opzichte van het gebruik van fossiele transportbrandstoffen kan bewerkstelligen, tenzij er uitzicht is op aanzienlijke efficiencyverbeteringen (zoals 2^de^ generatie-ethanolproductie). De vaststelling van een significant niveau kan SH (nog) niet aangeven, en zal behaald moeten worden op basis van wetenschappelijke studies.
Het gaat overigens niet alleen om de CO2-emissies van de suikerketen sec. Indien suikerriet een ander gewas verdringt en voor dat gewas elders tropisch bos gekapt wordt kan het netto CO2-effect nihil zijn.

Voedselvoorziening

Bedreiging van voedselvoorziening door ethanolproductie gaat een rol spelen, gezien de schaal waarmee Brazilië in de volgende jaren de ethanolproductie verhoogt, en de enorme potentiële vraag uit Europa. Daarbij zijn verdringings/verschuivingseffecten van belang. HJ geeft aan dat op termijn theoretisch verhoging van de efficientie van de landbouw een oplossing kan bieden, maar gelooft niet dat dit op korte termijn de uitbreiding van suikerrietplantages kan compenseren en niet andere nadelige effecten op milieu en natuur hebben..

Natuurbehoud / biodiversiteit

HJ geeft aan dat de discussie vooral speelt om de definitie van waardevolle natuur. Zo zijn de lokale Braziliaanse NGOs niet blij met plannen om suikerriet in cerrados (savannah) aan te planten.

Welvaart en welzijn

HJ geeft aan dat de inkomensverhouding in Brazilië nogal scheef ligt. Daarnaast zal de benodigde schaalvergroting waarschijnlijk een verdere mechanisatie van de oogst betekenen, waardoor waarschijnlijk banen verloren gaan. Een criterium voor duurzame ethanol, dat deze effecten voorkomen zouden moeten worden, is wenselijk, verificatie zal in de praktijk waarschijnlijk een probleem zijn.

2.2 Relevante ecologische en sociale duurzaamheidsaspecten bij de teelt van suikerriet en productie van ethanol?

- Standpunt GMOs: wel in een gesloten omgeving, niet in het veld.
- Arbeidsomstandigheden: minimaal ILO normen, Fair trade principes zouden als wenkend perspectief genomen kunnen worden. Echter, voor de grote agri-producten zoals soja maken een handvol

bedrijven (zoals Cargill, Daniels Midland Archer etc.) de dienst uit, en die zien niets in Fair Trade criteria.

3. Implementatie

Certificering van ethanol vergelijkbaar met FSC voor hout is zinnig en haalbaar. SNM is voorstander om pragmatisch te beginnen, dat wil zeggen een gefaseerde invoering van duurzaamheidscriteria is nodig om draagvlak bij alle stakeholders te creëren. Daarnaast het beste met de meest belangrijke criteria vastgesteld worden, en kunnen secundaire criteria later (b.v. na 5 jaar) geëvalueerd en aangescherpt worden. Generieke criteria voor alle soorten duurzame biomassa zijn zeker nuttig, maar per product-land combinatie zijn ook productspecifieke eisen nodig.

4. Visie/ belangen van de stakeholder

SNM staat in beginsel positief tegenover het gebruik van biomassa, het gaat niet om de vraag of biomassa maar hoe biomassa gebruikt wordt. Tenslotte acht HJ de in de enquête genoemde duurzaamheidsvraagstukken zijn volledig.

Appendix G Interview Both Ends

Interview with Nicole Walshe (NW), Both Ends, on 17.5.2006 by Martin Junginger. The interview was held in English.

1. Algemeen

In general, BothEnds is in favour of sustainability criteria (SC). SC for bioethanol (and other large-scale commodities) from Brazil (and in general) are necessary for two reasons: first of all, large-scale commodities require increasing amounts of land, these are often taken (illegally) from local villagers/stakeholders, which then only limited access to land. Second, large-scale application of monocultures have a negative ecological effect, e.g. on biodiversity, and therefore need to be checked

If SC are introduced, they should in principle apply to all ethanol produced, i.e. independent of the application as e.g. fuel, feedstock or for consumption. Minimal levels of SC should principally not depend on subsidies. Also, great care should be taken that by subsidizing ethanol for e.g. use as fuel it does not compete with food applications. If a (very high) subsidy on ethanol is given, this could result in an "ethanol-rush" at the cost of other crops.

Finally, both imported and domestically produced ethanol should be judged by these criteria, as far as applicable.

2. Inventarisatie relevante duurzaamheidcriteria voor bioethanol uit Brazilië

2.1.1 CO_2 en energie balans[23]:

In het algemeen is minder CO2 uitstoot goed voor duurzamheid. Ethanol komt vooral uit suikerriet, hetgeen in principe renewable is. Als ethanol in de plaats komt van fossiele brandstoffen (bijv door menging in benzine/ diesel), betekent dat dus een netto reductie van emissies. Dat impliceert dan ook een positief duurzaamheidseffect.

Maar randvoorwaarde hierbij is wel dat het volume van met ethanol gemengde fossiele brandstoffen netto leidt tot een aanwijsbare vermindering van verbranding van fossiele brandstoffen. Als er wel gemengd wordt maar tegelijk het totaal volume van brandstoffen toeneemt en er geen vermindering van fossiele brandstofgebruik optreedt kan er volgens mij, niet sprake zijn van een positief duurzamheidseffect. Toch zullen er ongetwijfeld mensen zijn die dit bestrijden, omdat het BAU scenario van netto volume groei van brandstofgebruik zonder ethanol bijmenging nog groter zou zijn. Er zijn mensen die dit BAU groeiscenario als referentiekader hanteren.

Al met al is er voor een op duurzamheidgericht energiebalans een quota systeem nodig, waarbij harde grenzen worden gesteld. Daarvoor is politieke wil en wellicht zelfs moed nodig. Die grenzen moeten volgens mij bij het verbranden liggen (dus the wheel) en niet in Rotterdam.).

2.1.2 Voedselvoorziening

It is essential that biomass production does not lead to food scarcity. Food supply is a very crucial issue. Large-scale monoculture may replace subsistence and small scale farming, disrupt local market structures and may deny local people access to food. A typical example is the expansion of soy beans in Argentina. Contrary to other South-American countries, Argentina faced far fewer problems of food scarcity in its past. In general there has typically been more widespread access to meat for example. With the replacement of dairy products and meat with soy produced for export to gain foreign exchange, Argentina now needs to import milk, meat and wheat. After the crisis in 2000, serious widespread food scarcity appeared for the first time, leading to malnutrition and protein deficiencies. Even though people were eventually provided with protein substitutes,

[23] Dit onderdeel is geschreven door Wiert Wiertsema, Both Ends, collega van Nicole Walshe.

another problem is, that people are not used to the soy-based meat replacements, i.e. do not know how to prepare it.
Therefore, food prices are a crucial indicator to monitor. Food prices should be monitored at the local as well as the national level, as there can be large discrepancies and access difficulties in one area may take time to become reflected in overall national prices. Another possible important indicator for the local level could be malnutrition levels of under 5's, directly measuring the situation of some of the most vulnerable of the population. It is also essential, that there be a strong process of involvement of local stakeholders while setting up and for monitoring of criteria. A criterion that food security is ensured is definitely required.

2.1.3. Natuurbehoud / biodiversiteit

It is necessary to first analyse what land can best be used for such production and what land is already available before seeking to convert new land. A principal point is that a substantial amount of land in Brazil has been used previously for agriculture, and is now fallow land. It is crucial that as much of this land as possible/suitable is used first for e.g. sugar cane, before new land is converted to agriculture.

Another aspect is leakage, i.e. sugarcane replacing soy, which in turn claims more Amazon forest. NW stresses the need to look broader than one crop and/or one single area. Amore comprehensive approach is required here.

2.1.4 Welvaart en welzijn

Neither economic wealth or general welfare should decline due to ethanol production; this would be against all Dutch development aid policies. Another issue is not the general creation of wealth / GDP growth, but mainly the wealth distribution, which is very unequal in Brazil. A criterion for wealth and welfare is definitely required, e.g. using the human development index / Gini coefficient.

2.2 Relevante ecologische en sociale duurzaamheidsaspecten bij de *teelt* en productievan biomassa?

All aspects mentioned in the listed in the interview are relevant.
In addition to general ILO labour standards, also the ILO rights for indigenous people should be included
Fair trade principles are difficult to apply for large scale commodities like sugarcane. In the case of Brazil, perhaps this could be applied of the sugarcane owned by independent farmers
Regarding the current situation on Brazil, especially in the North-East, forced labour and child labour occur frequently. Another issue is that workers are indentured (i.e. financially heavily dependent on their employer, who can then put additional pressure on them). NW will check with colleagues whether the situation is substantially better in São Paulo.
The view of Both Ends is that GMOs are not acceptable at all. The debate of most importance currently is on the use of gmos in the production of crops because of concerns relating to the as yet unknown longterm effects of use of GMOs, effects on soils, effects of possible cross pollination to non GMO crops, the concerns on the intellectual property debate, all this supporting the need to adopt the precautionary principle.

2.4 Transport

While inland transportation by ship may be preferable above transportation by truck form an energy point of view, this may have severe negative ecological consequences. An example is the Paraguay Parana rivers and the Pantanal Wetland system between Brazil, Argentina, and Paraguay where plans to construct straight canals and dredge/deepen rivers in order to facilitate bulk transportation of commodities (e.g. soy), will have damaging effects on the local ecosystems and communities if those plans go ahead.

3. Implementatie

Gradual implementation of SC is necessary from a practical point of view. If these criteria are to be introduced by e.g. the beginning of 2007, one not expects that all criteria can directly be met. However, for these criteria, a clear time table has to be established when these criteria have to be met. Furthermore, it should not be attempted to limit the number to a handful of key indicators. NW is not in favour of a system of "major" and "minor" criteria, all have to be fulfilled to lead to a sustainable product.

Certification of ethanol following the concept of e.g. FSC-certification of wood may be feasible, but the lessons learned from FSC should be incorporated. Monitoring should not be limited to certifiers, but to strongly involve the local population/stakeholders in monitoring, as well as in identification of criteria.

The (additional) costs are hard to quantify. However, it should be emphasised that in the end this a matter of internalizing external costs. The unsustainable production of biomass will sooner or later also lead to additional costs.

One should start to formulate general SC for biomass, but these will require additions for specific biomass types. For example, while sustainable water-use should be a general criterion, extra attention should be paid to Eucalyptus, as this tree has been known to use a lot of water, thus additional measures could be necessary.

4. Visie/ belangen van de stakeholder

The conversation covered in general terms the important issues regarding sustainability of ethanol.
The extremely rapid expansion of soy in South America has shown both strong detrimental environmental and social effects. The speed with which 'new ' commodities tend to expand, and the scale of production, create, or are in tension with the objectives of sustainable development.
It is essential to include local stakeholders throughout the whole process of criteria discussion and establishment. First of all, it is about production in their countries, secondly we as 'western' or foreign parties may simply not know of local sustainability issues, so these may be overlooked if local stakeholders are not involved. Thirdly, a process of societal monitoring (i.e. all local stakeholders, civil society, government actors, legislature) will be essential to the success of any certification process, but more importantly, to ensuring that a contribution is actually being made to sustainable development and that conditions for sustainable development exist. Broad societal monitoring at various levels and moments in time is required. While this makes a certification process more complex, it is necessary to ensure sustainability. It is important not to loose sight of the fact that the certification system or criteria definition are a means to an end, a means to ensuring better living conditions and sustainable development.
Criteria developed here must be applied broader, i.e. not only for the Netherlands but on a European level. The Dutch demand alone is not enough to ensure sustainable production over time, and to make a serious impact on the producing countries.

Appendix H Water use for sugar and ethanol production

Table H.1 shows the water use for sugar and ethanol production, assuming that half of the sucrose is converted into sugar and the other half into ethanol.

Table H.1 The total water use of sugar and ethanol production. Source: (Neto, E., 1996 in Macedo 2005).

		Mean use (Total m^3/t cane)	Distribution (%)
Feeding	Sugar cane washing	5.33	25.4
Extraction (grinding)	Imbibition	0.25	1.2
	Bearing cooling	0.15	0.7
Juice treatment	Preparation of lime mixture	0.01	0.1
	Cooling at sulphiting[1]	0.05	0.2
	Filter imbibition	0.04	0.2
	Filter condensers	0.30	1.4
Juice concentration	Condensers/multijets evaporation[1]	2.00	9.5
	Condensers/multijets heater[1]	4.00	19.0
	Molasses dilution	0.03	0.1
	Crystallizer cooling[1]	0.05	0.2
	Sugar washing[1]	0.01	0.0
Electrical power generation	Steam production	0.50	2.4
	Turbo-generator cooling	0.20	1.0
Fermentation	Juice cooling[2]	1.00	4.8
	Fermentation cooling[2]	3.00	14.3
Distillery	Condenser cooling[2]	4.00	19.0
Other	Floor & equipment cleaning	0.05	0.2
	Drinking	0.03	0.1
Total		21.00	100.0

[1] sugar production only
[2] ethanol production only

Appendix I Pest and diseases in sugar cane production

The main plagues are:

- Sugar cane beetle. Sugar can beetle can be effectively combated using biological control (wasps).
- Defoliating caterpillars. There is no efficient control for the five species of sugar cane defoliating caterpillars because they are only detected when most damage has already been done. The control by natural parasitoids and natural predators is very high, and is generally not a problem providing the defoliation is limited to one time.
- Spittlebugs. Spittlebugs are particularly a problem is São Paulo and neighbouring states. It can reduce the cane yield by 15 t/ha/y. Sugar cane burning helps to combat spittlebugs. Without cane burning, some 20% requires pest control. Pest control is done biologically, using a fungus (1 kg fungus/ha/y). Insecticides can also be used, but this is generally more expensive and risky for the environment and for farmer farmers.
- Leaf cutting ants. Leaf cutting ants can reduce cane yield by 3 t/ha/y and in addition the sugar content is decreased. The mean loss in the Centre South is calculated at 1.5-2.1 t/ha/y. Leaf cutting ants are controlled by specialised teams that search all cane crops and use thermofogging which is the local application of an pesticide syrup. The pesticide syrup consists of an organophosphate compound product (ethyl chlorpyrifos) at the concentration of 50 grams per litter and mineral oil-based syrup (oppa). Mechanical harvesting increases the occurrence of these ants because the ant nests are harder to locate.
- Migdolus beetle. The larva of this family causes damage to the cane root system. A mean reduction of cane yield of 25 t/ha/y occurs compared to areas treated with soil insecticide. In São Paulo about 0.1 Mha out of the 2.8 Mha sugar cane area is infected. Control of migdolus beetle takes place using pesticides at the furrow (to protect the field workers). The harvesting method has no impact on the occurrence or control.
- Sugar cane weevil. Cane weevil causes a yield loss of 20-23 t/ha/y in infested areas. Mechanical harvesting favours the occurrence of this pest.
- Termites and other pests. Losses are estimated at 10 t/ha/y in infested areas.

Appendix J Maximum concentrations of substances in water discharge

The maximum concentrations of various substances as included in the Water Pollution Emission Standards (Article 18 of the State Environmental Law 997) are (in mg/l):

a) Arsenic	0.2
b) Barium	5.0
c) Boron	5.0
d) Cadmium	0.2
e) Lead	0.5
f) Cyanide	0.2
g) Copper	1.0
h) Chromium	60.1
i) Overall Chromium	5.0
j) Stein	4.0
k) Phenols	0.5
l) Iron soluble (Fe^{2+})	15.0
m) Fluoride	10.0
n) Manganese (Mn^{2+})	1.0
o) Mercury	0.01
p) Nickel	2.0
q) Silver	0.02
r) Selenium	0.02
s) Zinc	5.0.

Appendix K Soil Erosion data for sugar cane and other crops

Below, five different tables are preseneted in which soil losses for sugar cane and various other crops under varying circumstances are given.

Table K.1. Soil and water losses in various agricultural crops. Source: (Bertoni et al., 1998 in Macedo, 2005).

	Soil loss (t/ha/y)	Water loss[1)] (% of rainfall)
Rice	25.1	11.2
Soybean	20.1	6.9
Corn	12.0	5.2
Potato	6.6	4.2
Cotton	24.8	9.7
sugar cane	*1.24*	*4.2*

1) Water loss is the part of rainfall not intercepted by vegetation or which is not going to infiltrate into the soil. So, it is the amount not available for the (sugar cane) plant. Note also that hydric erosion is the process by which most of soil and water losses occur. However it is possible to have water loss without soil erosion as well as soil loss without water loss.

Table K.2. Average annual soil loss by erosion and runoff during five years of growing various crops on mixed red soil with 12.8% slope in the Experiment Station of Campinas, São Paulo, Brazil from 1954 to 1959. Source: (Quintiliano et al., 1961)

	Soil loss (t/ha)	Runoff[1)] (mm)
Bare fallow	52	66
Common beans	33	66
Irish potato	11	38
Cassava	11	22
Castor beans	8.2	23
Maize + beans	1.0	5
Upland rice	0.5	16
Sugar cane (2 crops/5 years)	*0.1*	*2*

1) Runoff divided by annual precipitation equals water loss.Average rainfall during five years was 1,237 mm (range 984-1,607 mm)

Table K.3 Average annual soil loss by erosion and runoff during 14 years of growing various crops on massape soil[24] with 9.4% slope at the Experiment Station of Mococa, São Paulo, Brazil from 1945 to 1959. Source: (Quintiliano et al., 1961).

	Soil loss	Runoff[1)]
	(t/ha)	(mm)
Cassava	53	254
Cotton in rotation	38	250
Soybeans continuous	35	208
Cotton continuous	33	228
Soybeans in rotation	26	146
Sugar cane	*23*	*108*
Maize in rotation	19	151
Maize + common beans	14	128

[24] Massapê is a fertile soil (good chemical quality) regarded to be the first soil occupied by sugar cane 400 years ago in the North-eastern region. Despite this long period of time during which the land was noto managed well, sugar cane farms keep producing continuously there. Its physical quality is not very good, as it consits of expansible clay (2:1), which causes serious problems either when is too dry or too wet. Mucuna is a sort of bean (leguminosaceae) Stilozobium aterrimum, which is able to do symbiotic fixation of N_2 (gaseous nitrogen existent into the soil pores) and to produce up to 60 tonnes of green biomass (16 tonnes of dry matter). It fixes 200 Kg of nitrogen, 100 Kg of potassium, and 50 kg of calcium / ha, beyond other physical and biological benefits.

Maize continuous	12	67
Maize + Mucuna[24] incorporated	10	100
Maize + manure	6.6	97
Maize + Mucuna mulched	3.0	42
Gordura grass	2.6	46

[1)]Average rainfall over 14 years was 1,347 mm (range 943-1,791 mm)

Table K.4. Average annual soil loss by erosion and runoff during 12 years of growing various crops on red soil with 8.5% slope at the Experiment Station of Ribeirao Preto, São Paulo, Brazil from 1947 to 1959. Source: (Quintiliano et al., 1961).

	Soil loss	Runoff[1)]
	(t/ha)	(mm)
Castor beans	56.1	199
Common beans	54.3	180
Rami	54.2	196
Cotton	51.4	183
Cassava	42.6	170
Upland rice	36.6	143
Maize with residues incorporated	30.9	144
Peanut	30.6	134
Maize with residues burned	29.0	131
Maize+*Mucuna* incorporated	28.2	133
Sugar cane	21.0	88
Maize+lime	19.1	96
Maize+manure	8.9	62
Tephrosia candida	8.4	37
Jaragua grass	5.5	45

[1)]Average annual rainfall over 12 years was 1,286 mm (range 1,110-1,663 mm)
Source: Quintiliano et al., 1961

Table K.5 – Soil losses in tonnes/ha.yr , estimated according to the Universal Soil Loss Equation, for the Piracicaba –SP (BR) region for two different soil textures under a slope of 12% and 25 m length (De Maria and Dechen, 1998)

Crop	Month of Seeding	Soil A	Soil B
1. Sugar cane (plant)	October	39,0	108,6
2. Sugar cane (plant+5yr)	October	8,3	23,2
3. Soybean conventional	October	22,6	63,0
4. Corn conventional	October	11,5	32
5. Corn no-tillage	October	2,6	7,4
6. Uncovered soil	October	122,3	340,8

Soil A: Latossolo Roxo
Soil B: Pdzólico Vermelho
Obs.: Burnt sugar cane for both 1 and 2

Appendix L Breakdown of formal sector workers by education

Table L.1. Breakdown of formal sector workers by education, 2002. Source: (Macedo, 2005)

Education	Brazil	North-Northeast			Centre-South		
		Cane	Sugar	Ethanol	Cane	Sugar	Ethanol
Illiterate	117,289	33,722	59,349	4,140	12,845	3,644	3,589
4th grade not completed	287,744	39,571	73,565	15,604	107,23	35,265	16,509
4th grade	142,072	5,806	12,522	2,548	78,556	28,317	14,323
8th grade not completed	101,13	3,134	16,031	3,182	44,43	21,447	12,906
8th grade	40,103	1,679	3,968	900	17,404	10,032	6,12
High school started but not completed	23,880	868	2,649	519	7,990	8,174	3,680
High school	39,453	1,231	5,365	1,010	10,006	14,090	7,751
College started but not completed	3,795	102	334	78	966	1,639	676
College graduates	9,127	216	1,151	263	1,864	4,331	1,302
Total	764,593	86,329	174,934	28,244	281,291	126,939	66,856
Percentage							
Percentage illiterate	15	39	34	15	5	3	5
Up to 4th grade	56	53	49	64	66	50	46
5–8th grade	18	6	11	14	22	25	28
9–11th grade	8	2	5	5	6	18	17
College started but not completed	0	0	0	0	0	1	1
College graduates	1	0	1	1	1	3	2
Monthly earning in R$							
Illiterate	300	256	294	285	389	423	398
4th grade not completed	390	290	316	389	436	477	470
4th grade	513	336	489	425	490	625	524
8th grade not completed	524	371	410	423	506	647	582
8th grade	620	409	574	556	564	736	686
High school started but not completed	603	410	563	637	542	677	636
High school	788	649	805	787	734	846	763
College started but not completed	1,161	773	1,295	1,284	958	1,276	1,15
College graduates	2,361	2,308	2,908	2,581	2,415	2,141	2,493
Total	483	297	373	428	496	679	608

Appendix M Principles and General Criteria for Social and Environmental Certification Imaflora/SAN of the Sugar Cane Culture

Translated by Mariana Reis, Paulo Dolzan and Arnaldo Walter, UNICAMP.
No guarantees are given for the correct translation.

Imaflora

Rainforest Alliance

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Sustainable Agriculture Network (SAN): Conservación y Desarrollo (CYD), Ecuador · Fundación Interamericana de Investigación Tropical (FIIT), Guatemala · Fundación Natura, Colombia · IMAFLORA, Brazil · ICADE, Honduras, Pronatura Chiapas, México, Rainforest Alliance, Worldwide · SalvaNatura, El Salvador · Toledo Institute for Development & Environment (TIDE), Belice

PRINCIPLE 1 – ECOSYSTEM CONSERVATION
The agricultural activity must promote the natural ecosystems conservation as well as its recovery whether necessary.

1.1 CONSERVATION OF REMAINING NATURAL ECOSYSTEMS

1.1.1 The remainders of existing natural ecosystems (forest lakes, rivers, fens, forest areas and others) must be delimited, protected, conserved and recovered when degraded.

1.1.2 **The agricultural areas mustn't cause damages to remaining natural ecosystems. Primary forests and advanced periods of forest succession must not be converted. For certification ends it will be considered the conversions occurred after the year of 1994.**

1.1.3 **The practices used in the management of agro-ecosystems must promote the maximization of the space diversity, vertical and/or secular of the same ones.**

1.1.4 **The use of the land of the productive unit and the layout of agro-ecosystems must promote the integration of these with the landscape and make the developing of biological and genetic flow between local ecosystems and the agricultural systems possible.**

1.1.5 **The deforestation is forbidden**

1.2 NATURAL FORESTS PROTECTION AND REFORESTATION

1.2.1 The areas without agricultural aptitude must be reforested, or be recovered to its natural state.

1.2.2 **The Permanent Preservation Areas (PPA) must be unoccupied, and eventual economic explorations must be in accordance with the legislation of the Forest Code. These areas must be recovered in a tax of at least, 10% per year with native vegetation.**

1.2.3 **A plan for recovery and conservation of the Legal Reserve must be defined and implemented.**

1.2.4 **The public or internal ways that cross or surround the unit of agricultural production must be reforested.**

1.2.5 **Barriers of vegetation between the agricultural areas and the areas of human activities inside the property must be established, mainly in the cases where the agrochemicals are used.**

1.3 FIRE PREVENTION AND CONTROL

1.3.1 The use of fire to the soil cleaning, control of unwanted vegetation, pest and diseases is forbidden.

1.3.2 In areas with fire danger a system of prevention and fire control must exist.

1.3.3 **In zones with fire danger, a plan to prevent the fire and to qualify the workers in the control and prevention of fires must be done.**

PRINCIPLE 2 - WILD LIFE PROTECTION
The ones who are responsible for the development of the agricultural activity must provide means for the biodiversity recovery, establishing protection strategies and integrating environmental education projects.

2.1 –HABITATS PROTECTION AND RECOVERY

2.1.1 – The natural habitats inside the properties must be identified and managed in accordance with the biodiversity conservation objectives.

2.1.2 –Corridors of native vegetation to join parts of forests and to allow the fauna to migrate between parks, shelters, conservation areas and other protecting areas must be established.

2.2 - PROTECTION STRATEGIES

2.2.1 – Strategies to protect endemic, protected and in danger of extinguishing species as well as its respective habitats must be established.

2.2.2 – Hunting, fishing, the commercial collect of species of the fauna and flora, or in danger of extinguishing (UICN 2000) or species included in the CITES (International Convention for the Traffic of Wild Life Species), except for communities of subsistence, or other forms allowed by the national and local legislation are forbidden.

2.3 IMPLANTATION OF THE PRODUCTION UNITS

2.3.1 The production units cannot be located where they can generate negative effects in national parks, shelters of the wild life, biological corridors, forest reserves, areas of protection or other zones of public or private biological conservation.

2.4 – GENETICALLY MODIFIED ORGANISMS (GMO)

2.4.1 The use of any type of GMO for the agricultural production is not allowed, including seeds, and other input materials.

PRINCIPLE 3 – FAIR AND CORRECT TREATMENT OF THE WORKERS
The agricultural activity must provide welfare and socio-economic improvements for their workers and its families.

3.1 SOCIAL POLITICY IMPLEMENTATION

3.1.1 The company or producer must implement one social policy that incorporates the fulfilment of the national labour law, the agreements of the International Organization of Work (OIT) other international agreements and the fulfilment of the SAN norms.

3.1.2 The resources of the PAS must be managed on a commission mixing entrepreneurs, workers and government. These resources must be used in the development of social projects. In case of independent initiatives to the PAS, the company will have to apply financial resources in programs of social assistance to the workers, being these resources managed on a commission mixing entrepreneurs and workers.

3.2. ACT OF CONTRACT

3.2.1 For election and act of contract of workers, the discrimination based on race, sex, religion, political position, social origin, nationality, political affiliations or other legal groups, sexual choice or civil state is not allowed.

3.2.2 **The act of contract of man power for the company must be prioritized directly, saw wallet of work or contract of harvest. In the cases where the contract of outside workers, products or services occurs, the same rights and proportionate benefits to the proper man power must be assured.**

3.2.3 The wages of the workers must be equal or bigger than the minimum wage established and that the average wage for the region, being in accordance with its responsibilities and experiences. Men and women must receive the same remuneration for one same work**.**

3.2.4 **Work of minors of 16 years in the agricultural activities does not have to be used. The work in the age of 16 to 18 years will only be allowed in those activities considered not harmful by the official entities, activities in which sugar cane cut is not included and must be prioritized programs of learning and professional formation.**

3.2.5 Any type of forced work or enticement of the man power is not allowed.

3.2.6 It must be guaranteed the participation of the workers in the profits and/or results of the unit of agricultural production, as the legislation determines.

3.2.7 The transport of workers must be made with appropriate vehicles, under responsibility of the producer. Relative to the contract of others, the company must create contractual measures that guarantee the quality and security of this service.

3.3 RIGHT TO THE ORGANIZATION AND LIBERTY OF SPEECH.

3.3.1 The rights of the workers to be organized and to negotiate freely with its employers, as it is established at the conventions 87 and 98 of the International Organization of Work must be guaranteed.

3.3.2 The workers and its entities of representation must previously be consulted and be informed on technological and organizational changes of the agricultural production unit that regards them directly.

3.4 HEALTH ASSISTANCE

3.4.1 The company or producer must provide its workers basic services and guarantee conditions of work with the security requirements, healthy, order and cleanness, as guaranteed in the legislation.

3.4.2 The workers must receive constant qualification, training and equipment adjusted for the safe handling of the input materials, schemes machinery and agricultural equipment.

3.4.3 The workers must have its health regularly monitored and access to periodic medical services that guarantee that its physical capacity will not be affected by dangerous tasks such as application of agrochemicals, the load of heavy materials and machinery operations.

3.4.4 **Aiming at the reduction of the periodicity of the man power, the increase of job offers, the reduction of the environmental impacts, the increase of the alimentary security and other positive effect, it must be promoted:**

a) The diversification of cultures

b) Integration of the agricultural and industrial activities

c) Maximization of exploitation of the products, by-products and wastes of the culture and the mill.

d) Adoption of permanent programs of environmental recovery in the period between harvests.

3.5 BASIC HOUSING/ LODGINGS AND SERVICES

3.5.1 The permanent workers or temporary who live in the unit of production must have worthy and healthful housing, access to the basic services and healthy conditions necessary. The agricultural production units must guarantee free access to the lodgings for its familiar ones, friends, and entities of representation, cultural, recreational and religious**.**

3.5.2 The workers and its families must have access to education, medical services and spare time opportunities.

3.5.3 **The industrial units must have adequate dinning- hall for its workers.**

PRINCIPLE 4 - COMMUNITARY AFFAIRS
Commitment with the welfare and respect to the local community's culture where it is developed the agricultural activity must exist.

4.1 CONSULTING THE COMMUNITIES.

4.1.1 During the stages of planning and development of the agricultural activities the interests of the communitarian groups and the local inhabitants must be considered, when these developments affect directly its quality of life.

4.2 RESPECTS TO THE COMMUNITY VALUES.

4.2.1 Areas of social, cultural, biological, environmental and religious importance must be respected.

4.3 COMMUNITARY DEVELOPMENT

4.3.1 The communities near the property must have job priority, as well as qualification chances that prepare them to participate of the agricultural properties activities.

4.4 OWNERSHIP AND USE OF THE LAND

4.4.1 Rights and responsibilities of ownership and use of the land must be established. The responsible one for the agricultural production unit must prove its ownership or right of use of the land in long stated period and the legitimacy of its heading of property**.**

4.4.2 **The local communities with ownership or legal rights of use of the land will have to control the agricultural activity, except when they transfer this control voluntarily and with consciousness to other groups.**

4.4.3 Properties that are registered as large state for exploration at the INCRA data records will not be certified.

4.5 RELATIONS WITH THE LOCAL COMMUNITY.

4.5.1 The agricultural properties must contribute for the protection of the water sources and the community forests, collaborate with the development of the local economy and accept a just distribution of costs for the infrastructure of the community (schools, streets, plumbing and others).

4.6 ENVIRONMENTAL EDUCATION

4.6.1 A programs of environmental education directed to the administrative and field workers and its families must be developed. These programs must involve aspects of environmental protection, health, hygiene and subjects of sort, among others. These programs must be adapted to the culture, language and level of schooling of the benefited ones.

PRINCIPLE 5 – INTEGRATED PESTS AND DISEASES HANDLING
The agricultural activity must plan and control the system of management of the production unit considering the workers and the community's health as well as the land, the water resources and the natural ecosystem's quality. In the case of agrochemicals used in the agricultural activity it must cont with a system of integrated management tending the gradual reductions with sights to the elimination of the agrochemicals. The transport, storage and the final destination of the wastes and packing must be in accordance with the Brazilian law 7.802 regulated by the directive 4.074.

5.1 INTEGRATED PEST MANAGEMENT (IPM)

5.1.1 Practices that contribute for the management and control of the possible pest, diseases or spontaneous grass that affects the culture must be implemented. This control must be based on ecological principles, prioritising the use of physical, mechanical, cultural and biological controls. A plan of permanent reduction in the use of these agrochemicals must be elaborated, with stated periods and goals on a short, medium and long run, aiming its elimination.

5.1.2 When of the use of chemical products, it must be established evaluation and monitoring systems that determine when and where the populations of plagues arrive to threatening levels; which type of control is more recommendable and how to prevent serious problems in the production.

5.1.3 The responsible for the production unit must demonstrate the rotation and continuous reduction in the amount and toxicity of used chemistries**.**

5.1.4 The use of selective and of low toxicity products must be prioritised and the use of prevention defensives must be avoided.

5.1.5 The soluble or little organic mineral fertilizers must be prioritised in the cases where this practical can reduce the environmental risks.

5.2 ALLOWED AND FORBIDDEN AGROCHEMICALS.

5.2.1 The synthetic chemical products must be registered for its use on cultivations, approved by the Environment Protection Agency of the U.S.A. (EPA) and by the local agencies.

5.2.2 The use of chemical products forbidden by national or international agreements is not allowed. The products contained in the lists - Dirty Dozen Campaign, POP's and FAO-UNEP are included.

5.3 AGROCHEMICALS TRANSPORT

5.3.1 The workers who carry agrochemicals must be trained and equipment adjusted with the purpose of minimizing the accident risk and to control accidental leak.

5.3.2 An emergency plan must be established for execution in the case of accidents in the transport of agrochemicals. This plan must be registered and the people in charge must know it with depth. All the workers must be made familiar to the plan at least once a year.

5.3.3 The transport, storage and discarding of agrochemical packing must be planed in accordance with he Agro toxic Federal Legislation (decree 4074).

5.4 AGROCHEMICALS STORAGE

5.4.1 The agrochemicals must specifically be stored in appointed and projected areas for this end. The storage area must be located in the definitive distance of the offices, houses, rivers or other water sources, protected areas and areas of fuel and lubricant storage.

5.4.2 The infrastructure and the handling of the storage areas must be drawn to minimize the risks of accidents and the impacts to the human and environmental health. In the properties it must at least be kept the inventories of existences of agrochemicals. A list of the inventory with all the products stored, its date of purchase, validity and the information on use and measures of security must be available.

5.5 AGROCHEMICALS APPLICATION

5.5.1 The agrochemicals can only be applied by qualified staff who has received the qualification necessary and that its physical conditions are apt for this end and recognized by a doctor.

5.5.2 The appropriate doses and mixtures must be used, and also the adequate equipment (including the Equipment of Individual Protection – EIP).

5.5.3 The measures of security necessary for the workers to the community and the environment, must be used, including the restricted grace periods stipulated by the EPA.

5.5.4 The workers must have areas of bath and dressings room available. An exclusive area to wash the equipment of individual protection and an exclusive area to wash the equipment of application of the agrochemicals must exist.

5.5.5 For the control of diseases after-harvest it must be established systems of application of fungicides that prevent the environment and the workers contamination.

5.5.6 Demarcate limits for the application of agrochemicals in the proximity of water sources, habitations, schools and any another infrastructure where they have domestic animals or workers and its families must be adopted in order to guarantee that the same ones will not be reached or contaminated.

PRINCIPLE 6 - INTEGRATED WASTES MANAGEMENT
*The properties must count with an integral plan for solid and liquid wastes addressing the reduction, reuse, recycling and proper final disposal of all the wastes generated by the agricultural, industrial and domestic activities***.**

6.1 REDUCTION

6.1.1 A program tending to the reduction of waste or a production system that generate infected waste to the environment or that are harmful for the worker's, the neighbouring and the communities health must be developed in production units.

6.1.2 **The atmospheric emissions must be minimized by the application of environmentally acceptable technologies. The control of the atmospheric wastes can be carried through in stages.**

6.2 REUSE

6.2.1 The productive unit must implement strategies for the reuse of the waste that allow this action.

6.2.2 The use and application of reuse as agricultural input materials must be done in accordance with the parameters of efficiency and pollution.

6.2.3 The agricultural production unit must have as objective the diversification and integration of its activities and the maximum utilization of its products, by-products and waste.

6.3 RECYCLING

6.3.1 The productive unit must give to priority to the composting of the organic waste as a treatment system.

6.3.2 A recycling system for the non biodegradable wastes, such as plastic, paper, wood, metal and glass must be implemented.

6.4 VISUAL POLLUTION

6.4.1 The property must be clean, without accumulation of wastes of any type including garbage.

6.5 WASTES FINAL DISPOSAL

6.5.1 The final disposal of the wastes generated in the agricultural activity must be directed to reduce its risks of contamination to the environment and damages to human health.

6.5.2 The burning and the disposal of waste at open sky landfill or close to water sources are forbidden. In the case of incinerators or sanitary landfill, studies must be carried through to determine the size, localization and the techniques to minimize the socio environmental impacts in the construction phases and operation.

PRINCIPLE 7 - WATER RESOURCES CONSERVATION
The agro-industrial activity must promote the conservation of the existing water resources in short term, and the recovery of them at medium and long run also.

7.1 RIVERS PROTECTION

7.1.1 To the sedimentation and the contamination control, zones of amortization throughout the rivers, lakes or lagoons, ravines and around the sources must be established. The course of the natural hydraulic basin must not be altered.

7.1.2 To change the course of creeks or to modify in significant way the local hydrology is forbidden**.**

7.2 RATIONAL UTILIZATION

7.2.1 The reduction of the water use and its reuse must be promoted.

7.3 CONTAMINATION

7.3.1 **The sources of contamination must be eliminated or reduced to acceptable levels for the laws of the country and the program. Special attention must be given to fertilizers, pesticides, fuels and lubricant.**

7.4 WASTEWATER TREATMENT

7.4.1 All the residual waters generated by the agricultural activity must be treated using clean technologies before being poured out in natural canals.

7.5 WATER MONITORING

7.5.1 A periodic monitoring of the physical, chemical and biological characteristics of the drinking waters must be carried through to assure the quality of this resource. The residual waters must have a monitoring system that indicates the contamination levels. This system must be in accordance with the intensity and size, the system of production and with the existing ecological resources.

7.6 PROPER GROUNDWATER MANAGEMENT

7.6.1 A system of environmental self management for the underground water protection in the production unit that is exploring the resource must be established**.**

PRINCIPLE 8 - SOIL CONSERVATION
The agricultural activity must promote the conservation and recovery of the soil to assure its functions of support and nutrition in long stated period.

8.1 ESTABLISHMENT OF NEW UNITS OF PRODUCTION

8.1.1 The new units of production must only be established in the soil that presents adequate conditions for the development of agriculture.

8.1.2 Adequate practices of conservation of the soil and the water resources, adopting a unit of planning must be adopted. The planning, management and mechanization of agro-ecosystems must promote the maintenance and the recovery (when degraded) of the fertility, organic substance, biological activity, structure of the soil and prevent its pollution.

8.2 EROSION CONTROL

8.2.1 A plan to minimize the erosion must be elaborated and executed. The plan must consider the topography, the type of ground, the climatic conditions and the agricultural practices of the culture.

8.2.2 The planning, implantation and maintenance of infrastructure workmanships (roads, constructions, draining system, canals, etc.) must preserve the quality of the soil and the water resources.

8.3 SOIL MANAGEMENT

8.3.1 **The mechanization and handling of the culture must promote the conservation and recovery of the soil's fertility, the amount of organic substance, the biological activity and the soil's structure.**

PRINCIPLE 9 – MANAGEMENT AND MONITORING

The agricultural activities must be planned, monitored and be evaluated considering its technical, economic, social and environmental aspects.

9.1 PLANNING

9.1.1 **Conformity with the country, the states and the cities legislation and with the international agreements and treaties to which the country is signatory must be respected.**

9.1.2 **The payment of the taxes and taxes dues must be observed.**

9.1.3 It must have consolidated documentation with the respective mechanisms of control and evaluation, always harmonious with the standards of this document.

9.1.4 The company or producer must present a plan of objectives, goals, responsibilities and a calendar of activities in which the improvement of the social and environmental conditions of the property will be planned on short, medium and long run. The detailing and the scale of this plan must be in accordance with the size and intensity of the property.

9.1.5 Before placing in practical the new operations, processes, systems of production or expansion of new areas, evaluations of environmental and social impacts that will produce these changes in accordance with the scale of intensity of the same ones must be led.

9.2 MONITORING

9.2.1 The company or producer must implement a system of monitoring of social and environmental impacts. The complexity of the system is determined by the magnitude and intensity of the production systems and the natural resources and humans in the property and its around.

9.2.2 It must have a monitoring system and periodic evaluation, capable of producing information enough that allow the constant revision and adequacy, if necessary, of the handling management plan of the property.

9.2.3 The responsible ones for the unit of production must have the capacity to demonstrate an adequate fulfilment of the norms and the beginning of a process of continuous improvements.

9.2.4 The company or producer will have to demonstrate to the Program of Certification that there isn't any mixture between products of certified farms and products of areas not certified. A tracking system to distinguish the certified product in a chain from safekeeping custodies, as in the norms of RAS must be establish and registered.

9.2.5 **In the evaluation and economic development of the agricultural production unit the social and environmental planning costs must be taken in consideration. The economic sustainability of the agricultural production unit must be demonstrated to short and long stated period.**

9.2.6 The agricultural production unit must prove the payment of its commitments and fulfilment of its public and private contract and financings.

9.3 SUGAR CANE CUT AND BURNING

9.3.1 A plan for the complete elimination of the burnings, followed by social counterparts to the workers and suppliers must be defined and be implemented, including annual periods and goals.

a) It must anticipate the politics of total elimination of the burning of the sugar cane.

b) It must not have mechanical harvesting of burnt sugar cane.

c) It must have responsible and especially able team for the handling it fire.

d) Forums must be created with the participation of workers, entrepreneurs and government for the generation of job, income and professional qualification.

e) The companies must submit its plans of elimination of the burnings to these forums.

f) The plan of the company in the field of the social counterparts must gather at least the following aspects: training and re-qualification of the man power, chronogram of implantation of the mechanization of the harvest, diversification of activities and generation of job and income.

9.3.2 It will only be considered certified products that are composite of 100% of raw and certified sugar cane.

a) It will only be considered Certified, for institutional ends, the company of whom 80% of the processed and certified raw material and an implemented plan to reach 100%.

9.4 INDUSTRIAL ACTIVITIES.

9.4.1 The water's minimization and recycling must be promoted, aiming at the maintenance of its amount and quality.

a) The use of a closed system of water use and its adequate discarding is recommended.

9.4.2 The industrial units, exclusive of sugar and alcohol, must be self - sustainable in production and consumption of electric energy, during the harvest.

a) For other industrial units, that not of sugar and alcohol, it is recommended for them to be self sustainable in production and consumption of electric energy.

9.4.3 **The use and discarding of the industrial waste, especially vinasse must be done.**

9.4.3 The use of harmful chemical substances to health must be prevented.

9.4.4 The industrial activity must fulfil the legislation with regard to the pollutants emission pollutants on air, water and the soil.

a) The company must have a plan to minimize the emission of pollutants on air, water and soil.