Global Assessment of Biomass and Bioproduct Impacts
on Socio-economics and Sustainability

Project No: FP7-245085

General environmental impacts, principles, criteria and indicators of biomass production and conversion

WP 5 – Task 5.1

31 May 2011

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The Global-Bio-Pact project (Global Assessment of Biomass and Bioproduct Impacts on Socio-economics and Sustainability) is supported by the European Commission in the 7th Framework Programme for Research and Technological Development (2007-2013). The sole responsibility for the content of this report lies with the authors. It does not represent the opinion of the Community. The European Commission is not responsible for any use that may be made of the information contained therein. The Global-Bio-Pact project duration is February 2010 to January 2013 (Contract Number: 245085).

Global-Bio-Pact website: www.globalbiopact.eu

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Acknowledgements

The research leading to these results has received funding from the European Union Seventh Framework Programme (FP7/2007-2013) under grant agreement n° 245085.

Abbreviations

CO_2	Carbon dioxide
EIA	Environmental impact assessment
EU	European Union
GHG	Greenhouse gas
iLUC	Indirect land-use change
LCA	Life cycle assessment
N_2O	Nitrogen dioxide (laughing gas)
US	United States (of America)

Preface

This report was elaborated in the framework of the Global-Bio-Pact project (Global Assessment of Biomass and Bioproduct Impacts on Socio-economics and Sustainability) which is supported by the European Commission's 7th Framework Programme for Research (FP7).

The main aim of Global-Bio-Pact is the improvement and harmonisation of global sustainability certification systems for biomass production, conversion systems and trade in order to prevent negative socio-economic impacts. A number of sustainability certification systems are already in place, but their main focus up to now is on environmental impacts such as greenhouse gas emissions or biodiversity.

A core activity of Global-Bio-Pact is the description of socio-economic impacts in different countries to collect practical experience about socio-economic impacts of biofuels and bioproducts under different environmental, legal, social, and economic framework conditions. Despite its focus on socio-economic impacts, the project will investigate the linkages between socio-economic and environmental impacts in order to reveal conflicts and synergies.

This report presents a general overview of the environmental impacts associated with biofuels and bioproducts as well as the principles, criteria and indicators of existing certification systems. The report was jointly elaborated by IFEU, ProForest and Imperial College.

1 Introduction

Within the Global-Bio-Pact project, the objective of work package 5 (WP 5) is to identify hotspots of conflicts and synergies between socio-economic and environmental impacts of biomass production in developing countries. Based upon the assessment of existing studies and the results of WP 2 and 3, WP 5 is investigating the linkages between major environmental and identified socio-economic impacts of biofuel and bioproduct life cycles. This will reveal opportunities to minimise negative and optimise positive impacts on both the environment as well as social and economic situations.

Constituting the result of Task 5.1, the aim of this report is to provide a review of existing studies on environmental impacts as well as of existing certification systems for biomass. According to this two-fold aim, the report is divided into two sections: chapter 2 (by IFEU) presents a review of existing studies on environmental impacts whereas chapter 3 (by ProForest and Imperial College) focuses on existing certification systems for biomass. The intention is both to support the development of socio-economic criteria - by giving guidance on what already exists in the field of environment - and to prepare the ground for the assessment of environmental impacts of the case studies under Task 5.2.

2 Review of existing studies on environmental impacts (IFEU)

In many parts of the world, climate change and concerns of security of supply are the main drivers for the promotion of the use of renewable resources. One of the main pillars of most strategies to mitigate climate change and save non-renewable resources is the use of biomass for energy. Bioenergy can be obtained from wood and silvicultural residues, dedicated energy crops, agricultural co-products and residues as well as from organic waste. Already today, biomass is contributing about 15 % to the global energy consumption; however, most of it is traditional non-commercial firewood and charcoal for heating and cooking.

The focus of Global-Bio-Pact is on modern bioenergy, i.e. a commercial use of deliberately grown biomass for energy purposes. Today, the modern bioenergy carriers most commonly used for heat and power generation and for transport are biodiesel (e.g. from rapeseed), bioethanol (e.g. from maize and sugarcane) and pure plant oils (e.g. from oil palm). Strong incentives have been put in place to increase the use of biomass for energy both in the transport as well as in the energy supply sector (heat and/or power generation), mainly in the form of mandatory targets /US Congress 2007/, /EP & CEC 2009/. Many countries have successfully implemented policies to foster biofuels and bioenergy, including tax exemptions or relief, feed-in tariffs or quotas. Despite considerable potentials to mitigate climate change and save non-renewable resources, much less attention has been paid to the use of biomass for bioproducts. Nevertheless, the demand for industrial crops for biochemicals and biomaterials is slowly but steadily increasing. All in all, these non-food biomass uses are already putting pressure on global agricultural land /Bringezu et al. 2009/.

At the same time, global population growth and changing diets due to economic development lead to an additional demand for agricultural land for food and feed production. The result is an increased competition for land for the production of food and feed as well as bioproducts and bioenergy, which might even aggravate in the decades to come and jeopardise food security /Eickhout 2007/ and give rise to conflicts[1]. Most likely, agricultural land will be expanded at the cost of (semi-)natural ecosystems, which are converted into cropland. Several studies have pointed out the negative impacts of such direct and indirect land-use changes, among others in terms of biodiversity loss and greenhouse gas emissions /Searchinger et al. 2008/, /Fargione et al. 2008/, /Gibbs et al 2008/, /Gallagher et al. 2008/, /Ravidranath et al. 2009/.

In the last couple of years, a controversial discussion on the net benefit of biofuels and bioenergy has been ongoing, showing that the use of biomass for energy is not environmentally friendly per se, simply because biomass is a renewable resource. This discussion gained momentum in the light of increasing competition for agricultural land between the production of food, feed, fibre and fuel. The same arguments of course apply to bioproducts. In order to mitigate this competition and its negative side-effects, efficient multi-functional land-use systems as well as limitations of non-food biomass use need to be identified.

[1] In 2008, when food prices soared, biofuels were blamed for causing hunger and disturbing markets.

2.1 Environmental impacts of biofuels and bioproducts

Biofuels/bioenergy and bioproducts are generally considered to be environmentally friendly since they save non-renewable energy resources, are biodegradable and – at least at first glance – CO_2 neutral. The latter is of course only true for the direct combustion of biofuels which releases the same amount of CO_2 into the atmosphere that earlier has been taken up by the plants. However, when looking at the entire life cycle of biofuels – from biomass cultivation (including the input of fertilizers, pesticides etc.) through conversion into biofuels and their energy use – substantial amounts of (non-renewable) energy resources are required which in turn cause greenhouse gas (GHG) emissions. Thus, biofuels are not CO_2 neutral or environmentally friendly per se from a life-cycle point of view.

Like with any other product, a number of environmental impacts are usually associated with the production and use of biomass for biofuel / bioenergy or biomaterial purposes. These include impacts on **human health** (release of toxic substances, emission of photo-oxidants and ozone-depleting gases), on the **natural environment** (release of toxic substances, emission of acidifying and eutrophying gases, land-use impacts), on natural **resources** (non-renewable energy carriers and minerals) and **man-made environment**. These environmental assets are referred to as areas of protection (Table 2-1) or safeguard objects.

The definition of what constitutes an area of protection is mainly determined by a society's basic moral and ethical values, as well as the ethical values of the individuals who make this determination. Despite deserving protection, the major compartments of the environment, e.g. air, water and soil (also referred to as environmental media), are not classified as areas of protection. The reason behind this it that the protection of environmental media is derived from the protection of the paramount area of protection.

Table 2-1 Overview of the relevant areas of protection and main societal values connected to them /de Haes et al. 1999a/

Areas of protection:	Societal values:
1. Human health (HH)	intrinsic value of human life, economic value
2. Natural environment (NE)	intrinsic value of nature (ecosystems, species), economic value of life support functions
3. Natural resources (NR)	economic and intrinsic values
4. Man-made environment (MME)	cultural, economic and intrinsic values

The main environmental concerns related to biofuels/bioenergy and bioproducts are land use and related impacts on natural environment and resources:

- **Greenhouse gas emissions**: In recent years, several studies have pointed out that the greenhouse gas balance (carbon footprint) of biofuels/bioenergy is only positive as long as no major changes in land carbon stocks occur, e.g. caused by direct and indirect land-use changes.
- **Biodiversity**: Biodiversity is threatened by two different mechanisms: intensification of production on existing agricultural land (high inputs, monocultures etc.) and expansion of agricultural land (i.e. land use changes) at the cost of (semi-)natural ecosystems. The impacts are strongly depending on location, agricultural practices and previous land use.

- **Water**: Two aspects related to water are discussed in the context of biofuels/bioenergy and bioproducts: water quality and water quantity. Biomass cultivation and conversion may lead to water pollution/contamination and depletion of (scarce) water resources.
- **Soil**: Biomass cultivation – like other agricultural activities – may have negative impacts on soil physical, chemical and biological properties, including soil erosion (by water and wind), soil organic matter (SOM) decline, soil compaction and salinization.

These main areas of concern were also mentioned by the FAO-funded Bioenergy Environmental Impact Analysis (BIAS) project /Fritsche et al. 2010a/ which provides a framework assisting decision-makers and stakeholders in comparing the environmental impacts of competing bioenergy development options. The framework is based on the modules shown in Fig. 2-1: biodiversity, water, soil and greenhouse gases. The BIAS framework has already been evaluated against a real case study, which revealed its strengths and weaknesses /Franke et al. 2010/. The main outcome of this report is that substantial site-specific data (especially on soil carbon) are required to sufficiently evaluate impacts on the four modules.

In addition to those four modules, a fifth one, air, could be mentioned. However, it is quite challenging to assess the overall impact of bioenergy options on air quality due to the multitude of airborne pollutants which cause a range of different impacts (photo-oxidant formation, acidification, eutrophication or stratospheric ozone depletion) at various spatial levels.

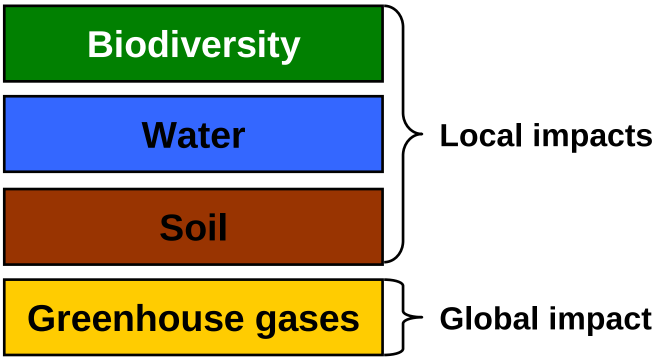

Fig. 2-1 The four key modules of the BIAS framework. Adapted from /Fritsche et al. 2010a/

2.2 Inventory / selection of assessment techniques

Since the 1970ies, environmental assessment has been developed as a systematic process to identify, analyze and evaluate the environmental effects of products or activities to ensure that the environmental implications of decisions are taken into account before the decisions are made (ex-ante analysis). Environmental assessment allows for an effective integration of environmental considerations and public concerns into decision-making. Fig. 2-2 depicts several environmental management techniques such as product carbon footprint (PCF), life cycle assessment (LCA), eco-audit, environmental impact assessment (EIA) and strategic environmental assessment (SEA).

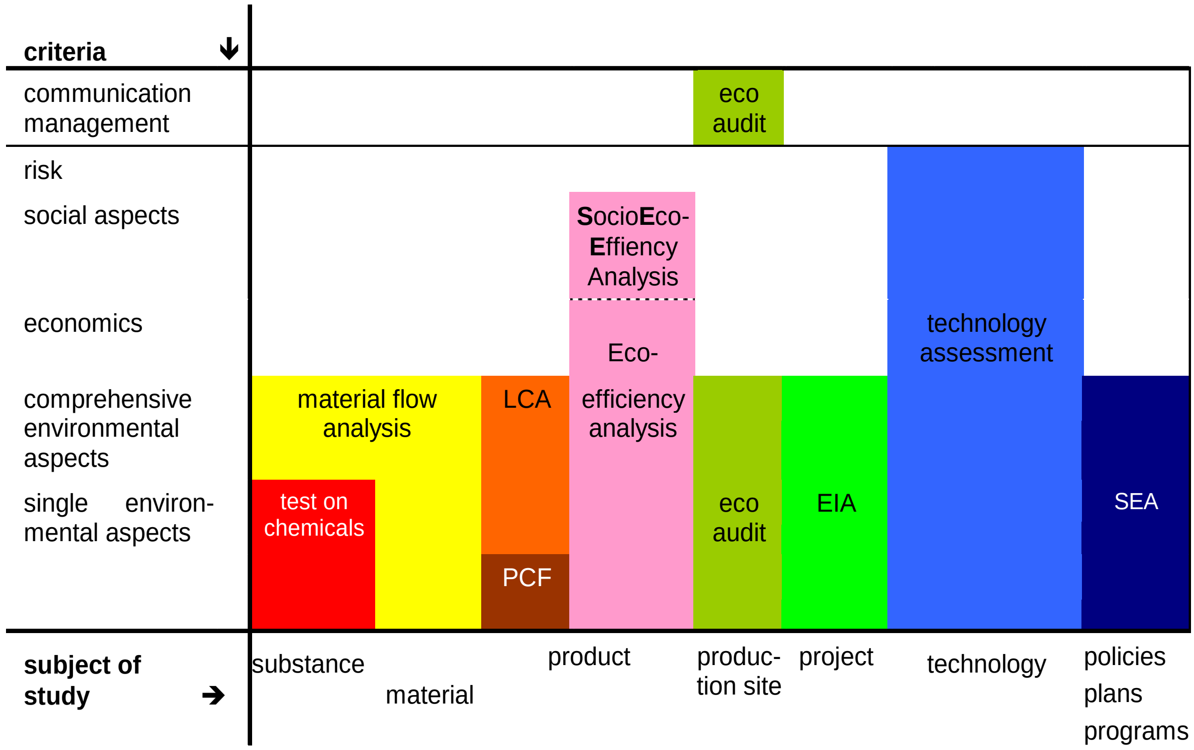

Fig. 2-2 Available techniques for environmental assessment (IFEU, own compilation)

Each of these techniques is appropriate for specific situations. Not only do they differ in the subject of study (product, production site, project or law), but also in their ability to address environmental impacts occurring at different spatial levels (Table 2-2). Life cycle assessment (LCA) is usually considered weak regarding local environmental impacts.

Table 2-2 Spatial differentiation in different environmental impact categories /UNEP 2003/

Climate change	**Global**	Stratospheric ozone depletion
Extraction of abiotic resources	↑	Extraction of biotic resources
Acidification		Nutrification / eutrophication
Human toxicity	↓	Eco-toxicity
Photo-oxidant formation	**Local**	Land use

For the purpose of Global-Bio-Pact, two assessment techniques are selected: life cycle assessment (LCA) and environmental impact assessment (EIA). Strategic environmental assessment (SEA) /EP & CEC 2001/ will not be taken into account, as the approach chosen within Global-Bio-Pact is based on case studies which are project-specific and not related to policies, plans or programs. For the purpose of Global-Bio-Pact, EIA (and not SEA) is the technique to be chosen. For more information regarding SEA of biofuels, the reader is referred to a recent OECD publication /OECD 2011/.

2.2.1 Life cycle assessment (LCA)

In the 1990s, a method has been developed which addresses the environmental aspects and potential environmental impacts (e.g. use of resources and the environmental consequences of releases) throughout a product's life cycle: Life Cycle Assessment (LCA). Being generic, LCA can be applied to any product or product system, but it also has some limitations, as it was developed mainly to compare products. It is a data-intense method which tends to generalise and therefore only insufficiently addresses site-specific environmental impacts (which cannot be averaged without losing their significance). For more information, the reader is referred to /Guinée 2002/ or /Klöpffer & Grahl 2009/ (in German).

Methodology

Life cycle assessments (LCA) address the environmental aspects and potential environmental impacts (e.g. use of resources and the environmental consequences of emissions) throughout a product's life cycle from raw material acquisition through production, use, end-of-life treatment, recycling and final disposal. The approach is therefore often called cradle-to-grave, well-to-wheel (biofuels) or farm-to-fork (food). LCA is internationally standardised through ISO standards 14040 and 14044 /ISO 2006/ and can assist in

- identifying opportunities to improve the environmental performance of products at various points in their life cycle and
- informing decision-makers in industry, government or non-government organizations (e.g. for the purpose of strategic planning, priority setting, product or process design or redesign).

There are four iterative phases in an LCA study (**Fig. 2-3**):

1) the goal and scope definition phase,

2) the inventory analysis phase,

3) the impact assessment phase, and

4) the interpretation phase.

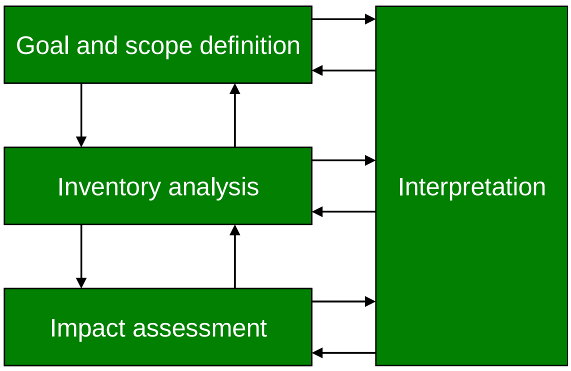

Fig. 2-3 Phases of an LCA /ISO 2006/.

Impact categories

Life cycle assessments usually address a number of environmental impact categories, such as the extraction of resources, land use, climate change, stratospheric ozone depletion, human toxicity, eco-toxicity, summer smog (photo-oxidant formation), acidification and nitrification / eutrophication (Table 2-3). All impact categories listed in this table are considered baseline impact categories and should be covered in a **full LCA study**.

Table 2-3 List of impact categories – divided into input related and output related categories – incl. their content and area of protection (AoP) involved /de Haes et al. 1999b/. HH = Human health, NE = Natural environment, NR = Natural resources, MME = Man-made environment

Impact category	Content	AoP
Input related categories		
Extraction of abiotic resources	Extraction of different types of non-living material from the natural environment	NR
a) Non-renewable (depletable)	Fossil fuels, uranium / mineral ores	
b) Renewable (recoverable)	Water (except for fossil ground water)	
Extraction of biotic resources	Extraction of species types of biomass from the natural environment	NR, NE
Land use		
a) Increase of land competition	Physical interventions leading to exclusive land occupation, or to change in land occupation	NR
b) Degradation of life support systems	Degradation of processes in the natural environment which are due to land use and have broad regulation functions	NE
c) Biodiversity degradation	Impacts of physical interventions on biodiversity (ecosystems, species) as values in themselves	NE
Output related categories		
Climate change	All impacts related to climate change caused by changes in radiative forcing	HH, NE, MME
Stratospheric ozone depletion	All impacts due to stratospheric ozone depletion (incl. possible impacts on human health)	HH, NE, MME, NR
Human toxicity	All impacts on human health caused by direct emissions of toxic substances both outdoor and indoor, and impacts caused by fine particles and by radiation	HH
Eco-toxicity	All impacts on natural species and ecosystems caused by direct emissions of toxic substances, incl. degradation products thereof	NE, NR
Photo-oxidant formation	All impacts related to tropospheric oxidant formation, incl. impacts from NO_X emissions.	HH, MME, NE, NR
Acidification	All impacts due to acidification, incl. direct impacts on leaves, cation exchange in leaves and soil through ammonium, and mobilisation of Al and other toxic metals	NE, MME, HH, NR
Nutrification / eutrophication	All impacts of macro-nutrients on the vegetation, both natural as well as crops, both terrestrial as well as aquatic, and indirect effects thereof	NE, NR

Although hardly ever used, there might be additional study-specific impact categories such as odour, noise, ionising radiation or casualties.

In recent years, LCA methodology is increasingly used to obtain so-called **energy and greenhouse gas (GHG) balances** (the latter is sometimes referred to as carbon footprint, too). Such a restriction in scope only leads to an incomplete picture of the environmental impacts that are associated with the investigated product.

2.2.2 Environmental impact assessments (EIA)

Methodology

Environmental Impact Assessment (EIA) is an assessment technique to explore the possible environmental effects of a proposed project, e.g. the execution of construction works or of other installations as well as other interventions in the natural surroundings and landscape. An EIA is usually performed before the decision on a project is made. It examines the anticipated environmental effects and determines the importance of these effects, on both the short and the long term. In doing so, an EIA focuses on local / site-specific environmental effects. Generally, it compares the expected environmental effects of the proposed project with the expected environmental effects of alternative actions or the so-called 'no action alternative' in case the site remains unchanged (Fig. 2-4).

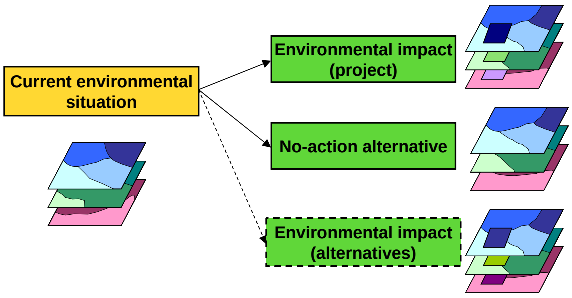

Fig. 2-4 Conventional procedure of an EIA

EIA primarily serves as a decision support tool for project managers and authorities which have to decide upon project approval. Within the European Union, it is mandatory to carry out an EIA for certain public and private projects according to the Council Directive 85/337/EEC of 27 June 1985 /CEC 1985/. The EIA Directive has been amended three times by Council Directive 97/11/EC of 3 March 1997, Directive 2003/35/EC of the European Parliament and of the Council of 26 May 2003 and Directive 2009/31/EC of the European Parliament and of the Council of 23 April 2009.

The environmental impact assessment shall identify, describe and assess in an appropriate manner, […], the direct and indirect effects of a project on the following factors:

- human beings, fauna and flora;
- soil, water, air, climate and the landscape;
- material assets and the cultural heritage;
- the interaction between the factors mentioned in the first, second and third indents.

An EIA in general includes the following steps:

1. Screening
2. Scoping
3. EIA study
4. Monitoring and auditing measures

1. Screening

Usually an EIA normally starts with a screening process to find out whether a project requires an EIA or not.

2. Scoping

Scoping is to determine what should be the coverage or scope of the EIA study for a project as having potentially significant environmental impacts. It helps in developing and selecting alternatives to the proposed action and in identifying the issues to be considered in an EIA.

3. EIA study, which consists of the following three parts

- A project description, a consideration of alternatives as well as a description of the status and trends of environmental factors against which predicted changes can be compared and evaluated in terms of importance.
- Impact prediction: a description of the likely significant effects of the proposed project on the environment resulting from:
  - the construction / installation of the project (temporary impacts)
  - the existence of the project (continuous impacts)
  - the operation phase of the project (continuous impacts)

  Prediction should be based on the available environmental project data. Such predictions are described in quantitative or qualitative terms considering e.g.
  - quality of impact
  - magnitude of impact
  - extent of impact
  - duration of impact.
- Mitigation measures are recommended actions to reduce, avoid or offset the potential adverse environmental consequences of development activities. The objective of mitigation measures is to maximise project benefits and minimise undesirable impacts.

4. Monitoring and auditing measures

Monitoring and auditing measures are post-EIA procedures that can contribute to an improvement of the EIA procedure.

Impact categories

There is no general list of criteria to assess the environmental impact nor a general description of methods to be used. Fixing the environmental criteria is part of the EIA process. Usually criteria address emissions to soil, ground and surface waters and air, effects on living environment and health of people in the surroundings, effects on surrounding ecosystems, and effects on cultural assets.

2.3 Review and evaluation of LCA studies

2.3.1 Impact categories covered

As already mentioned in chapter 2.2.1, life cycle assessments usually address a number of environmental impact categories. But even if a full LCA study is performed, sometimes only a sub-set of the baseline impact categories listed in Table 2-3 is covered. According to Klöpffer /2010/ most often, climate change (global warming potential), acidification and summer smog (photo-oxidant formation) are addressed. Less frequent are eutrophication, fossil resource extraction and stratospheric ozone depletion. More uncommon categories include land use, human toxicity and eco-toxicity, which still require methodological development, especially regarding sub-categories b) and c) under “land use” (degradation of life support systems and biodiversity degradation). The same holds for the extraction of water resources.

Comparing these observations with the main areas of concern mentioned in chapter 2.1, it can be concluded that most of the areas of concern related to biofuels/bioenergy and bioproducts are insufficiently covered in LCA studies, i.e. LCA is weak regarding area-related and site-specific environmental impacts. Therefore, other assessment techniques such as environmental impact assessment (EIA) are often used in addition.

In recent years, however, the scope of many LCA studies related to biofuels/bioenergy was restricted to two impact categories: the use of non-renewable energy resources and climate change. This is due to the fact that climate change and security of supply are seen as the main drivers for the promotion of the use of renewable resources.

2.3.2 LCA results for biofuels and bioproducts

In literature, hundreds of LCA studies on bioenergy and bio-based products can be found, covering a wide range of products. Unfortunately, their results are not always comparable. This is because the ISO standards 14040 and 14044 are only setting the scene for LCA studies while leaving quite some degrees of freedom to the practitioner, e.g. regarding co-product accounting, system boundaries and basic data.

Furthermore, there are only few LCA studies such as /Rettenmaier et al. 2010/ or /Zah et al. 2007/ that simultaneously screen / analyze a multitude of products from various crops applying common settings and definitions. Most often, LCA studies focus on one product from one biomass feedstock. Sometimes, the number of biomass feedstocks is increased, but only few publications compare different biofuels/bioenergy and bioproduct options.

The extent to which each life cycle stage contributes to the overall result varies between the environmental impact categories: the conversion stage, i.e. the use of fossil energy carriers for process energy generation, has the largest influence on energy and greenhouse gas balances. In contrast, conversion is of only minor importance for other environmental impact categories. The cultivation stage is most important in terms of acidification, eutrophication and ozone depletion, which are dominated by nitrogen fertiliser-related field emissions like N_2O (ozone depletion) or NH_3 (acidification and eutrophication). These emissions depend on the specific agricultural system (e.g. crop rotation) and agronomic practices (e.g. no-tillage). The utilisation stage has a considerable impact on acidification and eutrophication, mainly through NO_X emissions. Transports and the provision of specific ancillary products only have a minor influence.

Regarding the results for different environmental impact categories, a distinct pattern becomes obvious: in Table 2-4 the energy crops show environmental advantages in terms of energy and greenhouse gas savings but ambiguous results or even disadvantages regarding acidification, eutrophication, ozone depletion, summer smog, and human toxicity. With that, from a scientific point of view, an objective conclusion regarding the overall environmental performance of biofuels/bioenergy produced from the investigated crops cannot be drawn.

An overall conclusion has to be based on (subjective) value-choices, e.g. by ranking the impact categories in a given hierarchy (e.g. high, medium, and low priority). If, for example, energy saving and mitigation of greenhouse effect are subjectively given the highest priority, all bioenergy carriers in Table 2-4 are superior to their fossil equivalent, provided that there is no carbon stock change due to land use changes. However, it has to be noted that different individuals, organizations and societies may have different preferences; therefore different rankings may be derived based on the same objectively obtained results.

Table 2-4 Environmental performance of different energy crops excluding carbon stock changes due to direct and indirect land-use changes /Rettenmaier et al. 2010/. FAME = Fatty acid methyl ester, HVO = Hydrogenated vegetable oil, CHP = Combined heat & power, FT = Fischer-Tropsch, EtOH = Ethanol

	Energy savings	**Greenh. effect**	**Acidifi-cation**	**Eutrophi-cation**	**Summer smog**	**Ozone deplet.**	**Human toxicity**
Oil crops – FAME	+	o	o	–	o	– –	o
Oil crops – HVO	+	o	o	–	o	– –	–
Oil crops – CHP	+	o	–	–	o	– –	–
Oil crops – Heat	+	o	–	–	o	– –	–
Oil crops – Power	+	o	–	–	o	– –	–
Woody crops – FT diesel	+	o	o	o	o	O	o
Woody crops – 2G EtOH	+	+	–	–	o	–	–
Woody crops – CHP	+ +	+	o	o	o	O	o
Woody crops – Heat	+	+	o	o	o	O	o
Woody crops – Power	+	o	o	o	o	O	o
Herb. crops – FT diesel	+ +	+	o	–	o	–	o
Herb. crops – 2G EtOH	+ +	+ +	–	–	+	–	–
Herb. crops – CHP	+ + +	+ +	o	–	o	–	o
Herb. crops – Heat	+ +	+ +	–	–	o	–	–
Herb. crops – Power	+ +	+	o	–	o	–	–
Sugar crops – 1G EtOH	+ +	+	–	–	o	–	–

In recent years, however, greenhouse gas (GHG) balances have attracted a great deal of attention, especially after it had been shown that carbon stock changes due to direct and indirect land-use changes could reverse the (usually) positive GHG balance /Bringezu et al. 2009/, /Menichetti & Otto 2009/. The first GHG balance studies to account for GHG emissions due to (direct) land-use change from natural forest to oil palm plantation were published by /WWF 2007/ and /Reinhardt et al. /2007/. They showed that GHG balances of palm oil biodiesel could even turn out negative, i.e. that the use of palm-oil biodiesel could cause higher life cycle GHG emissions than the use of conventional diesel fuel. Carbon stock changes caused by land-use changes are mostly calculated following IPCC's stock-difference method which has originally been developed for national greenhouse gas inventories /IPCC 2006/.

In earlier review-type studies like /Quirin et al. 2004/ or the so-called well-to-wheels study /JEC 2007/, carbon stock changes had been set at zero, because mainly fallow / set-aside land was used for the cultivation of non-food biomass. In this case, the carbon stock does not change significantly since it remains agricultural land (not subject to natural succession).

The discussion around GHG balances highlighted the fact that the ISO standards on product life cycle assessment (14040 and 14044) are providing a good foundation but at the same time, there is a need for more precise calculation rules. Therefore, a new ISO standard for the carbon footprint of products (ISO 14067) is currently being developed (cf. chapter 2.3.3).

2.3.2.1 Reasons for variation in results

Despite ISO standards, the results of LCA studies may vary quite substantially. This can be due to a) differences in accounting for co-products (substitution versus allocation), b) differences in system boundaries (e.g. exclusion of land use changes) or c) differences in basic data (e.g. N_2O emission factors) /Gnansounou et al. 2009/, /Cherubini et al. 2009/.

Accounting for co-products

The production of biofuels and bioenergy mostly yields a wide range of co-products. For example, in rapeseed biodiesel production, rapeseed meal is obtained as a co-product. The way in which these co-products are accounted for in LCAs can have a strong impact on the results. Fig. 2-5 exemplifies the two different accounting methods for co-products.

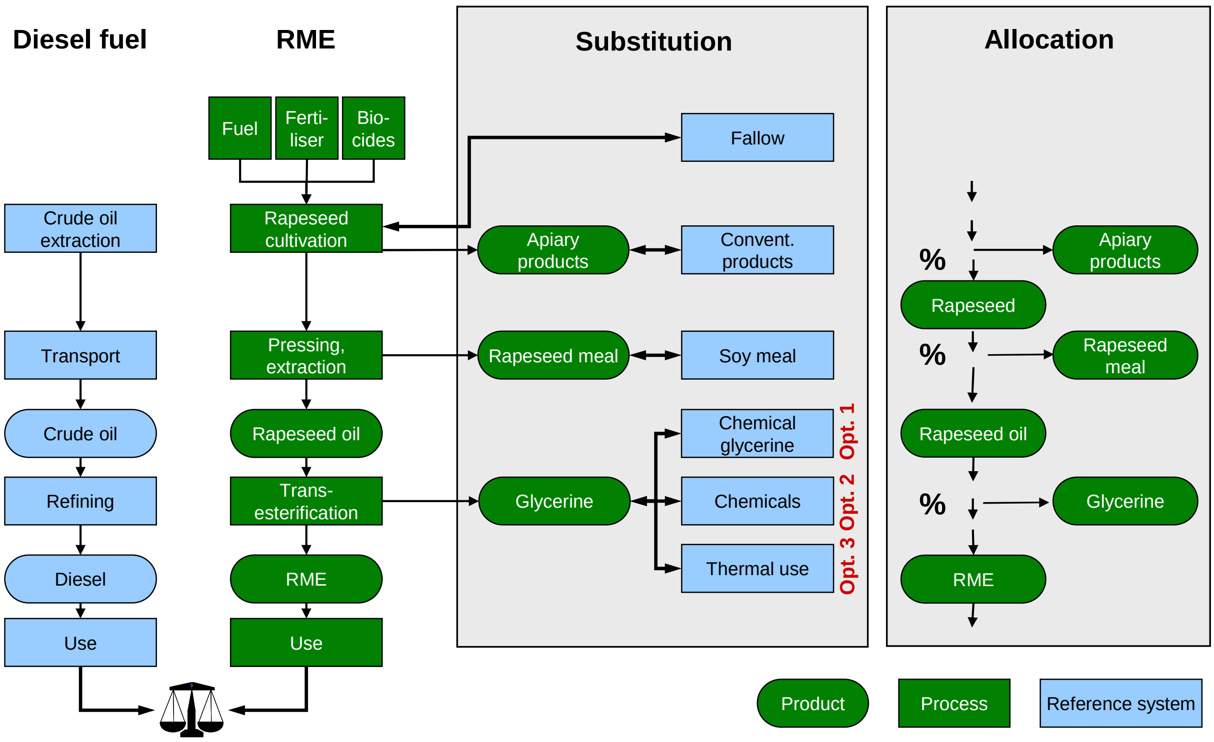

Fig. 2-5 Comparison of two different accounting methods for co-products: substitution (system expansion) and allocation method

The following two fundamentally different approaches /ISO 2006/, /Borken et al. 1999/ exist:

- **Allocation**: all environmental impacts (e.g. emissions) are allocated proportionately to the main product and the co-products, respectively, based on underlying physical relationships (e.g. mass or volume) or other relationships (e.g. energy content or economic value). The European Renewable Energy Directive (RED, 2009/28/EC) for example stipulates the use of allocation by energy content. This choice is adequate for the purpose of regulation, e.g. for the verification of compliance with the sustainability criteria. Other regulations such as the UNFCCC guidelines for CDM projects suggest four options: allocation by market price, substitution, allocation by energy content or attribution of all emissions to the main products.
- **Substitution**: according to the ISO standards for LCAs, allocation should be avoided wherever possible by expanding the system boundaries /ISO 2006/. The main idea is that co-products replace conventional products (fulfilling the equivalent function) and that the environmental impacts caused by the production of conventional products are thus avoided. These avoided environmental impacts are credited to the main product.

Impacts on land use

Land-use changes involve both direct and indirect effects /Fehrenbach et al. 2008/. Direct land-use changes (dLUC) comprise any change in land use or land cover which is directly induced by the cultivation of the energy crop under investigation. This can either be a change in land use of existing agricultural land (replacing fallow / set-aside land or grassland) or a conversion of (semi-)natural ecosystems such as grassland, forest land or wetland into new cropland. Indirect land-use changes (iLUC) occur if agricultural land so far used for food and feed production is now used for energy crop cultivation. Provided that the global demand for food and feed is constant, food and feed production is crowded out and displaced to another area where again unfavourable land-use changes, i.e. the conversion of (semi-)natural ecosystems, might occur. This phenomenon is also called leakage effect, crowding-out or displacement and is illustrated in Fig. 2-6.

Not only the production of energy crops in Europe leads to indirect land-use changes elsewhere in the world. Also the import of biomass or biofuel into Europe has such effects. This mechanism is shown in Fig. 2-7. In the producing country good agricultural practice and the absence of direct land-use change may be certified. However, the required area now being used by the new crop is no longer available for the previous food or feed production. As a result, food or feed production is displaced to other areas where in turn land-use changes may occur.

Indirect land-use (iLUC) change effects are difficult to verify empirically: they occur at global level and they are linked to the cultivation of energy crops (e.g. in Europe) via economic market mechanisms. These markets are very complex and the following dampening factors have to be taken into account:

- The use of co-products from the production of 1st generation biofuels plays an important role. If these co-products can be used as animal feed (e.g. rapeseed meal), they substitute conventional feed (e.g. soybean meal) and thus reduce the overall pressure on land.
- An increased demand for energy crops may trigger plant breeding and lead to increased yields, i.e. the use of one hectare of land for bioenergy does not necessarily mean that exactly one hectare of new land will be developed for the displaced food/feed/fibre crops.

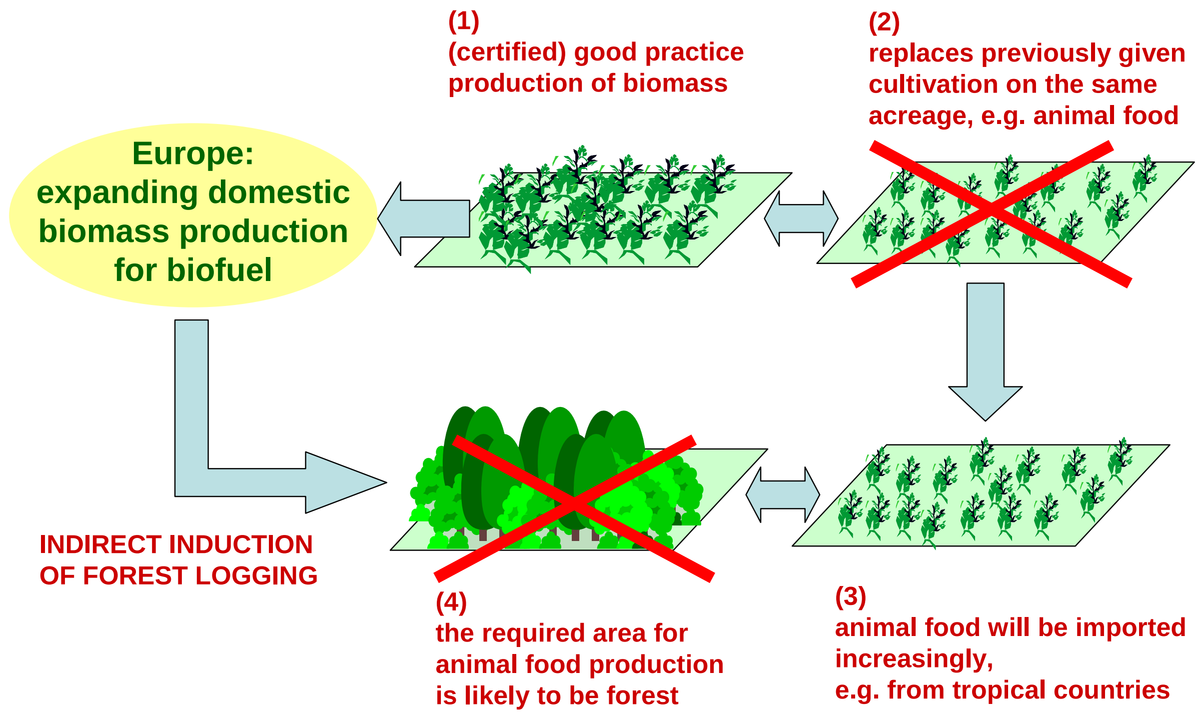

Fig. 2-6 Exemplary mechanism of indirect land-use change due to biomass for bioenergy production in Europe (/Fehrenbach et al. 2008/)

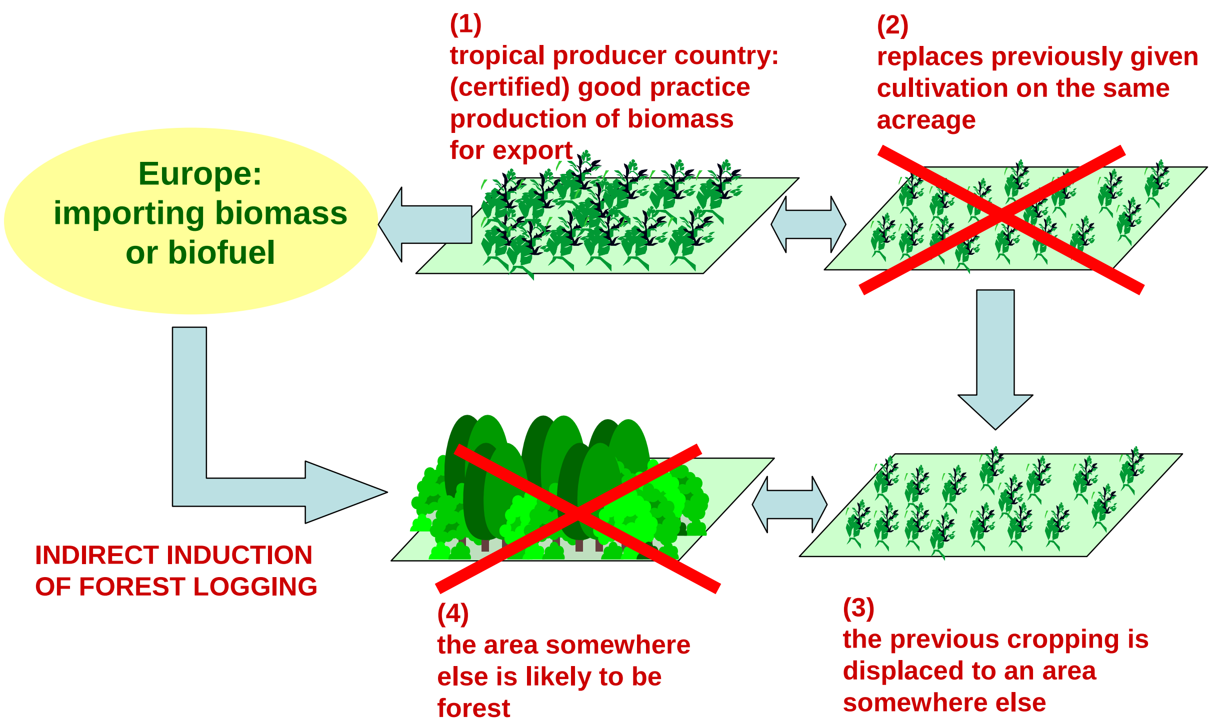

Fig. 2-7 Exemplary mechanism of indirect land-use change due to biomass for bioenergy import to Europe (/Fehrenbach et al. 2008/)

In contrast to direct land-use changes, indirect effects cannot be exactly allocated to the cultivation of a specific energy crop. In addition, they are closely linked to the increase of global food and feed production which results from global population growth and changing human diets due to economic development (increasing purchasing power). Therefore, several studies use partial and / or general equilibrium models (sometimes even linked to biophysical models) to quantify the iLUC effect of different non-food biomass expansion scenarios /Melillo et al. 2009/, /Havlík et al. 2010/, /Britz & Hertel 2010/. Despite all efforts, up to date there is no commonly accepted method on how to quantify iLUC effects /Banse et al. 2008/, /Kim et al 2009/, /Fehrenbach et al. 2009/. Kim & Dale /2011/ tested an empirical approach and concluded that either there is no iLUC due to US biofuels production or that the approach was not sensitive enough to detect it. However, O'Hare et al. /2011/ argue that Kim and Dale have used statistical methods inappropriately and drawn incorrect conclusions.

At the same time, there is no consensus how to integrate indirect land-use changes into life cycle assessments /Kløverpris et al. 2008/, /Liska & Perrin 2009/. However, if iLUC is not considered in LCAs, the informative value of a LCA is very low since its results for greenhouse effect may not at all reflect reality.

Both direct and indirect land-use changes ultimately lead to changes in the carbon stock of above- and below-ground biomass, soil organic carbon, litter and dead wood /Brandão et al. 2010/. Depending on the previous vegetation, the crop to be established and the agronomic practices, these changes can be neutral, positive or negative. For example, if fallow / set-aside land is transformed the carbon stock does not change significantly since it remains agricultural land (not subject to natural succession). The carbon stock change is therefore often set at zero. However, if (semi-)natural ecosystems such as grassland, forest land or wetland are converted, high carbon emissions can be caused. In contrast, the use of degraded land may even lead to carbon sequestration.

In addition to changes in carbon stocks, land use changes are having an impact on biodiversity as the conversion of (semi-)natural ecosystems into agricultural land most often results in a loss of biodiversity. Although there are proposals on how to address this impact in LCAs (e.g. /Koellner & Scholz 2008/), currently, there is no commonly accepted method.

2.3.3 Evaluation: Scientific challenges and future research needs

There are a number of scientific challenges regarding LCA methodology which are still debated in the scientific community. There is consensus that these issues have to be addressed and that there is need for future research. Some hot topics are described below.

Carbon footprint

Currently, the International Organization for Standardization (ISO) is working on a new standard for "Carbon Footprints of Products" for the quantification and communication of greenhouse gas (GHG) emissions associated with goods and services. The ISO 14067 standard builds largely on the existing ISO standards for life cycle assessments (ISO 14040/44) and environmental labels and declarations (ISO 14025). In comparison to the existing LCA standards it contains further provisions for the uniform quantification and communication of GHG emissions. Land use changes and carbon storage in product will be addressed, though reported separately. The standard currently is in Committee Draft status and is planned for final publication in 2012.

Indirect land use change

Quantification of indirect land-use change (iLUC) is currently debated among scientist. The difficulties of quantifying the emissions from iLUC are:

- ILUC can not be attributed individually to a specific biofuel production process, but depend upon the complex mechanisms of agricultural markets and prices of possible substitutes.
- Using one additional hectare for bioenergy production does not imply that one additional hectare of natural area needs to be converted to cropland.
- In some cases, bioenergy production has positive effects on land availability. For example, if co-products of bioenergy production are used as feed (soybean or rapeseed meal, sugar beet pulp etc.) they are substituting feed that would have to be produced otherwise.

Using historical date to empirically test iLUC approaches, Kim & Dale /2011/ state that crop intensification may have absorbed the effects of expanding US biofuel production. However, O'Hare et al. /2011/ argue that Kim and Dale have used statistical methods inappropriately and drawn incorrect conclusions. It is quite obvious that additional efforts are required to develop methodologies to observe indirect land-use change from historical data. Such efforts might reduce uncertainties in indirect land-use change estimates or perhaps form the basis for better policies or standards for biofuels.

Currently, there are two main approaches to quantify GHG emissions from iLUC: econometric models and deterministic approaches.

- **Econometric models** have originally been developed to simulate the effect of agricultural policies on markets and trades flows. They can be used to estimate market-induced changes in the use of land. In order to calculate GHG emissions, in a second step these models need to be combined with biophysical models that include global data on the carbon stock of different areas and land use options. The results of the studies differ between 18 to 180 g CO_{2eq} per megajoule biofuel (/Searchinger 2008/, /Al-Riffai et al. 2010/) due to differences in scenarios and the model setup.
- **Deterministic approaches** to include iLUC aim at providing an approach that is practicable and applicable for policies. On the basis of historic land use data a hectare based value (13.5 g CO_{2eq} per hectare per year) is proposed to be added on top of the GHG balance of the biofuels /Fritsche et al. 2010b/.

With Sheehan /2009/ it can be concluded that research on the quantification of iLUC still has a long way to go despite the already complex approaches of econometric modelling. He stresses at the same time that the uncertainties in the quantification of iLUC must not be a reason for disregarding them. This conclusion is shared by policy makers in Europe and the US: as iLUC may be significantly influence GHG emissions it can not be ignored when setting up policy support for biofuels that aim at reducing GHG.

Thus, it is clear that there is no scientifically agreed-upon method yet even if an increasing number of researchers addressed the problem in recent years. The future may lie in a combination of the deterministic approach and macro-economic models /Fehrenbach et al. 2009/, /Lywood 2008/. However, need for further research is given.

It still is an open question how to address iLUC in policy making. The European Commission stated in their report of 22 December 2010 /EC 2010/ that there were still a number of deficiencies and uncertainties associated with the examined modelling approaches and that no action would be taken for the time being – the problem was put off until July 2011. Four options will be assessed until then:

- take no action for the time being, while continuing to monitor,
- increase the minimum GHG saving threshold for biofuels,
- introduce additional sustainability requirements on certain categories of biofuels,
- attribute a quantity of GHG emissions to biofuels reflecting the estimated indirect land-use impact.

In the US the Environmental Protection Agency (EPA) issued a proposal regarding the inclusion of iLUC. After receiving criticism from different national and international actors, the implementation of this proposal was put on hold by a five-year moratorium agreed on in the House of Representatives on 24 June 2009. The proposal will be subject to a scientific review in the meantime.

Land use impacts on biodiversity and soil

Intensification of production on existing agricultural land (high inputs, monocultures etc.) and expansion of agricultural land (i.e. land use changes) at the cost of (semi-)natural ecosystems may lead to biodiversity loss. As these impacts are strongly depending on location, agricultural practices and previous land use, efforts towards a regionalization of LCA are needed.

Under the UNEP/SETAC life cycle initiative, a task force has been established which aims at establishing recommended practice and guidance for use for natural resources and land use categories. Regarding biodiversity, it was tried to develop a set of characterization factors for land use impacts on biodiversity. A number of publications assess methods to integrate biodiversity loss in LCAs by means of characterization factors for damage potentials. For example, characterization factors for 53 land use types and six intensity classes are calculated which comprise standardized species numbers /Koellner & Scholz 2008/. Another approach identifies the "natural degradation potential" (NDP) as direct indicator of the impacts of land use on habitats. It measures how influenced land is by human beings /Delucchi 2010/.

However, it is still not possible to agree on a method which is easily measurable and takes into account regional-specific features. Especially in LCAs, biodiversity is hard to assess because LCAs are not site-specific but product-specific. Biodiversity however is intrinsically tied to specific habitats (sites). Impacts on biodiversity in turn depend on the specific agricultural system (e.g. crop rotation) and agronomic practices. Moreover, cumulative effects have to be accounted for.

Soil ecological functions are also an important topic currently not included in LCAs. Saad et al. /2011/ suggest to calculate impact indicators (erosion resistance, groundwater recharge, mechanical and physicochemical filtration) in order to assess erosion regulation, freshwater regulation and water purification, i.e. functions that soils should fulfil. However, future research is required in this field. Impacts on soil are generally more related to agriculture as a whole rather than to the cultivation of a specific energy crop.

Water use

Both water pollution/contamination and depletion of (scarce) water resources are very relevant in the context of biomass cultivation and conversion to biofuels/bioenergy and bioproducts /Berndes 2002/. Thus, it is vital to address this topic in LCAs. However, different approaches as how to do so are discussed (e.g. /Koehler 2008/, /Pfister et al. 2009/) but not yet integrated in most LCAs. Water consumption might a suitable indicator. However, its meaning would be more significant if it would be set in relation to water availability in a region. Delucchi /2010/ suggests that water requirements for biofuel cultivation should encompass water that is necessary to dilute polluted water. Polluted water hereby is water with high concentrations of fertilizer and pesticides. The amount of clean water needed to dilute this contaminated water until water-quality guideline values are reached is then added to the water needed for the growth of the biofuels.

These discussions have lead to the development of the so-called water footprint. The concept is a "spatially and temporally explicit indicator of direct and indirect water use of consumers and producers" /WFN 2010/. Currently at the stage of a Preliminary Work Item (PWI), ISO 14046 (Water footprint – Requirements and guidelines) will complement existing standards on life cycle assessment (LCA) and ongoing work on carbon footprint metrics.

N_2O

Most LCAs use IPCC guidelines in order to calculate N_2O emissions from bioenergy cultivation /IPCC 2006/. According to IPCC, 1 % of the added nitrogen fertilizer is emitted as N_2O in the atmosphere. However, N_2O fluxes are highly variable in space and time, which makes an accurate determination of N_2O emissions difficult. These emissions depend on a number of factors such as processes of nitrification and denitrification, soil organic carbon, pH, soil drainage, texture and soil compaction. The IPCC emission factor of 1 % is therefore a rough value which does not capture site-, region- or country-specific conditions.

In 2008, an article was published in which the loss of N_2O was estimated at about 3-5 % /Crutzen et al. 2008/. Since N_2O is a powerful greenhouse gas, this would have a huge effect on the GHG balances: If the latter values were used, many GHG balances for biofuels/bioenergy would become disadvantageous. The article was heavily debated and several research groups tried to address this topic /Dallemand et al. 2010/, /Dallemand et al. 2009/. However, in most LCAs, the IPCC emission factor of 1 % is still used in the absence of a clear, exact and not too complex alternative method. It is necessary to conduct more research in this area, e.g. to move from IPCC's Tier I method to Tier 2 & 3 methods. Since IPCC's factors are heavily dependent on a rather coarse classification of soils and climates, strong efforts are needed to implement a regional measuring network in order 1) to approve or contest IPCC's emission factors and 2) to narrow the uncertainty ranges. In this context, the impact of agronomic practices (e.g. no-tillage) on N_2O emissions should be verified.

2.4 Review and evaluation of EIA studies

Impact categories covered

As stated above, there is no general list of criteria to assess the environmental impact nor a general description of methods to be used. Fixing the environmental criteria is part of the EIA process. Typically, EIA studies on biofuels and bioproducts cover the direct and indirect impacts of a project on humans, fauna and flora, soil, water, air, climate and landscape.

In contrast to other renewable energies, the use of biomass (dedicated crops) may have a severe impact on land use (Table 2-5). This impact is technology-inherent as the cultivation of dedicated crops requires land. The second technology-inherent impact of biomass is the emission of pollutants into air, soil and water which are to a large extent related to the agricultural production stage /Reinhardt & Scheurlen 2004/.

Table 2-5 Environmental impacts associated with different renewable energies. ● (red) = Technology-inherent impacts; ● (blue) = Additional site-specific and conversion facility-dependent impacts /Reinhardt & Scheurlen 2004/

Impact factors	Biomass	Hydro	Wind	Solar	Geothermal
Land use change	● (red)	● (blue)	● (blue)	● (blue)	● (blue)
Habitat fragmentation	● (blue)	● (red)	● (red)	● (blue)	● (blue)
Habitat degradation	● (blue)	● (red)	● (red)	● (blue)	● (blue)
Change of landscape aspect	● (blue)	● (blue)	● (red)	● (blue)	● (blue)
Change of water balance	● (blue)	● (red)			● (red)
Emission of pollutants	● (red)				● (blue)
Other emissions		● (blue)	● (red)		● (blue)

EIA results for biofuels and bioproducts

Since EIA studies primarily serve as a decision support tool for authorities which have to decide upon project approval, their results most often end up in the authorities' files. Moreover, EIA results are usually very site-specific (as they are relating to a specific project in a given location) and cannot be generalised or transferred to a wider context. Therefore, in literature only few EIA studies relating to an environmental zone, an entire region or even a continent can be found, e.g. /Biewinga & van der Bijl 1996/, /Scheurlen et al. 2005/ or /Fernando et al. 2010/. However, it has to be kept in mind that even country-specific studies are problematic as the territory of large countries might cover different environmental zones.

Many experts consider that the agricultural production stage dominates the overall environmental impacts of project related to biofuels or bioproducts. Therefore, EIA studies are often putting an emphasis on this stage. Fernando et al. /2010/ for example evaluated the environmental impacts of different energy crops cultivation in Europe (disregarding the biomass conversion stage) and applied different (subjective) weighting factors to the environmental impacts (Fig. 2-8). According to their results for weighting system I (WS I), most of the impacts are related to emissions of pollutants, soil degradation and use of resources. Comparing the different crop categories it can be concluded that perennial crops such as short rotation coppice (poplar, willow or Eucalyptus) usually perform better than annual crops mainly due to less frequent agricultural operations and lower agrochemicals input.

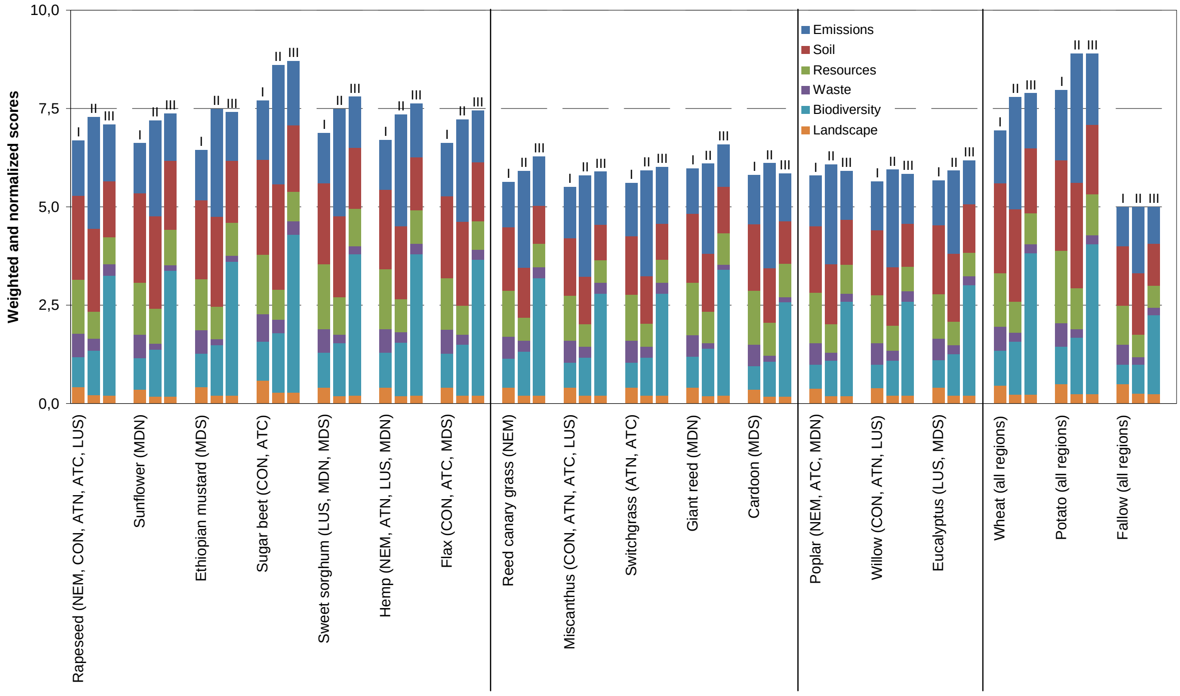

Fig. 2-8 EIA of energy crops cultivation in Europe per weighting system (WS). WS I: all indicators have the same weight; WS II: greater emphasis on GHG emission drivers; WS III: greater emphasis on biodiversity. /Fernando et al. 2010/

Peters et al. /in press/ developed a detailed matrix for north-eastern Germany in which different energy crops are compared to a reference crop (winter rye) regarding their impacts on soil, water, fauna, flora and landscape aspect. According to their findings, root crops (e.g. sugar beet or potato), maize and oil crops (e.g. rapeseed) show a more negative environmental impact than winter rye or other cereals. This is mostly related to soil erosion, soil compaction, the use of pesticides and emissions of pollutants into water bodies. In contrast, permanent grassland performs significantly better than all cereals. However, it has to be kept in mind that these results cannot be generalised or transferred to other regions / agro-environmental zones and that agricultural practices often are more important for the final impact than the type of crop.

Evaluation

Being project-related and mostly site-specific, EIA has some limitations regarding the assessment of environmental impacts of biofuels and bioproducts as it was developed for ex-ante decision support regarding projects. In the case of biofuels and bioproducts, a project would typically be the installation and operation of a conversion plant. However, the raw material (biomass) production to such a conversion plant is not considered in an EIA by default and depends both on the practitioner and the regulatory authority. If omitted, the lion's share of the environmental impacts would be faded out, as the above review has shown.

Moreover, a conversion plant only represents one stage of the entire life cycle of biofuels and bioproducts. Thus, restricting the quantification of the environmental impacts to the conversion plant would inevitably lead to an incomplete picture if the goal of the assessment was to evaluate the overall environmental impact of biofuels and bioproducts.

2.5 Conclusions

Like with any other product, a number of environmental impacts are usually associated with the production and use of biomass for biofuel / bioenergy or biomaterial purposes.

Our review of existing studies on environmental impacts revealed that the main environmental concerns related to biofuels/bioenergy and bioproducts are land use and associated impacts on natural environment and resources such as:

- greenhouse gas emissions,
- biodiversity,
- water and
- soil.

Moreover, it could be shown that a number of assessment techniques are available for environmental assessment. The choice and suitability of these techniques depends on the goal of the analysis, among others as environmental impacts occur at different spatial scales. For the purpose of Global-Bio-Pact, two assessment techniques are selected: life cycle assessment (LCA) and environmental impact assessment (EIA). These techniques differ in the subject of study (LCA: product; EIA: project) and show strengths and weaknesses regarding the assessment of the environmental impacts of biofuels and bioproducts:

	Advantage	Disadvantage
LCA	Generic: can be applied to any product or product system Covers the entire life cycle and avoids a shifting of burdens from one life cycle stage to another, from one geographic region to another or from one impact category to another	Generic: for the time being less suited to address site-specific environmental impacts Scientific debate on methodological issues Data-intensive
EIA	Specific: well suited to address site-specific environmental impacts	Specific: results cannot be generalised or transferred to other contexts / regions / agro-environmental zones Only covers selected life cycle stages

There are still a number of scientific challenges regarding LCA methodology which have to be addressed and resolved by the scientific community. Methods, system boundaries, assumptions and basic data need to be further harmonised in order to avoid different results for the same product system. As far as EIA is concerned, it has to be stressed that the baseline situation has to be properly studied in order to only evaluate the incremental differences of environmental impacts.

The main conclusions in the context of the Global-Bio-Pact project are:

- Sufficient evidence is provided in literature that biofuels and bioproducts are not CO_2 neutral or environmentally friendly per se, just because biomass is renewable
- Despite its focus on socio-economic impacts, the Global-Bio-Pact project should also consider environmental impacts in order to reveal conflicts and synergies.

- The assessment of environmental impacts for the case studies should at least cover the following four elements: greenhouse gas emissions, biodiversity, water and soil.
- Due to differences regarding the ability to address environmental impacts occurring at different spatial levels, a combination of two techniques is required: life cycle assessment (LCA) for greenhouse gas emissions and environmental impact assessment (EIA) for biodiversity, water and soil.

3 Review of existing certification systems for biomass (ProForest & Imperial)

3.1 Inventory / selection of certification systems

A number of voluntary certification schemes currently exist for agricultural crops and forestry products which could be used for bio energy production.

FSC is the oldest of these schemes, having been established almost 20 years ago, whereas others are still in final stages of development.

Some voluntary certification schemes for agriculture have been designed for specific crops (e.g. BSI/Bonsucro, RSPO, RTRS, Proterra), whereas other have been developed generically and applicable to a range of crops (e.g. ISCC, SAN, RSB).

GBEP has also been included, even though it is not a certification scheme. It is a set of measurement and monitoring criteria being developed for use by Governments and is therefore useful to take into account when developing impact criteria.

Table 3-1 Existing certification systems and their respective stage of development

	Operational	Early implementation	Under development
Forestry	FSC, PEFC		GBEP
Oil Palm	RSPO	SAN, ISCC, RSB	GBEP
Soybean	Proterra, Aapresid	SAN, ISCC, RTRS RSB	GBEP
Sugarcane		BSI/Bonsucro, SAN, RSB, ISCC	GBEP

FSC was the pioneering model for many of the certification schemes which now exist or are under development. The standards, which are the core of the certification scheme, have been in most cases developed with involvement of stakeholders – some have used a multi-stakeholder process where the text of the standard has been agreed on through a process of facilitated negotiation and consultation, whereas others have used stakeholder consultation for input but not as a decision-making process.

The existing sustainability standards are generally written as performance-based standards, where systems must exist as well as achieve the aims of the standard in practice. However, with the exception of the BSI/Bonsucro, these standards do not set metrics-based performance thresholds. They are not designed to be a framework for monitoring the impact of the operations, though in most cases they do require that the operators monitor their impact.

3.2 Selection of characteristics

The following topics have been selected to use as a framework to assess the environmental aspects of certification schemes:

- Soil
- Water
- Air
- Biodiversity
- Carbon and land use change

These topics have been selected using the ISEAL Impacts Code and an analysis of key environmental issues, outlined below.

3.2.1 ISEAL Impacts Code

The ISEAL Impacts Code specifies general requirements for the development and implementation of monitoring and evaluation programmes by social and environmental standards systems. The ISEAL Impacts Code includes a list of social, environmental and economic for standards systems to assess their contributions to impact. The environmental aspects are as following:

Water: Marine and fresh water conservation and quality, including protection from pollution

Soil: Maintenance of organic matter and biological activity, including prevention of erosion and pollution

Biodiversity: Biodiversity conservation at the genetic, species and ecosystems levels

Energy: Efficient energy use, including reduction in total use and increased use of renewable energy

Carbon: Mitigation and sequestration of greenhouse gas emissions and increased resilience and adaptation capacity of people, their livelihoods and ecosystems to climate change

Natural Resources: Efficient management of natural resources from production to post consumption, including integrity of ecosystem services, sustainable levels of harvesting and extraction and reduction and effective management of waste

3.2.2 Environmental issues in sustainability schemes

3.2.2.1 Water

Over the past decades efforts have been made to develop agrochemicals that have lower adverse environmental impacts. There has also been progress regarding application techniques, farm machinery, precision farming etc. Although progress has been made, inappropriate use of agro-chemicals such as herbicides, pesticides and fertilizers can have a significant impact on water quality, both for human consumption as well as streams, rivers and lake ecosystems.

Other issues include rates of withdrawal from the aquifer (particularly in water stressed areas), which is linked to water efficiency within the operations.

3.2.2.2 Soil

Maintaining soil productivity is critical for both environmental sustainability as well as sustaining the soil's capacity to be used for production.

Impacts from agriculture and forestry include for example use of heavy machinery (for ploughing, harvesting) which may result in soil compaction, over-irrigation which can result in soil salinization, poor road construction, planting practices and clearance of vegetation which can lead to wind and water erosion of soil, soil contamination from effluents, fuels or agri-chemicals. Increasingly, the soil carbon content is also being considered as an important parameter for measurement, particularly for certification schemes aiming to deliver the requirements of the EU Directive 2009/28/EC.

Typically, there are references to physical, chemical and biological soil parameters. Requirements to monitor and manage these characteristics are normally included in sustainability standards.

3.2.2.3 Air

When considering the plantation areas (e.g. the 'field') the most significant sources of air pollution are normally burning, either as part of land clearing (a single occurrence) or as a means of disposing of wastes and residues (an ongoing practice). Additionally, aerial application of pesticides may drift into adjacent areas, which is particularly a problem in populated areas.

3.2.2.4 Biodiversity

Agriculture and forestry operations may impact biodiversity through fragmentation of habitat (e.g. loss of connectivity), damage or destruction of habitat features (e.g. food sources, nesting sites for animals), opening up previously inaccessible areas (e.g. hunting and poaching), destruction of plant communities and replacement with single crops.

Within operations, it is important to identify and incorporate biodiversity into planning from the beginning (normally through some type of environmental impact assessment) as well as to monitor and manage biodiversity within the operations.

In practice, most operations will have some impact on biodiversity and when defining sustainability for certification scheme standards, stakeholders have considered options for protecting particularly important features. For example, identification and maintenance of 'high conservation values' has emerged as an important approach for a number of certification schemes including FSC (where it was originally developed), RSPO, RTRS, BSI/Bonsucro and RSB which all contain some reference to maintaining nationally significant and/or critically important conservation values.

3.2.2.5 Carbon and land use change

Land use change is particularly linked with impacts on biodiversity and greenhouse gasses. Conversion of large tracts of land, particularly forests, to single-crop plantations continues to be a concern within agriculture and forestry.

To address this concern, a number of certification standards include ‘cut-off dates’ for conversion. The ‘cut-off date’ is normally set based on the date where the standard is approved. A cut-off date too far in the future would drive short term land use change, whereas the introduction of a historic cut-off date would potentially exclude operators with otherwise good practices, who would never be able to meet the standard if such a cut-off date was introduced.

In addition to land use change, certification schemes have increasingly been including requirements to minimize carbon-equivalent emissions (GHG emissions) across the operations, particularly for bioenergy crops where the GHG emissions can be compared with the equivalent fossil energy emissions.

3.3 Review and evaluation

3.3.1 FSC

The founding meeting of the Forest Stewardship Council (FSC) was held in 1990, and the certification system developed between 1990 and 1993, with the first certificates issued in 1993.

There are currently more than 100 million hectares certified to FSC's Principles and Criteria, over 79 countries.

Environmental requirements are covered under the following Principles:

- Principle 6: Environmental impact
- Principle 8: Monitoring and assessment
- Principle 9: Maintenance of high conservation value forests
- Principle 10: Plantations

Note that indicators are developed nationally as part of the National Interpretation process.

Measurement: FSC is a performance based standard that does not include specific metrics for each requirement. It does include monitoring requirements, and specifies that composition and changes in flora and fauna must be recorded as well as more generally environmental and social impacts.

Coverage: FSC does not have specific requirements on carbon or air. The land use cut-off date is 1994.

The detailed analysis can be found in Appendix 1.

3.3.2 PEFC

The Programme for the Endorsement of Forest Certification (PEFC) is an umbrella certification scheme that endorses national certification schemes for compliance with the PEFC requirements, which are based on the Pan European Criteria and Indicators (PEC&I) for

Sustainable Forest Management of European Forests and the Pan-European Operational Level Guidelines (PEOLG, Europe), the ATO/ITTO principles, criteria and indicators for the sustainable forest management of African tropical forests and the ITTO guidelines on sustainable forest management (Africa).

There are currently 30 endorsed national certification systems and more than 220 million hectares of certified forests.

Environmental requirements are covered under the following criteria:

- Criterion 1: Maintenance and Appropriate Enhancement of Forest Resources and their Contribution to Global Carbon Cycles
- Criterion 2: Maintenance of Forest Ecosystem Health and Vitality
- Criterion 4: Maintenance, Conservation and Appropriate Enhancement of Biological Diversity in Forest Ecosystems
- Criterion 5: Maintenance and Appropriate Enhancement of Protective Functions in Forest Management (notably Soil and Water)

Measurement: The Pan European Criteria & Indicators has identified metrics-based indicators for each of the Pan European Criteria, designed for implementation at national level. These indicators are not included as part of the PEFC site-based certification, which uses the PEOLG, and performance based requirements (though in general there is more of a focus on systems, for example requiring that management planning takes certain aspects into account, or monitoring, rather than requiring that forest management achieves requirements in practice.

Coverage: The PEC&I includes quantitative (national) indicators for each of the issues identified. The PEOLG also includes requirements for each topic, though carbon and air are not covered in detail. There is no cut-off date for land use change.

The detailed analysis can be found in Appendix 2.

3.3.3 BSI/Bonsucro

The founding members of the Better Sugarcane Initiative (BSI) first met in 2005, and by 2007 the general principles of the standard had been agreed, followed by the criteria and indicators in 2008. The standard went out for public consultation in 2009, and version 2 was finalized in late 2009. In July 2010, a revised final version taking into account the requirements of the EU Directive 2009/28/EC was published. Recently, the name of BSI was changed to Bonsucro.

Environmental requirements are covered under the following Principles:

- PRINCIPLE 3. Manage input, production and processing efficiencies to enhance sustainability
- PRINCIPLE 4. Actively manage biodiversity and ecosystem services
- PRINCIPLE 5. Continuously improve key areas of the business

Measurement: BSI/Bonsucro includes detailed metrics for each of the requirements, including a performance threshold which must be measured in the field in order to judge compliance.

Coverage: With the exception of air, all of the issues are covered. Protection of air is referred to as a subcomponent of herbicide and pesticide application, and is also addressed as part of the GHG emission reduction requirements (though not explicitly). The cut-off date for land use change is 1 January 2008.

The detailed analysis can be found in Appendix 3.

3.3.4 RSPO

Though initial meeting were held as early as 2001, the Roundtable on Sustainable Palm Oil (RSPO) was formed in 2004 with the objective promoting the growth and use of sustainable oil palm products through credible global standards and engagement of stakeholders. The RSPO standard was approved in October 2007.

As of August 2010, there were 58 palm oil mills with RSPO certification and 83 facilities with RSPO supply chain certification.

Environmental requirements are covered under the following Principles:

- Principle 4: Use of appropriate best practices by growers and millers
- Principle 5: Environmental responsibility and conservation of natural resources and biodiversity
- Principle 7: Responsible development of new plantings

Measurement: The RSPO requirements tend to focus on qualitative performance requirements, though specific measurement parameters are identified for water and soil (nutrient status only).

Coverage: Carbon is not addressed (though the RSPO has a GHG working group). The cut-off date for land-use change is November 2005.

The detailed analysis can be found in Appendix 4.

3.3.5 RTRS

The Round Table on Responsible Soy (RTRS) was initiated in 2004, with the organization formally established in 2006. The standard-setting development group first met in late 2007, and the process included public consultations and field trials, before being finally approved in June 2010.
In 2010, an ‘add-on’ to the standard was developed on request of the Executive Board in order to meet the requirements of Directive 2009/28/EC, which was submitted for assessment to DG ENERGY in August 2010.

As of August 2010, the certification systems were being finalized with the first certificates expected in early 2011.

Environmental requirements are covered under the following Principles:

- Principle 4: Environmental Responsibility
- Principle 5: Good Agricultural Practice

Measurement: The RTRS uses qualitative performance requirements. Measurement of soil organic matter is specifically required.

Coverage: All of the issues identified are addressed in the RTRS standard. The land-use cut-off date is May 2009, though there are exceptions when land can be converted.

The detailed analysis can be found in Appendix 5.

3.3.6 Aapresid

Aapresid is the Argentinean Organization for No-Tillage (Asociación Argentina de Productores en Siembra Directa), and they operate an agricultural certification for members based on no-till and good agricultural practices.

The standard includes a list of good agricultural practices as well as agronomic management indicators. Environmental requirements are covered in the following requirements:

1. No Soil Disturbance / Presence of Soil Residue Cover
2. Crop Rotation
3. Efficient and Responsible Agrochemical Management
4. Strategic Crop Nutrition
5. Agronomic Management Indicators for soil

Measurement: The Aapresid standard includes qualitative performance requirements for good agricultural practices, and for soil indicates that the soil physical and chemical conditions should be monitored (specific and thresholds are not given).

Coverage: The standard explicitly covers soil. Carbon conservation is implicit in the no-tillage approach. Biodiversity, water and air are not addressed.

The detailed analysis can be found in Appendix 6.

3.3.7 RSB

The Roundtable on Sustainable Biofuels (RSB) is a multi-stakeholder process established in 2006.

The certification scheme is currently undergoing a field testing/trail phase, with certification anticipated for 2011.

The standard covers environmental requirements in the following principles:

- Principle 2: Planning, Monitoring and Continuous Improvement
- Principle 3: Greenhouse Gas Emissions
- Principle 7: Conservation

- Principle 8: Soil
- Principle 9: Water
- Principle 10: Air

Measurement: The RSB includes qualitative performance requirements, though soil organic matter content is identified as a specific measurement parameter. There is also a Water Assessment that must be undertaken in certain conditions which includes specific measurement parameters.

Coverage: The RSB addresses all of the issues identified. The cut-off date for land-use change is 1 January 2009.

The detailed analysis can be found in Appendix 7.

3.3.8 SAN

The Sustainable Agriculture Network (SAN) was originally developed for fruits, vegetables and coffee, and since 2009 was extended to cover oil palm, sugarcane and other grains and oilseeds.

Since 1992, almost 800 certificates for more than 31,000 farms have been issues in 24 countries.

Environmental requirements are covered in the following principles:

- 2. ECOSYSTEM CONSERVATION
- 3. WILDLIFE PROTECTION
- 4. WATER CONSERVATION
- 9. SOIL MANAGEMENT AND CONSERVATION
- 10. INTEGRATED WASTE MANAGEMENT

Measurement: The SAN standard includes specific measurement parameters for water, and qualitative performance requirements for all other requirements. The certification scheme also includes a process for developing local indicators, specific for crops and geographic locations, which may include measurement parameters and thresholds. These are not binding for certification.

Coverage: Carbon conservation and reduction is not specifically covered and there are limited requirements for air. There is no cut-off date for land-use change, however the standard does say that no conversion of natural ecosystems is allowed.

The detailed analysis can be found in Appendix 8.

3.3.9 GBEP

The Global Bioenergy Partnership (GBEP) is an intergovernmental process designed to develop national-level monitoring indicators for bioenergy.

The process has been ongoing throughout 2009 and 2010. The third draft of the GBEP Bioenergy Indicators has been assessed in this report though it is important to note these are not yet finalized.

Environmental requirements are addressed as following:

- Greenhouse Gas Emissions (ENV 1)
- Productive capacity of the land and ecosystems (ENV 2)
- Air Quality (ENV 3)
- Water Availability, use efficiency and quality (ENV 3)
- Biological Diversity (ENV 5)
- Land-use change, including indirect effects (ENV 6)

Measurement: The GBEP bioenergy indicators include specific measurement parameters and no performance requirements. They are not designed to be used for site-level certification.

Coverage: The GBEP bioenergy indicators address all of the environmental issues identified. They do not include a land-use cut-off date.

The detailed analysis can be found in Appendix 9.

3.3.10 ISCC

The International Sustainability and Carbon Certification (ISCC) is a certification scheme designed to meet the requirements of the EU Renewable Energy Directive.

The standard was formally launched in early 2010 and a number of ISCC certificates have now been issues, particularly for supply chain operators.

Environmental requirements are covered in the following principles:

- PRINCIPLE 1: Biomass shall not be produced on land with high biodiversity value or high carbon stock and not from peat land (according to Article 17(3) of the Directive 2009/28/EC and § 4 to 6 of the German BioSt-NachV and BioKraft-NachV). HCV areas shall be protected.
- PRINCIPLE 2: Biomass shall be produced in an environmentally responsible way. This includes the protection of soil, water and air and the application of Good Agricultural Practices

Measurement: The ISCC includes qualitative performance based requirements.

Coverage: The ISCC addresses all of the issues identified, however maintain biodiversity (rather than only high conservation values) is not addressed, and air is only covered with reference to burning. The land-use cut-off date is January 2008.

The detailed analysis can be found in Appendix 10.

3.4 Conclusions

The range of sustainability standards reviewed has a great deal of similarity in terms of coverage of issues identified for the review.

- Almost all of them include a cut-off date for land-use change
- Carbon reduction/conservation in operations is not well covered
- Carbon emissions related to land use change is explicitly covered in newer standards (BSI/Bonsucro, RTRS, RSB, ISCC, GBEP) but is implicit in all standards that have performance requirements related to land-use change
- Air is not particularly well covered
- Biodiversity is addressed in all of the standards reviewed, but the detail of the requirements varies considerably

There are variations in the way that the standards reviewed approach measurement:

- Most of the certification schemes use qualitative performance requirements
- Most have specific measurement parameters for soil, and several for water
- Several standards have National Interpretation processes which may define additional measurement parameters and performance metrics
- BSI/Bonsucro is the only standard reviewed with metrics-based performance requirements
- GBEP is the only standard reviewed without performance requirements

The standards have been written as normative documents for auditing compliance of plantations and forests, and therefore the Principles, Criteria and Indicators are designed to be to judge compliance. These are not monitoring frameworks for impacts of the operations, though the standards do require that monitoring is undertaken. In order to measure the impact of the operations, and how implementation of the sustainability standard may have specifically impacted environmental parameters, a different type of indicator is needed.

When considering the development of impact indicators as part of the Global-Bio-Pact project, there are two timescales to consider. One is before and after plantation are established (or harvesting, in the case of forestry), to compare the overall impact of the operations. The standards examined generally address the 'before' as a requirement to do an environmental impact assessment. However, it may not always be possible to undertake an EIA or similar baseline assessment for operations that have been long-established. In practice, it may be possible to use adjacent area as a comparator, however this approach has not been addressed by the existing standards.

The second timescale at which impacts should be considered is through ongoing monitoring of the operations and their impacts. Ongoing monitoring is generally a requirement in the standards examined, however with the exception of the BSI/Bonsucro, the parameters which should be measured are not set out in great detail and where parameter are provided, these are not consistent between the standards.

Use of the sustainability standards examined can be a good proxy for measuring impact, particularly as they do require monitoring and mitigation activities. However, this approach would not provide consistent parameters which could be compared between operations, including those not implementing a sustainability standard. Out of the standards assessed, only BSI/Bonsucro and GBEP systematically provide measurement parameters.

These standards are a useful starting point for developing impact indicators as they identify the important criteria and indicators for a variety of agriculture and forestry operations, and can be used as a framework for developing specific impact measurements for each of land use change, biodiversity, soil, water and air.

Table 3-2 Parameters to develop impact indicators for

	Parameters to develop impact indicators for
Carbon and land use change	Assessment of all parameters below before and after conversion
Biodiversity	Landscapes
	Ecosystems
	Plants & animals (including protected species)
	High Conservation Values
Soil	Physical, Chemical & biological status
	Soil carbon content
	Erosion
	Fertilizer use
	Contamination by fuels, human settlements and agro-chemicals
Water	Physical, Chemical & biological status
	Riparian zones
	Water use/efficiency
	Agro-chemical use
	Contamination by fuels, human settlements and agro-chemicals
Air	Pesticide spraying
	Burning of wastes and residues
	Burning for land use clearing
	Processing emissions

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5 Appendix

5.1 Appendix 1 FSC

	Criteria
Carbon and land use change	**6.1** Assessment of environmental impacts shall be completed – appropriate to the scale, intensity of forest management and the uniqueness of the affected resources – and adequately integrated into management systems. Assessments shall include landscape level considerations as well as the impacts of on-site processing facilities. Environmental impacts shall be assessed prior to commencement of site-disturbing operations.
	6.10 Forest conversion to plantations or non-forest land uses shall not occur, except in circumstances where conversion:
	a) entails a very limited portion of the forest management unit; and
	b) does not occur on high conservation value forest areas; and
	c) will enable clear, substantial, additional, secure, long term conservation benefits across the forest management unit.
	10.95 Plantations established in areas converted from natural forests after November 1994 normally shall not qualify for certification. Certification may be allowed in circumstances where sufficient evidence is submitted to the certification body that the manager/owner is not responsible directly or indirectly of such conversion.
Biodiversity	**6.2** Safeguards shall exist which protect rare, threatened and endangered species and their habitats (e.g., nesting and feeding areas). Conservation zones and protection areas shall be established, appropriate to the scale and intensity of forest management and the uniqueness of the affected resources. Inappropriate hunting, fishing, trapping and collecting shall be controlled.
	6.3 Ecological functions and values shall be maintained intact, enhanced, or restored, including:
	a) Forest regeneration and succession.
	b) Genetic, species, and ecosystem diversity.
	c) Natural cycles that affect the productivity of the forest ecosystem.
	6.4 Representative samples of existing ecosystems within the landscape shall be protected in their natural state and recorded on maps, appropriate to the scale and intensity of operations and the uniqueness of the affected resources.
	8.1 The frequency and intensity of monitoring should be determined by the scale and intensity of forest management operations as well as the relative complexity and fragility of the affected environment. Monitoring procedures should be consistent and replicable over time to allow comparison of results and assessment of change.
	8.2 Forest management should include the research and data collection needed to monitor, at a minimum, the following indicators:
	c) Composition and observed changes in the flora and fauna.
	d) Environmental and social impacts of harvesting and other operations.
	9.1 Assessment to determine the presence of the attributes consistent with High Conservation Value Forests will be completed, appropriate to scale and intensity of forest management.
	9.3 The management plan shall include and implement specific measures that ensure the maintenance and/or enhancement of the applicable conservation attributes consistent with the precautionary approach. These measures shall be specifically included in the publicly

	available management plan summary.
	9.4 Annual monitoring shall be conducted to assess the effectiveness of the measures employed to maintain or enhance the applicable conservation attributes.
Soil	**6.5** Written guidelines shall be prepared and implemented to: control erosion; minimize forest damage during harvesting, road construction, and all other mechanical disturbances; and protect water resources.
	8.1 The frequency and intensity of monitoring should be determined by the scale and intensity of forest management operations as well as the relative complexity and fragility of the affected environment. Monitoring procedures should be consistent and replicable over time to allow comparison of results and assessment of change.
Water	**6.6** Management systems shall promote the development and adoption of environmentally friendly non-chemical methods of pest management and strive to avoid the use of chemical pesticides. World Health Organization Type 1A and 1B and chlorinated hydrocarbon pesticides; pesticides that are persistent, toxic or whose derivatives remain biologically active and accumulate in the food chain beyond their intended use; as well as any pesticides banned by international agreement, shall be prohibited. If chemicals are used, proper equipment and training shall be provided to minimize health and environmental risks.
	6.7 Chemicals, containers, liquid and solid non-organic wastes including fuel and oil shall be disposed of in an environmentally appropriate manner at off-site locations.
	8.1 The frequency and intensity of monitoring should be determined by the scale and intensity of forest management operations as well as the relative complexity and fragility of the affected environment. Monitoring procedures should be consistent and replicable over time to allow comparison of results and assessment of change.
Air	

5.2 Appendix 2 PEFC

	Pan European Criteria and Indicators (PEC&I) – National monitoring and reporting
Carbon and land use change	**Criterion 1**: Maintenance and appropriate enhancement of forest and their contribution to global carbon cycle
	1.4 Carbon stock (Quantitative indicator)
	Carbon stock of woody biomass and of soils on forest and other wooded land
Biodiversity	**Criterion 4**: Maintenance, conservation and appropriate enhancement of biological diversity in forest ecosystems
	4.1 Tree species composition
	Area of forest and other wooded land, classified by number of tree species occurring and by forest type
	4.2 Regeneration
	Area of regeneration within even-aged stands and unevenaged stands, classified by regeneration type
	4.3 Naturalness
	Area of forest and other wooded land, classified by “undisturbed by man”, by “semi-natural” or by “plantations”, each by forest type
	4.7 Landscape pattern
	Landscape-level spatial pattern of forest cover
	4.8 Threatened forest species
	Number of threatened forest species, classified according to IUCN Red List categories in relation to total number of forest species

	4.9 Protected forests Area of forest and other wooded land protected to conserve biodiversity, landscapes and specific natural elements, according to MCPFE Assessment Guidelines
Soil	**Criterion 2**: Maintenance of forest ecosystem health and vitality 2.2 Soil condition Chemical soil properties (pH, CEC, C/N, organic C, base saturation) on forest and other wooded land related to soil acidity and eutrophication, classified by main soil types **Criterion 5**: Maintenance and appropriate enhancement of protective functions in forest management (notably soil and water) 5.1 Protective forests – soil, water and other ecosystem functions Area of forest and other wooded land designated to prevent soil erosion, to preserve water resources, or to maintain other forest ecosystem functions, part of MCPFE Class “Protective Functions”
Water	**Criterion 1**: Maintenance and appropriate enhancement of forest and their contribution to global carbon cycle **Criterion 2**: Maintenance of forest ecosystem health and vitality **Criterion 4**: Maintenance, conservation and appropriate enhancement of biological diversity in forest ecosystems **Criterion 5**: Maintenance and appropriate enhancement of protective functions in forest management (notably soil and water) 5.1 Protective forests – soil, water and other ecosystem functions Area of forest and other wooded land designated to prevent soil erosion, to preserve water resources, or to maintain other forest ecosystem functions, part of MCPFE Class “Protective Functions”
Air	**Criterion 2**: Maintenance of forest ecosystem health and vitality 2.1 Deposition of air pollutants Deposition of air pollutants on forest and other wooded land, classified by N, S and base cations

	PEOLG
Carbon and land use change	**1.2.a.** Forest management practices should safeguard the quantity and quality of the forest resources in the medium and long term by balancing harvesting and growth rates, and by preferring techniques that minimise direct or indirect damage to forest, soil or water resources.
Biodiversity	**4.1.a.** Forest management planning should aim to maintain, conserve and enhance biodiversity on ecosystem, species and genetic level and, where appropriate, diversity at landscape level. **4.2.g.** With due regard to management objectives, measures should be taken to balance the pressure of animal populations and grazing on forest regeneration and growth as well as on biodiversity.
Soil	**2.2 b.** Appropriate forest management practices such as reforestation and afforestation with tree species and provenances that are suited to the site conditions or the use of tending, harvesting and transport techniques that minimise tree and/or soil damages should be applied. The spillage of oil through forest management operations or the indiscriminate disposal of waste on forest land should be strictly avoided. **3.2.b.** Regeneration, tending and harvesting operations should be carried out in time, and in a way that do not reduce the productive capacity of the site, for example by avoiding damage to retained stands and trees as well as to the forest soil, and by using appropriate systems. **5.1.a.** Forest management planning should aim to maintain and enhance protective functions of forests for society, such as protection of infrastructure, protection from soil erosion, protection of water resources and from adverse impacts of water such as floods or avalanches. **5.2.a.** Special care should be given to silvicultural operations on sensitive soils and erosion prone areas as well as on areas where operations might lead to excessive erosion of soil

	into watercourses. Inappropriate techniques such as deep soil tillage and use of unsuitable machinery should be avoided on such areas. Special measures to minimise the pressure of animal population on forests should be taken.
Water	**1.1.a.** Forest management planning should aim to maintain or increase forest and other wooded area, and enhance the quality of the economic, ecological, cultural and social values of forest resources, including soil and water. This should be done by making full use of related services such as land-use planning and nature conservation.
	1.2.a. Forest management practices should safeguard the quantity and quality of the forest resources in the medium and long term by balancing harvesting and growth rates, and by preferring techniques that minimise direct or indirect damage to forest, soil or water resources.
	4.2.i. Special key biotopes in the forest such as water sources, wetlands, rocky outcrops and ravines should be protected or, where appropriate, restored when damaged by forest practices.
	5.1.a. Forest management planning should aim to maintain and enhance protective functions of forests for society, such as protection of infrastructure, protection from soil erosion, protection of water resources and from adverse impacts of water such as floods or avalanches.
	5.2.b. Special care should be given to forest management practices on forest areas with water protection function to avoid adverse effects on the quality and quantity of water resources. Inappropriate use of chemicals or other harmful substances or inappropriate silvicultural practices influencing water quality in a harmful way should be avoided.
	5.2.c. Construction of roads, bridges and other infrastructure should be carried out in a manner that minimises bare soil exposure, avoids the introduction of soil into watercourses and that preserve the natural level and function of water courses and river beds. Proper road drainage facilities should be installed and maintained.
Air	**2.1.b.** Health and vitality of forests should be periodically monitored, especially key biotic and abiotic factors that potentially affect health and vitality of forest ecosystems, such as pests, diseases, overgrazing and overstocking, fire, and damage caused by climatic factors, air pollutants or by forest management operations.

5.3 Appendix 3 BSI/Bonsucro

	Criteria
Carbon and land use change	**3.2** To monitor global warming emissions with a view to minimizing climate change impacts.
	EU RED: **6.2** To protect land with high biodiversity value, land with high carbon stock and peatlands.
Biodiversity	**4.1** To assess impacts of sugarcane enterprises on biodiversity and ecosystems services.
	4.2 To implement measures to mitigate adverse impacts where identified.
Soil	**5.2** To continuously improve the status of soil and water resources.
	4.2 To implement measures to mitigate adverse impacts where identified.
Water	**5.2** To continuously improve the status of soil and water resources.
	4.2 To implement measures to mitigate adverse impacts where identified.
Air	

	Indicators
Carbon and land use change	Global warming burden per unit mass product
	% Ground cover of tops or leaves after harvest
	Percent of areas defined internationally or nationally as legally protected or classified as High Conservation Value areas (interpreted nationally and officially as described in Appendix 1) planted to sugarcane after the cut off date of 1 January 2008.
	EU RED: Percentage of land with high biodiversity value, high carbon stock or peatlands planted to sugarcane after the cut off date of 1 January 2008.
Biodiversity	Existence and implementation of an environmental management plan (EMP) taking into account endangered species, habitats and ecosystems as well as reference to ecosystem services and alien invader plant and animal control.
Soil	% Ground cover of tops or leaves after harvest
	Soil surface mechanically tilled per year (% of area under cane)
	Percent fields with samples showing analyses acceptable limits
	Use of co-products does not affect traditional uses (e.g. fodder, natural fertilizer, local fuel) or affect the soil nutrient balance or soil organic matter
	Fertilizer applied according to soil or leaf analysis
	Nitrogen and phosphorus fertilizer (calculated as phosphate equivalent) applied per hectare per year
Water	Net water consumed per unit mass of product
	Herbicides and pesticides applied per hectare per year
Air	Herbicides and pesticides applied per hectare per year

5.4 Appendix 4 RSPO

	Criteria
Land use change	**Criterion 7.3** New plantings since November 2005, have not replaced primary forest or any area required to maintain or enhance one or more High Conservation Values.
Biodiversity	**Criterion 5.1** Aspects of plantation and mill management, including replanting, that have environmental impacts are identified, and plans to mitigate the negative impacts and promote the positive ones are made, implemented and monitored, to demonstrate continuous improvement.
	Criterion 5.2 The status of rare, threatened or endangered species and high conservation value habitats, if any, that exist in the plantation or that could be affected by plantation or mill management, shall be identified and their conservation taken into account in management plans and operations.
Soil	**Criterion 4.2** Practices maintain soil fertility at, or where possible improve soil fertility to, a level that ensures optimal and sustained yield.
	Criterion 4.3 Practices minimise and control erosion and degradation of soils.
	Criterion 5.3 Waste is reduced, recycled, re-used and disposed of in an environmentally and socially responsible manner.
	Criterion 7.2 Soil surveys and topographic information are used for site planning in the establishment of new plantings, and the results are incorporated into plans and operations.
	Criterion 7.4 Extensive planting on steep terrain, and/or marginal & fragile soils, is avoided.
Water	**Criterion 4.4** Practices maintain the quality and availability of surface and ground water.
	Criterion 5.3 Waste is reduced, recycled, re-used and disposed of in an environmentally and socially responsible manner.

Air	**Criterion 5.5** Use of fire for waste disposal and for preparing land for replanting is avoided except in specific situations, as identified in the ASEAN guidelines or other regional best practice. **Criterion 5.6** Plans to reduce pollution and emissions, including greenhouse gases, are developed, implemented and monitored. **Criterion 7.7** Use of fire in the preparation of new plantings is avoided other than in specific situations, as identified in the ASEAN guidelines or other regional best practice.

	Indicators
Land use change	An HCV assessment, including stakeholder consultation, is conducted prior to any conversion. Dates of land preparation and commencement are recorded
Biodiversity	**(5.1)** Documented impact assessment. Where the identification of impacts requires changes in current practices, in order to mitigate negative effects, a timetable for change should be developed. **(5.2)** Information should be collated that includes both the planted area itself and relevant wider landscape-level considerations (such as wildlife corridors). This information should cover: Presence of protected areas that could be significantly affected by the grower or miller. Conservation status (e.g. IUCN status), legal protection, population status and habitat requirements of rare, threatened, or endangered species, that could be significantly affected by the grower or miller. Identification of high conservation value habitats, such as rare and threatened ecosystems, that could be significantly affected by the grower or miller. If rare, threatened or endangered species, or high conservation value habitats, are present, appropriate measures for management planning and operations will include: Ensuring that any legal requirements relating to the protection of the species or habitat are met. Avoiding damage to and deterioration of applicable habitats. Controlling any illegal or inappropriate hunting, fishing or collecting activities; and developing responsible measures to resolve human-wildlife conflicts (e.g., incursions by elephants).
Soil	**(4.2)** Records of fertilizer inputs are maintained. Evidence of periodic tissue and soil sampling to monitor changes in nutrient status. A nutrient recycling strategy should be in place. **(4.3)** Maps of fragile soils must be available. A management strategy should exist for plantings on slopes above a certain limit (needs to be soil and climate specific). Presence of road maintenance programme. Subsidence of peat soils should be minimised under an effective and documented water management programme. A management strategy should be in place for other fragile and problem soils (e.g. sandy, low organic matter, acid sulphate soils) **(5.3)** Documented identification of all waste products and sources of pollution Safe disposal of pesticide containers. Having identified wastes, a waste management and disposal plan must be developed and implemented, to avoid or reduce pollution.

	(7.2) Soil suitability maps or soil surveys adequate to establish the long-term suitability of land for oil palm cultivation should be available. Topographic information adequate to guide the planning of drainage and irrigation systems, roads and other infrastructure should be available. **(7.4)** Maps identifying marginal and fragile soils, including excessive gradients and peat soils, should be available. Where limited planting on fragile and marginal soils is proposed, plans shall be developed and implemented to protect them without incurring adverse impacts.
Water	**(4.4)** An implemented water management plan. Protection of water courses and wetlands, including maintaining and restoring appropriate riparian buffer zones. Monitoring of effluent BOD. Monitoring of mill water use per tonne of FFB **(5.3)** Documented identification of all waste products and sources of pollution Safe disposal of pesticide containers. Having identified wastes, a waste management and disposal plan must be developed and implemented, to avoid or reduce pollution.
Air	**(5.5)** Documented assessment where fire has been used for preparing land for replanting. **(5.6)** An assessment of all polluting activities must be conducted, including gaseous emissions, particulate/soot emissions and effluent (see also criterion 4.4). Significant pollutants and emissions must be identified and plans to reduce them implemented. A monitoring system must be in place for these significant pollutants which goes beyond national compliance. The treatment methodology for POME is recorded. **(7.7)** No evidence of land preparation by burning. Documented assessment where fire has been used for preparing land for planting. Evidence of approval of controlled burning as specified in ASEAN guidelines or other regional best practice.

5.5 Appendix 5 RTRS

	Criteria
Carbon and land use change	4.1 On and off site social and environmental impacts of large or high risk new infrastructure have been assessed and appropriate measures taken to minimize and mitigate any negative impacts.
	4.4.1 After May 2009 expansion for soy cultivation has not taken place on land cleared of native habitat except under the following conditions:
	4.4.1.1 It is in line with an RTRS-approved map and system (see Annex 4.) or
	4.4.1.2 Where no RTRS-approved map and system is available:
	a) Any area already cleared for agriculture or pasture before May 2009 and used for agriculture or pasture within the past 12 years can be used for soy expansion, unless regenerated vegetation has reached the definition of native forest (see glossary).
	b) There is no expansion in native forests (see glossary)
	c) In areas that are not native forest (see glossary), expansion into native
	habitat only occurs according to one of the following two options:
	Option 1. Official land-use maps such as ecological-economic zoning are used and expansion only occurs in areas designated for expansion by the zoning. If there are no official land use maps then maps produced by the government under the Convention on Biological Diversity (CBD) are used, and expansion only occurs outside priority areas for conservation shown on these maps.
	Option 2. An High Conservation Value Area (HCVA) assessment is undertaken prior to clearing and there is no conversion of High Conservation Value Areas.
	4.3 Efforts are made to reduce emissions and increase sequestration of Greenhouse Gases (GHGs) on the farm.
Biodiversity	4.5 On-farm biodiversity is maintained and safeguarded through the preservation of native vegetation.
Soil	4.2 Pollution is minimized and production waste is managed responsibly.
	4.3 Efforts are made to reduce emissions and increase sequestration of Greenhouse Gases (GHGs) on the farm.
	5.3 Soil quality is maintained or improved and erosion is avoided by good management practices.
Water	4.2 Pollution is minimized and production waste is managed responsibly.
	5.1 The quality and supply of surface and ground water is maintained or improved.
	5.2 Natural vegetation areas around springs and along natural watercourses are maintained or re-established.
	5.5 All application of agrochemicals is documented and all handling, storage, collection and disposal of chemical waste and empty containers, is monitored to ensure compliance with good practice.
	5.6 Agrochemicals listed in the Stockholm and Rotterdam Conventions are not used.
Air	4.2 Pollution is minimized and production waste is managed responsibly.
	5.9 Appropriate measures are implemented to prevent the drift of agrochemicals to neighbouring areas.

	Indicators
Carbon and land use change	4.1.1 A social and environmental assessment is carried out prior to the establishment of large or high risk new infrastructure.
	4.1.2 The assessment is carried out by someone who is adequately trained and experi-enced for this task.
	4.1.3 The assessment is carried out in a comprehensive and transparent manner.
	4.1.4 Measures to minimize or mitigate the impacts identified by the assessment are

	documented and are being implemented.
	4.3.1 Total direct fossil fuel use over time is recorded, and its volume per hectare and per unit of product for all activities related to soy production is monitored.
	4.3.2 If there is an increase in the intensity of fossil fuel used, there is a justification for this. If no justification is available there is an action plan to reduce use.
	4.3.3 Soil organic matter is monitored to quantify change in soil carbon and steps are taken to mitigate negative trends.
Biodiversity	4.5.1 There is a map of the farm which shows the native vegetation.
	4.5.2 There is a plan, which is being implemented, to ensure that the native vegetation is being maintained (except areas covered under Criterion 4.4)
	4.5.3 No hunting of rare, threatened or endangered species takes place on the property
Soil	4.2.2 There is adequate storage and disposal of fuel, batteries, tires, lubricants, sewage and other waste.
	4.2.3 There are facilities to prevent spills of oil1 and other pollutants.
	4.3.3 Soil organic matter is monitored to quantify change in soil carbon and steps are taken to mitigate negative trends.
	5.3.1 Knowledge of techniques to maintain soil quality (physical, chemical and biological) is demonstrated and these techniques are implemented.
	5.3.2 Knowledge of techniques to control soil erosion is demonstrated and these techniques are implemented.
	5.3.3 Appropriate monitoring, including soil organic matter content, is in place.
Water	4.2.2 There is adequate storage and disposal of fuel, batteries, tires, lubricants, sewage and other waste.
	4.2.3 There are facilities to prevent spills of oil1 and other pollutants.
	5.1.1 Good agricultural practices are implemented to minimize diffuse and localized impacts on surface and ground water quality from chemical residues, fertilizers, erosion or other sources and to promote aquifer recharge.
	5.1.2 There is monitoring, appropriate to scale, to demonstrate that the practices are effective.
	5.1.3 Any direct evidence of localized contamination of ground or surface water is reported to, and monitored in collaboration with local authorities.
	5.1.4 Where irrigation is used, there is a documented procedure in place for applying best practices and acting according to legislation and best practice guidance (where this exists), and for measurement of water utilization.
	5.2.1 The location of all watercourses has been identified and mapped, including the status of the riparian vegetation.
	5.2.2 Where natural vegetation in riparian areas has been removed there is a plan with a timetable for restoration which is being implemented.
	5.2.3 Natural wetlands are not drained and native vegetation is maintained.
	5.5.1 There are records of the use of agrochemicals, including: a) products purchased and applied, quantity and dates; b) identification of the area where the application was made; c) names of the persons that carried out the preparation of the products and field application; d) identification of the application equipment used; e) weather conditions during application.
	5.5.2 Containers are properly stored, washed and disposed of; waste and residual agro-chemicals are disposed in an environmentally appropriate way.
	5.5.3 Transportation and storage of agrochemicals is safe and all applicable health, environmental and safety precautions are implemented.
	5.5.4 The necessary precautions are taken to avoid people entering into recently sprayed

	areas.
	5.5.5 Fertilizers are used in accordance with professional recommendations (provided by manufacturers where other professional recommendations are not available)
	5.6 1 There is no use of agrochemicals listed in the Stockholm and Rotterdam Conventions.
Air	4.2.1 There is no burning on any part of the property of crop residues, waste, or as part of vegetation clearance, except under one of the following conditions:
	a) Where there is a legal obligation to burn as a sanitary measure;
	b) Where it is used for generation of energy including charcoal production and for drying crops;
	c) Where only small-caliber residual vegetation from land clearing remains after all useable material has been removed for other uses.
	5.9.1 There are documented procedures in place that specify good agricultural practices, including minimization of drift, in applying agrochemicals and these procedures are being implemented.
	5.9.2 Records of weather conditions (wind speed and direction, temperature and relative humidity) during spraying operations are maintained.
	5.9.3 Aerial application of pesticides is carried out in such a way that it does not have an impact on populated areas. All aerial application is preceded by advance notification to residents within 500m of the planned application.
	5.9.4 There is no aerial application of pesticides in WHO Class Ia, Ib and II within 500m of populated areas or water bodies.
	5.9.5 There is no application of pesticides within 30m of any populated areas or water bodies.

5.6 Appendix 6 Aapresid

	Criteria
Carbon and land use change	N/A
Biodiversity	N/A
Soil	1. No Soil Disturbance / Presence of Soil Residue Cover A practice that consists in the absence of continuous soil tillage, and the presence of a permanent soil cover (crops or residues). It contributes to: Minimize soil erosion; Reduce the use of fuel; Lower carbon emissions; Improve water quality; Increase soil biological activity; Increase soil fertility; Improve productivity and yield stability; and Lower production costs. 2. Crop Rotation It means the alternation of different crops in time and space. This practice has advantages from the agronomic standpoint. It has an inhibitory effect on pathogens; It uses nutrients in a balanced way; and It improves the soil physical, chemical and biological conditions. It has an inhibitory effect on pathogens; It uses nutrients in a balanced way; and It improves the soil physical, chemical and biological conditions. 5. Strategic Crop Nutrition Adopting a rational fertilization strategy in every production unit, which not only considers the amount of nutrients to apply, but also their efficient use by crops, constitutes a challenge that will have to be fulfilled to achieve an environmentally sustainable production. The soil chemical health should be maintained or recovered. The soil nutrient balance is a good method to evaluate it, considering production strategy in a comprehensive way. As a consequence, it is key essential to conduct soil testing.
Water	3. Integrated Pest Management (IPM) It aims to optimize the control of weeds, diseases, insects and other pests, reducing the sanitary problems through different methods considering economic, social and environmental factors. It requires a deep knowledge of the pest biology as well as of the environment. The concept of “eliminating” a pest has been changed for that of “maintaining it below the economic damaging threshold”. The IPM implies a lower environmental impact and a more efficient business management. 4. Efficient and Responsible Agrochemical Management It is necessary to achieve a highly efficient application of phyto-sanitary products in all the treatments applied according to responsible agronomic decisions. This means: To choose the product with less toxicity and/or higher selectivity, which only controls the “target pest” without affecting the others; To consider the minimum time needed between the product application and harvest; To store and transport the products in a safe way; To care for workers’ health; and To manage sewage waters and containers in the right way.
Air	

5.7 Appendix 7 RSB

	Criteria
Carbon and land use change	Criterion 3a. In geographic areas with legislative biofuel policy or regulations in force, in which biofuel must meet GHG reduction requirements across its lifecycle to comply with such policy or regulations and/or to qualify for certain incentives, biofuel operations subject to such policy or regulations shall comply with such policy and regulations and/or qualify for the applicable incentives.
	Criterion 3b. Lifecycle GHG emissions of biofuel shall be calculated using the RSB lifecycle GHG emission calculation methodology, which incorporates methodological elements and input data from authoritative sources; is based on sound and accepted science; is updated periodically as new data become available; has system boundaries from Well to Wheel; includes GHG emissions from land use change, including, but not limited to above- and below-ground carbon stock changes; and incentivizes the use of co-products, residues and waste in such a way that the lifecycle GHG emissions of the biofuel are reduced.
	Criterion 3c. Biofuel blends shall have on average 50% lower lifecycle greenhouse gas emissions relative to the fossil fuel baseline. Each biofuel in the blend shall have lower lifecycle GHG emissions than the fossil fuel baseline.
Biodiversity	Criterion 7.a Conservation values of local, regional or global importance within the potential or existing area of operation shall be maintained or enhanced.
	Criterion 7.b Ecosystem functions and services that are directly affected by biofuel operations shall be maintained or enhanced.
	Criterion 7.c Biofuel operations shall protect, restore or create buffer zones.
	Criterion 7.d Ecological corridors shall be protected, restored or created to minimize fragmentation of habitats.
	Criterion 7.e Biofuel operations shall prevent invasive species from invading areas outside the operation site.
Soil	Criterion 8.a Operators shall implement practices to maintain or enhance soil physical, chemical, and biological conditions.
Water	Criterion 9.a Biofuel operations shall respect the existing water rights of local and indigenous communities.
	Criterion 9.b Biofuel operations shall include a water management plan which aims to use water efficiently and to maintain or enhance the quality of the water resources that are used for biofuel operations.
	Criterion 9.c Biofuel operations shall not contribute to the depletion of surface or groundwater resources beyond replenishment capacities.
Air	Criterion 10.a Air pollution emission sources from biofuel operations shall be identified, and air pollutant emissions minimized through an air management plan.
	Criterion 10.b Biofuel operations shall avoid and, where possible, eliminate open-air burning of residues, wastes or by-products, or open air burning to clear the land.

	Indicators
Carbon and land use change	Criterion 3 b
	The Participating Operator shall report the lifecycle GHG emissions of the feedstock or biofuel using the RSB GHG Calculation Methodology (RSB-STD-01-003-01).
	In certain instances where the RSB GHG Calculation Methodology is not available for a fuel pathway, the Participating Operator shall report the lifecycle GHG emissions of the feedstock or biofuel using an alternative, RSB-listed methodology, as indicated in the RSB GHG Calculation Methodology (RSB-STD-01-003-01).
	Criterion 3 c
	Lifecycle greenhouse gas emissions of a biofuel blend, calculated following the methodology in Criterion 3b, shall be on average 50% lower than the applicable fossil fuel baseline.

	Each biofuel in the blend shall have lower lifecycle GHG emissions, calculated following the methodology in Criterion 3b, than the applicable fossil fuel baseline. The minimum lifecycle GHG reduction of the biofuel blend, starting at 50%, shall increase over time. (progress requirements) Criterion 7a Areas identified as “no-go areas” shall not be used for biofuel operations after the 1st of January 2009, unless feedstock production or processing operations are legally authorised as part of the conservation management for the area concerned.
Biodiversity	Criterion 7a. Areas identified as “no-go areas” shall not be used for biofuel operations after the 1st of January 2009, unless feedstock production or processing operations are legally authorised as part of the conservation management for the area concerned. Participating Operators shall identify the conservation value(s) within the area of a potential or existing operation during the screening exercise of the RSB impact assessment process (Principle 2). Conversion or use of new areas for biofuel operations shall not occur prior to the screening exercise. Where conservation values of local, regional or global importance have been identified, Participating Operators shall carry out a specialized impact assessment in accordance with the Conservation Impact Assessment Guidelines (RSB-GUI-01-007-01). Biofuel operations shall prioritize areas with the lowest possible risk of impacts to the identified conservation values. Areas identified as “no-go areas” shall not be used for biofuel operations after the 1st of January 2009, unless feedstock production or processing operations are legally authorised as part of the conservation management for the area concerned. Areas that contain identified conservation values of global, regional or local importance or that serve to maintain or enhance such conservation values shall not be converted after the 1st of January 2009, or earlier as prescribed by other relevant international standards. Areas that contain conservation values of global, regional or local importance or serve to maintain or enhance such conservation values shall only be used if adequate management practices maintain or enhance the identified conversation values (e.g. sustainable biomass harvesting). Hunting, fishing, ensnaring, poisoning and exploitation of rare, threatened, endangered and legally protected species shall not occur on the operation site. Criterion 7b In accordance with the results of the impact assessment process, Participating Operators shall implement practices through the Environmental and Social Management Plan (ESMP) that maintain ecosystem functions and services both inside and outside the operational site, which are directly affected by biofuel operations. Criterion 7c In accordance with the results of the impact assessment process, buffer zones shall be protected, restored or created to avoid negative impacts from biofuel operations on areas that are contiguous to the operation site. In accordance with the results of the impact assessment process, within the operational site, buffer zones shall be protected, restored or created to avoid negative impacts from the biofuel operations on areas that contain conservation value(s) of local, regional or global importance. Criterion 7d Existing ecological corridors within the operational site shall be set-aside and protected with appropriate surrounding buffer zones. Whenever the operational site impairs the connectivity between surrounding ecosystems, ecological corridors shall be created by the operator. New ecological corridors shall be created within the operation site if it is surrounded by areas containing wildlife and there is evidence that such corridors would improve connec-

	tivity. (Progress requirement) Any ecological corridor destroyed between the 1st of January 2004 and the 31st December 2008 on or near the operation site and for which the Participating Operator is directly accountable shall be restored. (Progress requirement) Criterion 7e Participating Operators shall not use any species officially prohibited in the country of operation. If the species of interest is not prohibited in the country of operation, Participating Operators shall seek adequate information about the invasiveness of the species to be used for feedstock production, e.g. in the Global Invasive Species Database (GISD). If the species is recorded as highly invasive under similar conditions (similar climate, and similar local ecosystems, and similar soil types), this species shall not be used. If the species has not been recorded as representing a high risk of invasiveness under similar conditions (climate, local ecosystems, soil type), Participating Operators shall follow the specific steps: 1) During the feedstock selection and development, Participating Operators shall conduct a Weed Risk Assessment (WRA) to identify the potential threat of invasion. If the species is deemed highly invasive after the Weed Risk Assessment, this species shall not be used. 2) During feedstock production, Participating Operators shall set up a management plan, which includes cultivation practices that minimise the risks of invasion, immediate mitigation actions (eradication, containment or management) in case of escape of a plant species outside the operation site (possibly through the provision of a specific fund), as well as a monitoring system that checks for escapes and the presence of pests and pathogens outside the operation site. 3) During harvesting, processing, transport and trade, Participating Operators shall contain propagules in an appropriate manner on site and during transport.
Soil	Criterion 8a Soil erosion shall be minimized through the design of the feedstock production site and use of sustainable practices in order to enhance soil physical health on a watershed scale. Participating Operators shall implement practices to maintain or enhance soil organic matter on the feedstock production site. The use of agrarian and forestry residual products for feedstock production, including lignocellulosic material, shall not be at the expense of long-term soil stability and organic matter content. Where the screening exercise has triggered the need for a Soil Impact Assessment (RSB-GUI-01-008-01), Participating Operators shall: Develop a soil management plan as part of the Environmental and Social Management Plan (ESMP). Perform periodic sampling of soil on the feedstock production site to evaluate the effect of the soil management plan on the organic matter content. Where the practices included in the soil management plan are not seen during monitoring to maintain soil organic matter at the optimal level, alternative practices shall be investigated. Participating Operators shall implement measures to improve soil health, such as Conservation Agriculture practices as defined by the FAO including (progress requirement) a. Organic direct planting, b. Permanent soil cover, c. Crop rotation, or d. Fallow areas with natural or planted vegetation in order to recover natural fertility and interrupt pest life cycles.
Water	Criterion 9 a The use of water for biofuel operations shall not be at the expense of the water needed by the communities that rely on the same water source(s) for subsistence. The Participating Operator shall assess the potential impacts of biofuel operations on water

availability within the local community and ecosystems during the screening exercise of the impact assessment process and mitigate any negative impacts.

Water resources under legitimate dispute shall not be used for biofuel operations until any legitimate disputes have been settled through negotiated agreements with affected stakeholders following a free, prior and informed consent (as described in 2a and its guidance) enabling process.

Where the screening exercise has triggered the need for a Water Assessment (RSB-GUI-01-009-01), Participating Operators shall:

identify downstream or groundwater users and determine the formal or customary water rights that exist;

evaluate and document the potential impacts of biofuel operations on formal or customary water rights that exist;

respect and protect all formal or customary water rights that exist through the Environmental and Social Management Plan (ESMP) to prevent infringement of such rights. No modification of the existing rights can happen without the Free Prior and Informed Consent (as described in 2a and its guidance) of the parties affected.

Criterion 9 b

Participating Operators shall develop and implement a water management plan and integrate it into the Environmental and Social Management Plan (ESMP).

The water management plan shall be made available to the public, unless limited by national law or international agreements on intellectual property.

The water management plan shall be consistent with local rainfall conditions, not contradict any local or regional water management plans, and include the neighboring areas, which receive direct runoff from the operational site. Any negative impact on these neighboring areas shall be mitigated.

The Participating Operator shall undertake annual monitoring of the effectiveness of the water management plan.

The water management plan shall include steps for reusing or recycling waste water, appropriate to the scale and intensity of operation. (progress requirements)

Criterion 9 c

Water used for biofuel operations shall not be withdrawn beyond replenishment capacity of the water table, watercourse, or reservoir from which the water comes.

Irrigated biofuel crops and freshwater-intensive biofuel operations systems shall not be established in long-term freshwater-stressed areas, unless the implementation of:

a. good practices or

b. an adequate mitigation process that does not contradict other requirements in this standard ensures that the water level remains stable.

Participating Operators shall not withdraw water from natural watercourses to the extent that it modifies its natural course or the physical, chemical and biological equilibrium it had before the beginning of operations.

Where the screening exercise has triggered the need for a Water Assessment (RSB-GUI-01-009-01), Participating Operators shall:

Identify critical aquifer recharge areas, replenishment capacities of local water tables, watercourses, and ecosystem needs. The potential impacts of biofuel operations on any of these aspects shall be evaluated, and any negative impacts mitigated.

Define the use and share of water resources for biofuel operations in agreement with local experts and the community; any water user committees shall be consulted.

The Participating Operator shall demonstrate commitment to the improvement of water efficiency over time through the implementation of water-saving practices (progress requirements)

Criterion 9 d

Biofuel operations shall not occur on a critical aquifer recharge area without a specific authorization from legal authorities.

	Participating Operators shall implement the best available practices which aim to maintain or enhance the quality of surface and ground water resources that are used for biofuel operations to the level deemed optimal for the local system for sustained water supply, ecosystem functioning and ecological services. Adequate precautions shall be taken to contain effluents and avoid runoffs and contamination of surface and ground water resources, in particular from chemicals & biological agents. Buffer zones shall be set between the operation site and surface or ground water resources. Where the screening exercise has triggered the need for a Water Assessment (RSB-GUI-01-009-01), Participating Operators shall: determine the optimal water quality level required to sustain the system, taking into account local economic, climatic, hydrologic and ecologic conditions. For existing operations, degradation of water resources that occurred prior to certification and for which the Participating Operator is directly accountable shall be reversed. Wherever applicable, operators (except small-scale operators) shall participate in projects that aim to improve water quality at a watershed scale. (progress requirement) Waste water or runoff that contains potential organic and mineral contaminants shall be treated or recycled to prevent any negative impact on humans, wildlife, and natural compartments (water, soil). (progress requirement)
Air	Criterion 10 a An emission control plan appropriate to the scale and intensity of operations shall be included as part of the Environmental and Social Management Plan (ESMP) that identifies regard major air pollutants including carbon monoxide, nitrogen oxides, volatile organic compounds, particulate matter, sulphur compounds, dioxins and other substances recognised as potentially harmful for the environment or human health. The plan shall identify all potential air pollution sources and describe their nature. The plan shall describe any air pollution mitigation strategies that are employed, or else the rationale for not utilizing such strategies. The Participating Operator shall investigate and, whenever possible in the local context, implement Best Available Technology (BAT) to reduce air pollution, appropriate to the scale and intensity of operation. (progress requirement) Criterion 10 b A plan shall be put in place to phase out any open-air burning of leaves, straw and other agricultural residues within three years following certification. If workers' health and safety is at stake or when no viable alternative is available or affordable in the local context, if burning may prevent natural fires, or if the cultivation of the crop periodically requires burning for viability in the long term without any equivalent alternatives, limited open-air burning practices may occur. Open air burning of agricultural residues and by-products shall not occur following the phase-out plan (10.b.1). (progress requirement)

5.8 Appendix 8 SAN

	Criteria
Carbon and land use change	2. ECOSYSTEM CONSERVATION Summary of the Principle (not binding for audit purposes): Natural ecosystems are integral components of the agricultural and rural countryside. Carbon capture, crops pollination, pest control, biodiversity and soil and water conservation are just some of the services provided by natural ecosystems on farms. 2.1 Critical Criterion. All existing natural ecosystems, both aquatic and terrestrial, must be identified, protected and restored through a conservation program. The program must include the restoration of natural ecosystems or the reforestation of areas within the farm that are unsuitable for agriculture.

	2.2 Critical Criterion. The farm must maintain the integrity of aquatic or terrestrial ecosystems inside and outside of the farm, and must not permit their destruction or alteration as a result of management or production activities on the farm.
Biodiversity	2.3 Production areas must not be located in places that could provoke negative effects on national parks, wildlife refuges, biological corridors, forestry reserves, buffer zones or other public or private biological conservation areas. 2.4 The harvesting of threatened or endangered plants or species is not permitted. The certification of farms that have areas that have deforested within the two years prior to the first moment of contact regarding certification is not permitted. Cutting, extracting or harvesting trees, plants and other non-timber forest products is only allowed in instances when the farm implements a sustainable management plan that has been approved by the competent authorities, and has all the permits required by law. If no applicable laws exist, the plan must have been developed by a competent professional. 2.5 There must be a minimum separation of production areas from natural terrestrial ecosystems where chemical products are not used. A vegetated protection zone must be established by planting or by natural regeneration between different permanent or semi-permanent crop production areas or systems. The separation between production areas and ecosystems as defined in Annex 1 must be respected. 2.6 Aquatic ecosystems must be protected from erosion and agrochemical drift and runoff by establishing protected zones on the banks of rivers, permanent or temporary streams, creeks, springs, lakes, wetlands and around the edges of other natural water bodies. Distances between crop plants and aquatic ecosystems as indicated in Annex 1 must be respected. Farms must not alter natural water channels to create new drainage or irrigation canals. Previously converted water channels must maintain their natural vegetative cover or, in its absence, this cover must be restored. The farm must use and expand vegetative ground covers on the banks and bottoms of drainage canals. 2.7 The farm must establish and maintain vegetation barriers between the crop and areas of human activity, as well as between production areas and on the edges of public or frequently traveled roads passing through or around the farm. These barriers must consist of permanent native vegetation with trees, bushes or other types of plants, in order to promote biodiversity, minimize any negative visual impacts and reduce the drift of agrochemicals, dust and other substances coming from agricultural or processing activities. The distance between the crop plants and areas of human activity as defined in Annex 1 must be respected. 2.8 Farms with agroforestry crops located in areas where the original natural vegetative cover is forest must establish and maintain a permanent agroforestry system distributed homogenously throughout the plantations. The agroforestry system's structure must meet the following requirements: a. The tree community on the cultivated land consists of minimum 12 native species per hectare on average. b. The tree canopy comprises at least two strata or stories. c. The overall canopy density on the cultivated land is at least 40%. Farms in areas where the original natural vegetation is not forest – such as grasslands, savannas, scrublands or shrublands - must dedicate at least 30% of the farm area for conservation or recovery of the area's typical ecosystems. These farms must implement a plan to establish or recover natural vegetation within ten years.
Soil	9.1 The farm must execute a soil erosion prevention and control program that minimizes the risk of erosion and reduces existing erosion. The program activities must be based on the identification of soils affected by or susceptible to erosion, as well as soil properties and characteristics, climatic conditions, topography and agricultural practices for the crop. Special emphasis must be placed on controlling runoff and wind erosion from newly tilled or planted areas, as well as preventing sedimentation of water bodies. The farm must use and expand vegetative ground covers on the banks and bottoms of drainage canals to reduce erosion and agrochemical drift and runoff towards water bodies. 9.2 The farm must have a soil or crop fertilization program based on soil characteristics and properties, periodic soil or foliage sampling and analysis, and advice from a competent and

	impartial professional or authority. The number of soil or foliage samples must correspond with the size of the production area, types of soil, and variations in its properties, as well as results of previous analyses. The producer must keep the results of these analyses on the farm for a two-year period. Organic and non-organic fertilizers must be applied so as to avoid any potential negative impacts on the environment. The farm must give priority to organic fertilization using residues generated by the farm. 9.3 The farm must use and expand its use of vegetative ground cover to reduce erosion and improve soil fertility; structure and organic material content, as well as minimize the use of herbicides. There must be a vegetative ground cover establishment and expansion plan that indicates the areas with existing cover, as well as areas where cover will be established in the future. The farm must include a timeframe for these activities. 9.4 The farm must promote the use of fallow areas with natural or planted vegetation in order to recover natural fertility and interrupt pest life cycles. The farm must have a plan that indicates the fallow techniques or practices (planting, natural regeneration, etc.) and their timing. These areas must be identified in the fields and on the farm map. Burning is not allowed to prepare land. 9.5 *Critical Criterion.* New production areas must only be located on land with the climatic, soil and topographic conditions suitable for intensity level of the agricultural production planned. The establishment of new production areas must be based on land use capacity studies that demonstrate long-term production capacity. The cutting of natural forest cover or burning to prepare new production areas is not permitted.
Water	2.6 Aquatic ecosystems must be protected from erosion and agrochemical drift and runoff by establishing protected zones on the banks of rivers, permanent or temporary streams, creeks, springs, lakes, wetlands and around the edges of other natural water bodies. Distances between crop plants and aquatic ecosystems as indicated in Annex 1 must be respected. Farms must not alter natural water channels to create new drainage or irrigation canals. Previously converted water channels must maintain their natural vegetative cover or, in its absence, this cover must be restored. The farm must use and expand vegetative ground covers on the banks and bottoms of drainage canals. 4.1 The farm must have a water conservation program that ensures the rational use of water resources. The program activities must make use of the best available technology and resources. It must consider water re-circulation and reuse, maintenance of the water distribution network and the minimizing of water use. The farm must keep an inventory and indicate on a map the surface and underground water sources found on the property. The farm must record the annual water volume provided by these sources and the amount of water consumed by the farm. 4.2 All surface or underground water exploited by the farm for agricultural, domestic or processing purposes must have the respective concessions and permits from the corresponding legal or environmental authorities. 4.3 Farms that use irrigation must employ mechanisms to precisely determine and demonstrate that the volume of water applied and the duration of the application are not excessive or wasteful. The farm must demonstrate that the water quantity and the duration of the application are based on climatic information, available soil moisture, and soil properties and characteristics. The irrigation system must be well designed and maintained so that leakage is avoided. 4.4 The farm must have appropriate treatment systems for all wastewaters it generates. The treatment systems must comply with applicable national and local laws and have the respective operating permits. There must be operating procedures for industrial wastewater treatment systems. All packing plants must have waste traps that prevent the discharge of solids from washing and packing into canals and water bodies. 4.5 *Critical Criterion.* The farm must not discharge or deposit industrial or domestic wastewater into natural water bodies without demonstrating that the discharged water complies with the respective legal requirements, and that the wastewater's physical and biochemical characteristics do not degrade the receiving water body. If legal requirements do not exist, the discharged wastewater must comply with the following minimum parameters:

Water Quality Parameter	Value
Biochemical Oxygen Demand ($DBO_{5, 20}$)	Less than 50 mg/L
Total suspended solids	
pH	Between 6.0 – 9.0
Grease and oils	Less than 30 mg/L
Fecal coliforms	Absent

The mixing of wastewater with uncontaminated water for discharge into the environment is prohibited.

4.6 Farms that discharge wastewater continuously or periodically into the environment must establish a water-quality monitoring and analysis program that takes into account potential contaminants and applicable laws. The program must indicate the wastewater sampling points and frequency and the analyses to be carried out. A legally accredited laboratory must conduct all analyses. Laboratory results must be kept on the farm for at least three years. The program must comply with the following minimum requirements for analysis and sampling:

Water Quality Parameter	Wastewater discharge rate (cubic meters/day) Less than 50	Wastewater discharge rate (cubic meters/day) 50 to 100	Wastewater discharge rate (cubic meters/day) More than 100
Biochemical Oxygen Demand ($DBO_{5, 20}$)	Annual	Half-yearly	Every 3 months
Total suspended solids	Monthly	Weekly	Daily
pH	Monthly	Weekly	Daily
Grease and oils	Annual	Half-yearly	Every 3 months
Fecal Coliforms	Annual	Half-yearly	Every 3 months

4.7 *Critical Criterion.* The farm must not deposit into natural water bodies any organic or inorganic solids, such as domestic or industrial waste, rejected products, construction debris or rubble, soil and stones from excavations, rubbish from cleaning land, or other materials.

4.8 The farm must restrict the use of septic tanks to the treatment of domestic wastewater (grey water and sewage) and non-industrial wastewater to prevent negative impacts on underground or surface water. The tanks and their drainage systems must be located in soils suitable for this purpose. Their design must coincide with the volume of wastewater received and treatment capacity, and must permit periodic inspections. Wastewater from the washing of machinery used for agrochemical applications must be collected and must not be mixed with domestic wastewater or discharged to the environment without previous treatment.

4.9 If total or partial compliance with the requirements of this standard that relate directly or indirectly to the contamination of natural water bodies cannot be proven, the farm must conduct a surface-water quality monitoring and analysis program. The program must indicate the sampling points and frequency, and must be continued until it can be proven that farm activities are not contributing to the degradation of the quality of the receiving water bodies. This does not exclude monitoring and water-analysis obligations stipulated by law or as indicated by local authorities. At a minimum, the following analyses must be conducted:

	Parameter	Sampling Time
	Suspended solids	During the rainiest month of the year.
	Total nitrogen	
	Phosphorus compounds	
Air	10.2 The use of open waste dumps and open-air burning of waste is not permitted. The burning of waste products is only allowed in an incinerator designed for that purpose, based on technical studies that determined the size, optimum location and control measures for minimizing the environmental and human health impacts related to its construction and operation. The farm must have the relevant legal permits for the construction and operation of this incinerator, as well as the appropriate operating procedures.	

5.9 Appendix 9 GBEP (3rd draft)

	Criteria
Carbon and land use change	ENV 1A Life-cycle greenhouse gas emissions from bioenergy production and use, as per the methodology chosen nationally or at Community level, and reported using the GBEP Common Methodological Framework for GHG Lifecycle Analysis of Bioenergy 'Version Zero'
	ENV 6A Land use for bioenergy feedstock production - Total area of land for bioenergy feedstock production, and as compared to total, arable and cultivated land areas; and share of bioenergy land area subject to nationally defined suitability regulatory scheme for bioenergy crop expansion (e.g. agroecological zoning)
	ENV 6B Land-use change due to bioenergy feedstock production
	6B1: Share of bioenergy from non-LUC feedstocks
	6B1.1: Share of bioenergy from yield increases
	6B1.2: Share of bioenergy from residues and wastes
	6B1.3: Share of bioenergy from abandoned, unused degraded or contaminated land (i.e. land not suitable for food/feed production)
	6B2: Net annual rate of conversion of arable land caused directly by bioenergy feedstock production
	6B3: Net annual rate of conversion of pasture land caused directly by bioenergy feedstock production
	6B4: Net annual rate of deforestation and forest degradation caused directly by modern bioenergy feedstock production (i.e. excluding “traditional” bioenergy)
	6B5: Net annual rate of conversion of wetlands caused directly by modern bioenergy feedstock production
	6B6: Reduction in use of agricultural land below business as usual due to measures linked to bioenergy production (e.g. increase in livestock productivity as a result of agreements between livestock producers and bioenergy producers or cross-sectoral policy explicitly linked to bioenergy or additional increases in non-bioenergy crop yields that can be attributed to investment in bioenergy technologies)
Biodiversity	ENV 5A Conversion of areas of high biodiversity importance and ecosystems of national importance
	Area of land recognized nationally as being of high biodiversity importance and percentage of these areas converted per year
	Area of land recognized as ecosystems of national importance and percentage of these

	areas converted per year
	ENV 5B Potential impacts on biodiversity in the managed landscape - Proportion of bioenergy production areawhere negative impacts on biodiversity are reduced and/or positive impacts promoted by 1) employing cultivation and harvest systems with low impacts on biodiversity, 2) ensuring maintenance or enhancement of ecological corridors and/or buffer zones, or 3) restoring or conserving areas within and
	around production areas for biodiversity and ecosystems
	ENV 5C Potential impacts on biodiversity from the use of invasive (alien) species - Number of invasive (alien) species used for bioenergy production, and area of coverage, by risk category
Soil	ENV 2A Soil quality - Percentage area of land on which bioenergy feedstock is produced or harvested for which soil chemical, biological and physical quality is maintained or improved
Water	ENV 4A Proportion of water resources used – Water withdrawn for irrigation and process water for bioenergy production, expressed as a total volume and as percentages of total actual renewable water resources (TARWR) and of total human water withdrawals
	ENV 4B Water use efficiency - Volume of irrigation and process water used per unit of useful bioenergy output, disaggregated into renewable and non-renewable water
	ENV 4C Water quality - Influence on water quality of fertilizer and pesticide application for bioenergy feedstock cultivation and of the discharge of water effluents from processing plants
	Annual fertilizer (N and P) and pesticide application for bioenergy feedstock production:
	amount per hectare
	total volumes in watershed
	percentages of amounts applied for whole agriculture in watershed
	Total biological oxygen demand (BOD) of effluent per unit of bioenergy produced
Air	ENV 3A Emissions of non-GHG pollutants, including air toxics – Emissions of non-GHG pollutants, including air toxics, from bioenergy cultivation (land clearing and crop burning), conversion, transportation and use

5.10 Appendix 10 ISCC

	Criteria
Carbon and land use change	1.3 Biomass is not produced on land with high carbon stock
Biodiversity	1.1 Biomass is not produced on land with high biodiversity value
	1.2 Biomass is not produced on grassland with high biodiversity
Soil	Applicable outside of Europe:
	2.3.1 Field cultivation techniques used to reduce the possibility of soil erosion
	2.4.1 Soil organic matter is preserved
	2.4.2 Organic fertilizer is used according to nutritional requirements
	2.4.3 There is a restriction on burning as part of the cultivation process
	2.4.4 Techniques have been used that improve or maintain soil structure
Water	Applicable outside of Europe:
	Minor Must: 2.2.1 Natural vegetation areas around springs and natural watercourses are maintained or re-established.
	2.5.1 Mineral oil products and plant protection products are stored in an appropriate manner, which reduces the risk of contaminating the environment

	2.5.2 The producer respects existing water rights, both formal and customary, and can justify the irrigation. Local legislation is followed Minor must: 2.5.3 The producer can justify the method of irrigation used in light of water conservation Minor must 2.5.4: To protect the environment, water is abstracted from a sustainable source 2.6.1 During the application of fertilizers with a considerable nitrogen content care is taken not to contaminate the surface and ground water 2.6.2 Fertilizers with a considerable nitrogen contents are only applied onto absorptive soils 2.6.3 Records of fertilizer application 2.6.6 Fertilizers are stored in an appropriate manner, which reduces the risk of contamination of water courses 2.6.7 Fertiliser is used according to an input/output balance 2.6.8 The use of raw sewage sludge is not allowed 2.8.8 Surplus application mix or tank washings is disposed of in a way not to contaminate the ground water There are facilities to deal with spillage to avoid contamination of the ground water 2.9.1 Plant protection products are stored in accordance with local regulations in a secure, appropriate storage. Potential contamination of the ground water must be avoided 2.9.3 There are facilities to deal with spillage to avoid contamination of the ground water
Air	
	2.4.3 Burning as part of the cultivation process is not allowed without permission 2.10.6 There is a farm waste management plan. Waste recycling avoids or reduces wastage and avoids the use of landfill or burning

	Indicators
Carbon and land use change	1.3 Biomass is not produced on land with high carbon stock This means land that used to have one of the following statuses in January 2008 or thereafter and no longer had this status at the time of growing and harvesting biomass: (1) Wetlands wetlands are areas that are covered with or saturated by water permanently or for a significant part of the year. In particular all wetlands that have been included in the list of internationally important wetlands according to article 2, section 1 of the Convention of February 2nd 1971 on Wetlands of International Importance, especially as habitat for waterfowl and waders of international importance (BGBl. 1976 II S. 1266) fall into this category. Wetlands are in particular areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six meters. • Covered with water means that water is visible on the surface as water surface. • Saturated by water is a soil that shows also water at the surface, but not as a closed water surface. Areas that are permanently covered by or saturated with water show this state throughout the year. • Areas that are covered by or saturated with water during a considerable part of the year do not show this state throughout the year. A considerable part of the year means that coverage or saturation with water lasts long enough so organisms adapted to wet or reduced conditions dominate. This holds especially for shallow water, shores, peatland, low-moor bog, fen and moor. The conservation of the status of a wetland also implies that this condition is not to be changed or compromised,

(2) continuously forested areas

Continuously forested areas are areas that

• stretch over more than 1 hectare with trees higher than 5 metres and a canopy cover of more than 30%, or trees able to reach these thresholds on the respective site;

• stretch over more than 1 hectare with trees higher than 5 metres and a canopy cover of between 10% and 30%, or trees able to reach these thresholds in situ, unless reliable evidence is provided that the carbon stock of the area before and after conversion is such that the requirements regarding the greenhouse gas saving, required by ISCC, would be fulfilled.

• are forest according to the respective national legal definition.

The canopy cover is the degree of the coverage of an area by tree crowns of a storey. The coverage of a tree equals the size of its crown. The crown size can be estimated or measured. For the determination of the canopy cover of a forest in percent the vertical projection of all tree crowns must be used.

The status of forest areas includes all stages of development and age. Thus, it is quite possible that the canopy cover temporarily falls below 10 or 30 %, e.g. after tree harvest or a natural hazard (e.g. windfall). Such incidents do, however, not change the status of the area as forested area as long reforestation or natural succession is ensured within a justifiable time.

The canopy cover percentage marks the mean canopy cover of a forest area; it refers to an area of homogeneous coverage. If an area shows measurably varying coverage, it must be divided into subareas of homogeneous canopy cover to determine the mean canopy cover. The mean canopy cover is calculated from the canopy covers of the subareas.

Continuously forested areas are to be judged as entity, no matter how much of this continuously forested area lies within the farm land or the production area. Accordingly, the whole area is the basis for the calculation of the threshold values of 10 or 30%. If the total area of the forested area exceeds 1 ha and is stocked with trees higher than 5 metres, the area and each part of it that lies within the farm land or the production area is termed continuously forested area. Even if only 0.5 ha of the continuously forested area lie within the farm land, these 0.5 ha must be classified as continuously forested area just like the total forested area.

Only exceptionally can biomass be used, that has been produced on areas which had or just grew into a canopy cover of 10 to 30 % and which have been converted after January 2008. The determination and objective evidence of the carbon stock of the area before the conversion on the basis of exact measurements is necessary to prove that the greenhouse gas emission saving is fulfilled before and after the conversion.

These regulations do not apply to short rotation plantations, because they count among permanent crops and belong to farm land.

In Germany, the status of an area as forest is determined by the Federal Forest Act and the forest acts of the states. A conversion (clearance) of forest to other land-use is only allowed after authority approval. Wood is generally suitable as biomass grown according to the Sustainability Ordinance if harvested from a soundly and sustainably managed forest in Germany.

The provisions in this control point shall not apply if at the time the raw material was obtained, the land had the same status as it had in January 2008.

Biodiversity

4.1.1 Biomass is not produced on land with high biodiversity value

This means land that had one of the following statuses in or after January 2008, no matter whether or not the land still has this status:

(1) Forest land

Forest land comprises primary forests and other natural areas that are covered with native tree species and do not show clearly visible indications of human activity and the ecological processes are not significantly disturbed.

Tree species are defined as native, if they grow within their natural geographical range on sites and under climatic conditions to which they have adapted naturally and without human interference.

The following tree species do not count as native:

• Tree species that have been introduced by humans and that would not occur in that area otherwise; and

• tree species and breeds that would not occur on these sites or under these climatic conditions, even if these sites or climatic conditions generally fall within the larger geographical range of the species.

Clearly visible indications of human activity are:

• Land management (i.e. wood harvest, forest clearance, land use change),

• heavy fragmentation through infrastructural constructions such as roads, power lines,

• Disturbances of the natural biodiversity (e.g. significant occurrence of non-native plant or animal species).

Activities of indigenous people or other humans managing the land in a traditional way do not count as clearly visible indications of human activity, if they manage the forest on a subsistence level and their influence on the forested area is minimal (e.g. the collection of wood and non-timber products, the felling of a few trees as well as small-scale forest clearance according to traditional management systems).

(2) Areas designated by law or by the relevant competent authority to serve the purpose of nature protection

Areas for nature protection purposes comprise areas that are designated by law or by the relevant competent authority to serve the purpose of nature protection as well as ISCC 202 Sustainability Requirements 7 of 31 areas that have been acknowledged by the European Commission as areas for the protection of rare, threatened or vulnerable ecosystems or species.

In Germany, all areas designated to serve the purpose of nature protection are protected parts of nature and landscape on the basis of the nature conservation acts of the states. They include the biotopes protected by federal or state law as well as Natura 2000 areas, nature conservation areas, national parks, national natural monuments, biosphere reserves, landscape protection areas, natural parks, natural monuments and protected landscape elements according to the Federal Act for the Protection of Nature of July 29th 2009 (BGBl. I, S. 2542) entering into force on March 1st 2010. Comparable legal regulations must be regarded in other countries.

It is allowed to grow biomass on areas that serve the purpose of nature protection as long as the cultivation and the harvest of the biomass do not compromise the defined protection purpose. The protection purpose and the respective imperatives and interdictions must be followed according to the relevant protected area declaration. As long as a Natura 2000 area has not been placed under protection order, the relevant preservation objectives are authoritative.

(3) areas for the protection of rare, threatened or endangered ecosystems or species recognised by international agreements or included in lists drawn up by intergovernmental organisations or the International Union for the Conservation of Nature.

4.1.2 Biomass is not produced on grassland with high biodiversity

Grassland of high biodiversity is defined as grassland which in the absence of human intervention would:

(1) remain grassland of intact natural species composition, ecological characteristics and processes (natural grassland); or

(2) not remain grassland and which is rich in species and not degraded (artificial grassland),

unless there is evidence that the harvesting of the biomass is necessary to preserve its grassland status.

Natural grassland develops under certain climatic and other factors (e.g. natural grazing, natural fires) preventing succession to dense forest. Its special characteristic is to remain grassland without any effort of humans.

Natural grassland with high biological diversity is characterized by intact ecological characteristics and processes as well as a natural species composition. A significant occurrence of invasive species, for instance, could indicate that a natural grassland does not feature a natural species composition. A disturbance of ecological characteristics and processes can be caused by a significant change through humans, for instance. As long as this influence does not cause a change in the natural species composition or a significant disturbance of the ecological characteristics and processes, an area is still to be regarded as natural grassland.

In savannahs, for instance, extensive pasturing and anthropogenic fire do not pose a significant disturbance.

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Artificially created grassland is mainly agricultural land permanently cultivated for green fodder; it can be permanent grassland such as meadows, mowing pastures and grazing pastures.

Biomass can not be harvested from areas that have been declared natural grassland of high biodiversity in January 2008 or thereafter. Whereas biomass is allowed to be harvested from artificially created grassland with high biodiversity, in case the preservation of the grassland status requires the harvest of the biomass.

Local conditions of species richness must be regarded when evaluating whether a grassland features high biodiversity. Here, species richness must be assessed along the lines of the bio geographical conditions and site conditions (e.g. a species inventory for that region, if available).

In case, of a land-use change from a grassland without high biodiversity, the greenhouse gas emissions caused by that change must be incorporated into the greenhouse gas emissions calculation.

As long as no geographic areas featuring grassland with high biodiversity are determined, natural grassland is generally not allowed to be used for biomass production. Neither can artificially created grassland with high biodiversity be used.

In case artificially created grassland areas are not permanently managed as grassland, but form part of a crop rotation system (fallow, rotations of pasture and cropping), they are to be treated as farmland on which biomass can be grown and used according to the sustainability ordinances. Set-aside farmland still counts as agriculturally managed land. The right to use this land after termination of the set-aside period in the same way and to the same extent endures. This holds also for areas that have changed in the course of the set-aside period.

Thus, grassland areas that have evolved on former set-aside areas are generally suitable for the production of biomass.