



BioTrade2020plus

Supporting a Sustainable European Bioenergy Trade Strategy

**Intelligent Energy Europe
IEE/13/577/SI2.675534**

Deliverable 2.3

**REPORT ON THE ASSESSMENT OF CRITERIA AND INDICATORS IN
EXISTING SUSTAINABILITY SCHEMES FOR LIGNOCELLULOSIC
FEEDSTOCKS**

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The BioTrade2020plus Project

Objectives

The main aim of BioTrade2020plus is to provide guidelines for the development of a **European Bioenergy Trade Strategy for 2020 and beyond** ensuring that imported biomass feedstock is sustainably sourced and used in an efficient way, while avoiding distortion of other (non-energy) markets. This will be accomplished by analyzing the potentials (technical, economical and sustainable) and assessing key sustainability risks of current and future lignocellulosic biomass and bioenergy carriers. Focus will be placed on wood chips, pellets, torrefied biomass and pyrolysis oil from current and potential future major sourcing regions of the world (Canada, US, Russia, Ukraine, Latin America, Asia and Sub-Saharan Africa).

BioTrade2020plus will thus provide support to the use of stable, sustainable, competitively priced and resource-efficient flows of imported biomass feedstock to the EU – a necessary pre-requisite for the development of the bio-based economy in Europe.

In order to achieve this objective close cooperation will be ensured with current international initiatives such as IEA Bioenergy Task 40 on “Sustainable International Bioenergy Trade - Securing Supply and Demand” and European projects such as Biomass Policies, S2BIOM, Biomass Trade Centers, DIA-CORE, and PELLCERT.

Activities

The following main activities are implemented in the framework of the BioTrade2020plus project:

- Assessment of **sustainable potentials of lignocellulosic biomass** in the main sourcing regions outside the EU
- Definition and application of sustainability criteria and indicators
- Analysis of the main economic and market issues of biomass/bioenergy imports to the EU from the target regions
- Development of a dedicated and **user friendly web-based GIS-tool** on lignocellulosic biomass resources from target regions
- **Information to European industries** to identify, quantify and mobilize sustainable lignocellulosic biomass resources from export regions
- **Policy advice on long-term strategies** to include sustainable biomass imports in European bioenergy markets
- **Involvement of stakeholders** through consultations and dedicated workshops

More information is available at the BioTrade2020plus website: www.biotrade2020plus.eu

About this document

This report corresponds to Deliverable 2.3 – Report on the assessment of criteria and indicators in existing sustainability schemes for lignocellulosic feedstocks. It has been prepared by IINAS.

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RE	Restricted to a group specified by the consortium (including the Commission Services):	
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Acronyms and Abbreviations

2G	2 nd generation (or advanced) biofuels
ASI	Regional Initiative for the Development and Implementation of National Level Criteria and Indicators for the Sustainable Management of Dry Forests in Asia
ATO	African Timber Organization
BE	Belgium
BEE	Biomass Energy Europe project
BMELV	German Federal Ministry of Food, Agriculture and Consumer Protection (until 2013)
BMEL	German Federal Ministry of Food and Agriculture (from 2014 onwards)
BMP	Best Management Practices (US)
Bonsucro EU	Bonsucro scheme aimed to show compliance with the EU Renewable Energy Directive's requirements
C&I	Criteria and Indicators
CAP	Common Agricultural Policy
CAPEX	Capital expenditures
CBD	Convention on Biological Diversity
CEN	European Committee for Standardization
CENBIO	Centro Nacional de Referência em Biomassa (Brazil)
CFS	Committee on World Food Security
CILSS	Permanent Interstate Committee for Drought Control in the Sahel
CL	Country Level
DK	Denmark
EC	European Commission
EFI	European Forest Institute
EMBRAPA	Brazilian Agricultural Research Corporation
EP	European Parliament
EPA	US Environmental Protection Agency
EU	European Union
EU ETS	European Emissions Trading System
EU MS	European Union Member State
EU TR	European Union Timber Regulations
FAO	Food and Agriculture Organization of the United Nations
FCCC	Framework Convention on Climate Change
FLEGT	Forest Law Enforcement, Governance and Trade

FSC	Forest Stewardship Council
FMU	Forest Management Unit
GBEP	Global Bioenergy Partnership
GEF	Global Environment Facility
GGL	Green Gold Label
GHG	greenhouse gas(es)
GIS	Geographical Information System
GMO	genetically modified organisms
IAS	Invasive Alien Species
IDB	Inter-American Development Bank
IEA	International Energy Agency
IINAS	International Institute for Sustainability Analysis and Strategy
ILO	International Labor Organization
iLUC	indirect land use change(s)
INFRES	Innovative and effective technology and logistics for forest residual biomass supply in the EU
INRA	Institut National de la Recherche Agronomique (FR)
INRO	Initiative on Sustainable Supply of Raw Materials for the Industrial Use of Biomass
IPCC	Intergovernmental Panel on Climate Change
ISCC	International Sustainability Carbon Certification
ISCC-EU	International Sustainability Carbon Certification scheme to show compliance with the EU Renewable Energy Directive's requirements
ISCC PLUS	International Sustainability Carbon Certification for food and feed products as well as for technical/chemical applications and applications in the bioenergy sector
ISO	International Organization for Standardization
ITTO	International Tropical Timber Organization
JR	Joanneum Research
Logistec	Logistics for Energy Crops Biomass
MCFPE	Ministerial Conference on the Protection of Forests in Europe
NEN	Netherlands Standardization Institute
NL	The Netherlands
NLBI	Non-legally Binding Instrument on all types of Forests
OPEX	Operating expense
PEFC	Program for the Endorsement of Forest Certification
RED	Renewable Energies Directive 2009/28/EC

RFS	Renewable Fuel Standard
RPS	Renewable Portfolio Standard
RSB	Roundtable on Sustainable Biomaterials
RSPO	Roundtable on Sustainable Palm Oil Production
RSPO RED	Roundtable on Sustainable Palm Oil Production. Scheme aimed to show compliance with the EU Renewable Energy Directive's requirements
RTRS	Roundtable on Responsible Soy
RTRS RED	Roundtable on Responsible Soy. Scheme aimed to show compliance with the EU Renewable Energy Directive's requirements
SADC	Southern African Development Community
SAFA	Sustainability Assessment of Food and Agriculture systems
SAN	Sustainable Agriculture Network
SBP	Sustainable Biomass Partnership
SFI	Sustainable Forestry Initiative
SFM	Sustainable Forest Management
SRC	Short Rotation Woody Crops
ToSIA	Tool for Sustainability Impact Assessment
UK	United Kingdom
UNEP	United Nations Environment Programme
VGGT	Voluntary Guidelines on the Responsible Governance of Tenure of Land, Fisheries and Forests in the Context of National Food Security
WB	World Bank
WP	Work Package
WWF	World Wildlife Fund

1. INTRODUCTION AND OBJECTIVES

Work Package (WP) 2 of the BioTrade2020plus project examines the “availability and sustainability of biomass in target regions”. Task 2.2 “Sustainability criteria and indicators (definition and application)”, elaborates on the following deliverables:

- D2.3 Report on the assessment of criteria and indicators in existing sustainability schemes for lignocellulosic feedstocks (this report).
- D2.4 Report on the updated sustainability criteria to be considered for bioenergy (including social, political and institutional as well as environmental and economic aspects) for 2020 and 2030.
- D2.5 Report on the issues conditioning the operability of the sustainability schemes including the impact on costs.

The main aim of this deliverable (D 2.3) is to identify a comprehensive list of sustainability criteria and indicators (C&I) that might be relevant for the purposes of BioTrade2020plus. This project targets lignocellulosic biomass in selected countries around the world, including: Brazil (Atlantic Corridor), Colombia, Kenya and Mozambique, Malaysia and Indonesia, Ukraine (Central-Western) and United States (South East). The targeted feedstocks within the scope of the project are:

- Primary and secondary forest residues
- Primary and secondary agricultural residues
- Surplus land as the basis for existing forest plantations, new forest plantations and dedicated biomass crops.

Not all feedstocks are equally relevant in the selected countries. Thus, for each country the most relevant feedstocks (or surplus land) are selected.

The findings of this deliverable will be used further to elaborate the approach to sustainability in the project and, more particularly, the list of C&I to be included in D2.4. These outcomes will be later applied in the work of WP3 (analysis of the market and demand) and WP4 (interactive tool).

The BioTrade2020plus is being carried out in parallel to another EU research project under the FP7 framework: Delivery of sustainable supply of non-food biomass to support a “resource-efficient” Bioeconomy in Europe – S2Biom¹. This project is focused on the EU level and neighboring countries even if also considers imports from third countries. S2Biom has a specific WP addressing the “Value chain sustainability across the biobased sectors”. This WP aims to provide an improved understanding among decision-makers in policy and industry regarding sustainability requirements. Efforts in both projects have been aligned with the purpose of offering a coherent approach to non-food biomass sustainability.

Given this, work on this deliverable benefited from previous efforts developed in Deliverable 5.2 of S2Biom project “Benchmark and gap analysis of criteria and indicators (C&I) for legislation, regulations and voluntary schemes at international level and in selected EU Member States” (Iriarte & Fritsche 2015a). The S2Biom deliverable identified and benchmarked sustainability requirements in a broad variety of schemes (and regulations) in

¹ www.s2biom.eu

the agriculture, forestry and bioenergy sectors as well as other relevant sectors of the bioeconomy.

Patterns (occurrence of any requirement or sustainability indicator) within the selected schemes and sectors and gaps were also analyzed. The C&I identified in that work have been the starting point for this report.

Complementarily, the work presented here considered efforts from other activities in third countries as well as on-going research projects with particular focus on lignocellulosic biomass that could enhance the approach to sustainability to be developed within this project.

This BioTrade2020plus deliverable meets two objectives:

- It identifies **general** sustainability indicators for non-food biomass that allow for a comprehensive overview of concerns and requirements with respect to biomass sustainability.
- It compiles **specific** indicators for lignocellulosic biomass to deepen associated sustainability concerns, and respective requirements.

This compilation will contribute to further develop the so-called “umbrella approach” that considers all biomass feedstocks and conversion processes leading to different end-uses should be subject to the same sustainability considerations to avoid market distortions.

The deliverable is structured as follows:

- **Section 2** describes the schemes selected (including regulations and efforts from research projects) to identify relevant sustainability C&I.
- **Section 3** draws various approaches to sustainability
- In **Section 4**, general and specific sustainability requirements (and relevant regulations in third countries) for lignocellulosic biomass are described.
- **Section 5** shows the recommendations and conclusions, including a compilation of sustainability requirements.

The last section provides the references.

In the external **Annex**, a comprehensive recompilation of sustainability requirements in various schemes and research projects is provided.

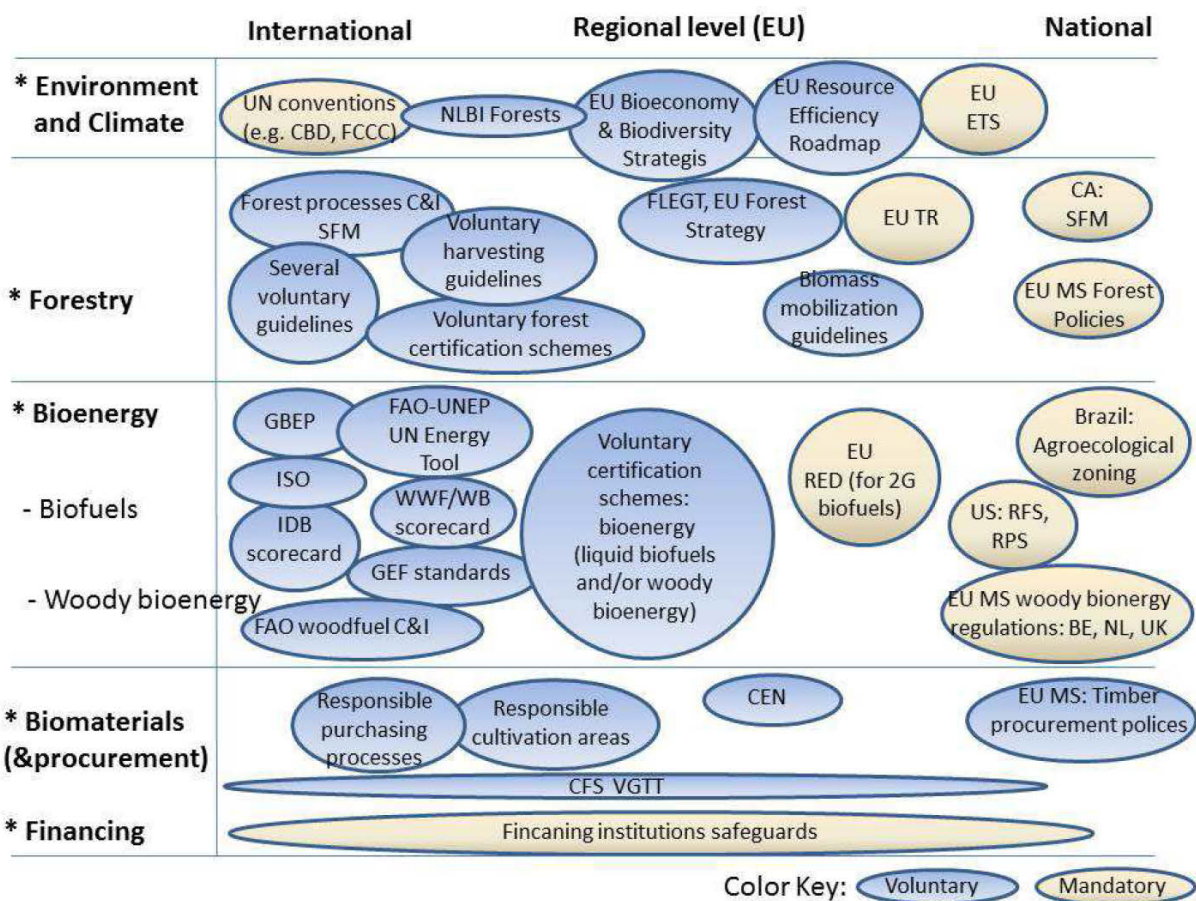
2. IDENTIFICATION OF RELEVANT SCHEMES

During last years, many actors, from different sectors and with different purposes, have developed a variety of activities targeting directly or indirectly biomass sustainability.

Figure 1 illustrates a (non-exhaustive) compilation of some of the efforts developed from different angles and with different geographical scopes with particular attention to solid bioenergy. As discussed by Fritsche & Iriarte (2014) these activities are very diverse and the following characteristics can be distinguished:

- Type of scheme or regulation: mandatory or voluntary;
- Type of bioenergy: biofuels vs. solid vs. all types (including gaseous);
- Application level: international, regional or national;
- Sector of origin: energy, forestry, agriculture or others;
- Scope of sustainability: environmental vs. holistic approach (i.e. including social and economic requirements).

Figure 1 Map of selected initiatives related to sustainability of solid bioenergy



Source: IINAS, EFI, JR (2014)

Note: From left to right and from top to bottom (see also Acronyms) - UN conventions: CBD, FCCC; NLBI Forests (Non-legally Binding Instrument on all types of Forests), EU ETS (EU Emissions Trading System), Forest processes on (sustainability C&I) for SFM, FLEGT (Forest Law Enforcement, Governance and Trade), EU TR (EU Timber Regulation), CA SFM regulations, EU MS forest policies, GBEP, FAO, UNEP, ISO, WWF/World Bank scorecard, IDB Scorecard, GEF standards, EU RED for 2G (2nd generation or advanced) biofuels, US: RFS (Renewable Fuel Standard), RPS (Renewable Portfolio Standard), EU MS woody bioenergy regulations, CFS, VGGT, CEN

The variety of initiatives responds to different necessities and visions and reflects a broad range of concerns and respective approaches to sustainability. Hence, these activities apply different sustainability C&I. This proliferation might cause several inconveniences as discussed by Pelkmans et al. (2013) and at the same time offers various opportunities.

This report has benefited from the compilation of sustainability requirements in various sectors of the bioeconomy (forestry, agriculture, bioenergy, waste, etc.) made in the S2Biom project (Iriarte & Fritsche 2015a). In Table 1, a selection of representative schemes and regulations of these sectors is presented. This selection pays particular attention to those initiatives relevant in the EU context, even if some international initiatives are also considered.

Some of these activities are more relevant for the main product (out of the cultivation) than for the residues that could be subject for bioenergy. Nonetheless, all the requirements captured in the schemes have been included here in order to have an extensive compilation of sustainability requirements that could be useful in other parts of the project.

Table 1 Identified Sustainability Schemes and Regulations in Biomass Supply and Use Sectors.

Scheme or Regulation	Reference	Sector	Geographical scope	Type of scheme
SAFA- Sustainability Assessment of Food and Agriculture systems	FAO 2013	Agriculture	International	International voluntary sustainability assessment
SAN- Sustainable Agriculture Network	SAN 2010	Agriculture	International	Voluntary certification
RSPO- Roundtable on Sustainable Palm Oil (Agriculture + Bioenergy)	RSPO 2013a+b	Agriculture / Bioenergy	International	Voluntary certification
RTRS- Round Table on Responsible Soy (Agriculture + Bioenergy)	RTRS 2013a+b	Agriculture / Bioenergy	International	Voluntary certification
Bonsucro- Better Sugarcane Initiative	Bonsucro 2014	Agriculture / Bioenergy	International	Voluntary certification
CAP- Common Agricultural Policy	EU 2013a-c; EU 2014a+b	Agriculture	EU-28	EU legislation
EU organic production	EU 2007+ 2008a	Agriculture	EU-28	EU legislation
FSC- Forest Stewardship Council	FSC 2014	Forest	International	Voluntary certification

Scheme or Regulation	Reference	Sector	Geographical scope	Type of scheme
PEFC- Programme for the Endorsement of Forest Certification	PEFC 2012	Forest	International	Voluntary certification
SFI- Sustainable Forestry Initiative	SFI 2015	Forest	North America	Voluntary certification
Tarapoto (Forest Management Unit level and National Level)	FAO 2008	Forest	International	International process
ITTO- International Tropical Timber Organization (Forest Management Unit level and Country Level)	FAO 2008	Forest	International	International process
ASI- Regional Initiative for the Development and Implementation of National Level Criteria and Indicators for the Sustainable Management of Dry Forests in Asia (Country Level)	FAO 2008	Forest	International	International process
ATO- African Timber Organization (Country Level)	FAO 2008	Forest	International	International process
CILSS- Permanent Interstate Committee for Drought Control in the Sahel (Country Level)	FAO 2008	Forest	International	International process
SADC- Southern African Development Community (Country Level)	FAO 2008	Forest	International	International process
Lepaterique (Country Level)	FAO 2008	Forest	International	International process
Near East Process (Country Level)	FAO 2008	Forest	International	International process
MCFPE- Ministerial Conference on the Protection of Forests in	FAO 2008	Forest	International	International process

Scheme or Regulation	Reference	Sector	Geographical scope	Type of scheme
Europe (Forest Europe) (Country Level)				
Montreal Process (Country Level)	FAO 2008	Forest	International	International process
EU Forest Strategy	EC 2013	Forest	EU level	EU Strategy
EU Timber Regulation	EU 2010	Forest	EU level	EU Regulation
GBEP- Global Bioenergy Partnership	GBEP 2011	Bioenergy	International	International process
RED – EU Renewable Energy Directive	EU 2009	Bioenergy	EU level	EU Regulation
National schemes for solid bioenergy (BE, DK, NL, UK)	Pelkmans et al. 2012; Iriarte, Fritsche, Pelkmans 2014a; NEN 2014	Bioenergy	EU country level	EU regulations
Other EU MS regulations related to solid bioenergy	Pelkmans et al. 2012	(Related to bioenergy)	EU country level	EU MS regulations or guidelines
Non-EU countries bioenergy regulations	e.g. Goovaerts et al. 2013; CENBIO 2013; Schut, Slingerland, Locke 2010	Bioenergy	National various	Non-EU regulations
Voluntary guidelines for forest residue harvesting	Fritsche et al. 2014	(Forest) Bioenergy	National (various)	Voluntary guidelines
Guidelines for ash recycling	Swedish Forest Agency 2008	(Forest) Bioenergy	Sweden	EU MS guidelines
Guidelines for woodwaste combustion	Alakangas 2014	(Forest) Bioenergy	Finland	EU MS guidelines

Scheme or Regulation	Reference	Sector	Geographical scope	Type of scheme
RSB- Roundtable on Sustainable Biomaterials	RSB 2010+2011	Bioenergy (include bioproduct)	International	Voluntary certification
SBP- Sustainable Biomass Partnership	SBP 2014	Bioenergy	International	Voluntary certification
Greenergy	Greenergy 2011	Bioenergy	International	Voluntary certification
ISCC EU- International Sustainability and Carbon Certification	ISCC 2015	Bioenergy (include bioproducts)	International	Voluntary certification
GGL-Agri- Green Gold Label Program. Agricultural source	GGL 2013a	Bioenergy	International	Voluntary certification
GGL-Forest- Green Gold Label Program. Forest Management	GGL 2013b	Bioenergy	International	Voluntary certification
EU Biodiversity Strategy	EU 2012	Other	EU level	EU Strategy
EU Waste Directive	EU 2008b	Other	EU level	EU Legislation
EU Resource Efficiency Strategy	EC 2011	Other	EU level	EU Strategy
EU Bioeconomy Strategy	EC 2012a	Other	EU level	EU Strategy
German Biorefinery Roadmap	BMELV 2012	Other	EU MS	MS Strategy

Source: Iriarte & Fritsche (2015a); FMU = Forest Management Unit; CL = Country level; MS = Member State

In addition, this deliverable took also into account other international efforts that regard specifically to lignocellulosic biomass sustainability, including:

- Best Harvesting Practices in the United States
- Environmental Zoning for Eucalyptus in Brazil
- International Sustainability Carbon Certification (ISCC) Add-on for SRC
- ToSIA - Tool for Sustainability Impact Assessment
- Requirements for lignocellulosic crops in research projects, including:
 - INFRES: ‘Innovative and effective technology and logistics for forest residual biomass supply in the EU’
 - Logistec: Logistics for Energy Crops Biomass

- SRCplus: Short Rotation Woody Crops (SRC) plantations for local supply chains and heat use

There are other initiatives that are related to the work on sustainability to be developed in this project that were partially considered due to various reasons:

- The „Initiative on Sustainable Supply of Raw Materials for the Industrial Use of Biomass (INRO)“ has elaborated sustainability C&I for the production of raw material by agriculture up to the primary distributors. These indicators are not considered here since they are based to a large extent on the EU RED and still sustainability requirements for raw materials consisting of wood or waste products have not been elaborated (INRO 2013).
- The Global Environment Facility (GEF 2012) has published the report entitled „Global Assessments and Guidelines for Sustainable Liquid Biofuel Production in Developing Countries“. Given the lack of specificity for lignocellulosic feedstocks, sustainability requirements have not been included here².
- In the US there are other approaches such as US Renewable Fuel Standard (RFS2)³ and the California Low Carbon Fuel Standard that in addition to determining boundaries (they differentiate what is sustainable and what it is not) apply a “performance based approach”. The RFS2 requires that each category of renewable fuel emit fewer GHG emissions than the petroleum fuel it replaces and sets specific GHG threshold for each renewable fuel type. Also, the RFS2 sets restrictions on the type of feedstock and the types of land that can be used to grow and harvest the feedstock (Goovaerts et al. 2013). The biofuels categories (renewable fuel, advanced biofuel, biomass-based diesel, and cellulosic biofuel) are defined based on the nature of feedstock/technology, the production process used, and minimum GHG reduction thresholds obtained. The definition (requirements) of renewable biomass limits the types of biomass as well as the type of land from which biomass may be harvested to produce compliant renewable fuels. There are seven types of feedstock that qualify as “renewable biomass” (EPA 2010):
- Planted crops and crop residue from agricultural land cleared prior to December 19, 2007 and actively managed or fallow on that date.
- Planted trees and tree residue from tree plantations cleared prior to December 19, 2007 and actively managed on that date.
- Animal waste material and byproducts.
- Slash and pre-commercial thinnings from non-federal forestlands that are neither old-growth nor listed as critically imperiled or rare by a State Natural Heritage program.
- Biomass cleared from the vicinity of buildings and other areas at risk of wildfire.
- Algae.
- Separated yard waste and food

The definition of renewable biomass incorporates land restrictions for planted crops and crop residue, planted trees and tree residue, slash and pre-commercial thinnings, and biomass from wildfire areas.

² Nevertheless, this project thresholds proposed here as well as in the Biomass Futures project were considered in D2.4 of the BioTrade2020plus project.

³ <http://www.epa.gov/oms/fuels/renewablefuels/index.htm>

3. APPROACHES TO SUSTAINABILITY

Prior discussing particular sustainability indicators that might be of interest for assuring sustainability of lignocellulosic feedstocks (and respective bioenergy carriers), as it will be provided in Section 4, this report has made an effort to distinguish between the various approaches to address sustainability. This is aimed to provide clarity and guidance when sustainability assessments are performed.

To propose specific sustainability indicators for lignocellulosic biomass, it is important to clarify the objectives that these indicators should meet. Indicators have a clear purpose in any sustainability approach (e.g. tailored to a feedstock, geographical context or value chain) and hence might be only relevant in a particular context or for a specific purpose.

As extensively discussed in D2.4 of this project and already discussed by Iriarte & Fritsche (2015b), there are several aspects that have to be differentiated in a biomass sustainability assessment:

- **Scope** of the assessment (i.e. value chains or biomass potentials),
- **Ambition** of the sustainability (“sustainability” might refer to different indicators addressing various topics, and respective thresholds so the “ambition” might be diverse).
- In both cases, several **types of indicators** (different categories) can be distinguished: minimum requirements, and reporting indicators (comparative with non-renewable reference, comparative with biomass reference, and descriptive indicators).

Depending on the scope of the indicators, it is possible to distinguish between (Iriarte, Fritsche 2015a)⁴:

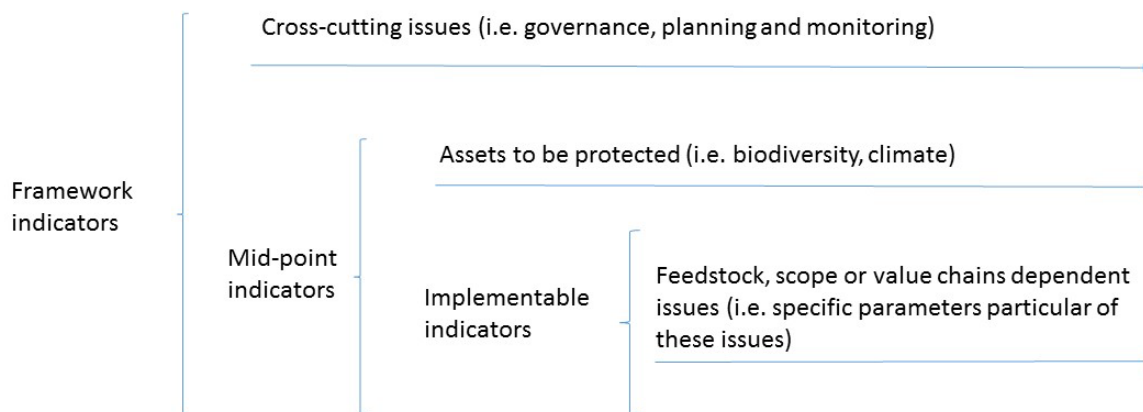
- **Framework indicators** are general cross-cutting requirements that might apply to several C&I, i.e. compliance with laws or planning and monitoring. This framework issues are too general for the purposes of the sustainability work of the BioTrade2020plus so they are not discussed here⁵.
- **Mid-points indicators** are those requirements that aim to address goods or commons to be maintained or protected (i.e. “Biodiversity cultivation and management”)
- **Implementable indicators**, aim to delineate concrete indicators adapted to various feedstocks or value chains, based on the mid-point indicators. In this category, cross-cutting requirements that could affect to several mid-point indicators are also included.

Figure 2 illustrates the architecture of the various types of indicators.

⁴ The different types of indicators and their applicability have been extensively discussed in D2.4 of the project.

⁵ For a detailed compilation of framework requirements within various schemes see Iriarte & Fritsche (2015a)

Figure 2 Conceptualization of the types of indicators



Source: own elaboration based on Iriarte & Fritsche (2015a)

Complementing these provisions, we can also distinguish between various overall approaches to promote or assess sustainability:

- There are schemes or regulations where a list of “**minimum requirements**” that have to be met are delineated (e.g. with respect to GHG emissions savings),
- **Performance** based approaches that give more incentives to that value chains with “better results” (e.g. in terms of feedstocks used, GHG emissions savings achieved),
- **Combined approaches.** In some voluntary certification schemes, we can distinct between “core indicators” and “complementary indicators”. In some voluntary certification schemes (e.g. Bonsucro, SAN, RSPO) indicators are classified depending on their relevance for certification. Thus, while achieving compliance with some indicators is a must, complying with other indicators is voluntary. Each scheme has different nomenclature and specifications for each type of indicator.

For instance, in order to achieve certification with the Bonsucro Production Standard, full compliance with the 16 “core indicators” is required plus a minimum satisfaction of 80 % of all the indicators (Bonsucro 2014). To obtain or maintain the certification under the SAN (SAN 2010), farms must comply with at least 50% of the applicable criteria of each principle and at least 80% of the total applicable criteria of the Standard. Furthermore, a farm must fully comply with a “critical criterion” to be certified or to maintain certification, otherwise the farm will not be certified, or certification will be cancelled, even if all other certification requirements have been met.

- **Voluntary guidelines.** Different organizations (including Governments) have developed recommendations or voluntary guidelines for different activities related to biomass harvesting, use and corresponding activities. For instance, the Swedish Forest Agency (2008) developed “Recommendations for extraction of harvesting residues and ash recycling”. This is also the case for the Best Harvesting Practices in the US (see section 3.2).

These different approaches have to be kept in mind to avoid confusion in the interpretations.

4. SUSTAINABILITY REQUIREMENTS

Based on the initiatives identified in Section 2, and the work in parallel to this deliverable developed in D2.4, two types of indicators have been identified:

- General sustainability indicators for non-food biomass (Section 4.1)
- Specific indicators for lignocellulosic biomass (4.2)

4.1 General Sustainability C&I

This section depicts the proposed mid-point sustainability C&I. This set is composed by 12 criteria and 27 indicators that consider the environment, social and economic dimensions. This list of indicators provides the umbrella approach to any non-food biomass and is based on an extensive compilation of indicators and requirements already in place in several schemes (see D2.4).

In the environment dimension:

Criterion: Resource use

- Land use efficiency (biomass including by- and co-products along life cycles, per hectare of cultivated area)
- Secondary resource efficiency (heating value of biomass output divided by heating value of secondary resource; applies to conversion of residues and wastes)
- Energy efficiency (cumulative energy requirements; all inputs based on LHV primary energy) compared to outputs)
- Functionality (economic value of outputs (€/GJ and €/ton, compared to economic value of heat which could be produced from burning primary inputs; reference = heat from NG ~ 10€/GJ; economic values excluding taxes for industrial customers)

Criterion: Climate change

- Life cycle-based CO₂eq incl. direct land use change (GHG emissions along value chains, i.e. cropping & harvesting, logistics, pre-treatment, conversion, distribution, end-use) in relation to final output (combination of electricity, heat, biofuels & biomaterials)
- Other GHG emissions (from indirect land use changes and carbon stock changes in forests)

Criterion: Biodiversity

- Protected areas and land with significant biodiversity value (categories established by the RED, but also High Conservation Value and High Nature Value areas)
- Biodiversity conservation and management ("Agrobiodiverse cultivation" such as crop rotation, diversity in the landscape, avoidance of alien species; amount of chemicals, e.g. pesticides/herbicides, and release/monitoring of GMOs)

Criterion: Soil

- Erosion (probability of erosion where mitigation measures are not feasible)
- Soil Organic Carbon (probability of SOC loss where mitigation measures are not feasible, depending on type of crops – perennial/annual - and respective land management)
- Soil nutrient balance (probability of nutrient balance loss where mitigation measures are not feasible)

Criterion: Water

- Water availability and regional water stress (water use in relation to TARWR, or average replenishment from natural flow in a watershed)
- Water use efficiency (water use for biomass cultivation/irrigation, and processing, per kg biomass)
- Water quality (presence of water pollutants, e.g. nitrate, phosphorous, pesticides, biological and chemical oxygen demand)

Criterion: Air

- Emissions of SO₂eq (life cycle emissions of SO₂, NO_x, NH₃ and HCl/HF from bioenergy, expressed in SO₂ equivalents, calculated in accordance to GHG emissions)
- Emissions of PM₁₀ (life cycle emissions of fine particulate matter, calculated in accordance to GHG emissions)

In the social dimension:**Criterion: Participation and transparency**

- Effective participatory processes (enable effective participation of all directly affected stakeholders by means of a due diligence consultation process, incl. Free Prior & Informed Consent when relevant)
- Information transparency (freely availability of documentation necessary to inform stakeholder positions in a timely, open, transparent and accessible manner)

Criterion: Land tenure

- Compliance with the VGGT (CFS 2012)

Criterion: Employment and labor rights

- Full direct jobs equivalents along the full value chain (number of jobs - gross figures - from biomass along the full value chain)
- Full direct jobs equivalent in the biomass consuming region (or country) (number of jobs - gross figure - from biomass in the biomass consuming region or country)
- Human and Labor Rights (adherence to ILO (1998) principles and voluntary standards)
- Occupational safety and health for workers (measures taken to guarantee occupational and health safety for workers)

Criterion: Health

- Risks to public health (measures taken to safeguard public health, i.e. regulation of noise level and prevention of accidents),

Criterion: Food & fuelwood

- Measures to avoid risks for negative impacts on price and supply of national food basket and fuelwood (and other products).

In the economic dimension:**Criterion: Production costs**

- Current levelized life-cycle cost (excluding subsidies)
- Future levelized life-cycle costs (excluding subsidies).

4.2 Specific Sustainability Requirements and Guidelines for Lignocellulosic Biomass

Beyond the mid-point indicators, there are other requirements that could be specifically targeted to different types of lignocellulosic biomass. To elaborate the list of guidelines and sustainability indicators, presented in Table 2 (See Section 5) several efforts have been revised, aimed to reflect a great variety of concerns with respect to several feedstocks and regions representative of the efforts targeted in this project.

The compilation shown in Table 2 has benefited as well from the revision already conducted in the framework of S2Biom (Iriarte, Fritsche 2015a). This has been the starting point used to complement several initiatives at the EU level with efforts in other research projects as well as in third countries. Following subsection describe relevant regulations, guidelines or research effort that might be of interest for BioTrade2020plus.

4.2.1 Best Harvesting Practices in the United States

Building on existing Best Management Practices (BMPs, see Iriarte, Fritsche, Pelkmans 2014), several states in the US have developed BMPs focused on biomass harvesting. In the Southern region, BMPs address (Barrett 2013):

- Streamside management zones,
- Stream crossings,
- Forest roads and skid trails,
- Fertilizer and pesticide application,
- Harvesting and reforestation
- Waste disposal

The main focus of guidelines is the amount of down woody material (i.e., coarse woody debris and fine woody debris) that can be sustainably removed. The amount that can be sustainably removed depends on forest types and site-specific conditions and the range of down wood material retention targets varies between 15 % and 35 % of potentially harvestable material (Kittler et al. 2012).

4.2.2 Environmental Zoning in Brazil

Brazil is not yet a relevant player in the international arena of solid bioenergy trade but given the amount of land available and the expertise gained in extensive eucalyptus short rotation plantations, this country could be a relevant exporting country of lignocellulosic feedstock in the mid-term.

Brazil has integrated the sustainability of feedstock production by means of environmental zoning (CENBIO 2013). This zoning reflects environmental, social and economic variables by means of a GIS-based assessment that result in a categorization of the land, from “inappropriate” to “suitable” areas.

At the federal level, the Brazilian Government launched two national agro-ecological zoning initiatives for sugarcane in 2009 (EMBRAPA 2009), and for palm oil in 2010 (EMBRAPA 2010). The principles guiding the sugarcane agro-ecological zoning were (CENBIO 2013):

- Exclusion of areas with native vegetation. Removal of native vegetation for the expansion of sugarcane cultivation is forbidden,
- Exclusion of some regions for cultivation (e.g. Amazon),
- Identification of areas with low needs for irrigation,

- Identification of low-slope areas (less than 12 %), to allow mechanical harvesting,
- Prioritization of degraded areas or pasture, identifying land currently underutilized or occupied by livestock or degraded pastures as suitable for sugarcane production, and
- Respect for food security guiding the expansion of sugarcane production in order to avoid any sort of risk to food production or to food security.

Furthermore, EMBRAPA, in collaboration with other institutions has also developed a zoning procedure based on climate and soil for planting eucalyptus in southern region of Rio Grande do Sul State (Filippini Alba et al. 2011).

4.2.3 ISCC - Short Rotation Coppices

The International Sustainability and Carbon Certification (ISCC)⁶, which is a voluntary certification scheme applicable for all types of biomass and biomass-based products. Complementary to ISCC-EU aimed to show biofuels sustainability with regard to the RED, ISCC PLUS has been developed for food, feed, technical/chemical applications (e.g. bioplastics) and other bioenergy applications (e.g. solid biomass). Moreover, ISCC PLUS 260-01 (ISCC 2012) provides specific add-ons for short rotation coppices that gives provisions for:

- Audit frequency at farm level
- Calculation of greenhouse gas (GHG) emissions for SRC

4.2.4 ToSIA indicators for the forestry sector

The ToSIA “Tool for Sustainability Impact Assessment” is the decision support tool for the forestry sector, aimed to analyze the sustainability effects of changes due to deliberate actions (e.g. in policies or business activities) or due to external forces (e.g. climate change, global markets) (EFI 2013). ToSIA considers impacts of changes in forestry-wood production chains in the environmental, economic, and social impacts.

Given the specific focus on the forest sector of this tool, additional indicators that might be relevant for the BioTrade2020plus sustainability approach are indicated in the annex.

4.2.5 Requirements for lignocellulosic crops in research projects

In this respect we have considered the ongoing activities in three research projects relevant for lignocellulosic biomass: Infres, LogistEC and SRCplus. The annex to this report shows the specific requirements in each research project.

Infres, Logistec and Europruning (aimed to promote an extensive utilization of the agricultural prunings for energy in Europe by means of developing a new improved logistics for pruning residues) are „sister projects“ in which sustainability considerations are being aligned (INRA 2014).

Infres made a selection of indicators for the forest sector in the environmental, social and economic themes, differentiating between „minimum indicators“ and „extended indicators“ (Tuomasjukka et al. 2013). Extended indicators refer to those that may be more difficult to collect, or which are very specific for a region or for a limited part of the value chain.

The Infres project also analyzed in detail the impacts of harvest forest residue extraction (Tuomasjukka et al. 2014). The literature review showed that most short term studies found no negative impacts of harvest residue extraction. The authors acknowledged that this fact couldn't be interpreted as a safeguard against possible long term adverse effects. They

⁶ <http://www.iscc-system.org/en/iscc-system/about-iscc/>

concluded that the lack of quantitative sustainability criteria for the evaluation of harvest residue extraction implies that the implementation of renewable energy policies cannot be based on solid scientific evidence. In this report, it was also pointed out that a common recommendation from the literature is to adopt a precautionary principle and to avoid practices that could potentially lead to adverse impacts on sustainability. In the annex specific notes about the impacts and respective recommendations with respect to forest residue harvesting, are stated.

The Biomass Energy Europe (BEE) project was initiated to harmonize methodologies for biomass resource assessments for energy purposes in Europe and its neighboring countries in order to improve consistency, accuracy and reliability of biomass assessments for energy. This project proposed a comprehensive list of sustainability requirements to assess different types of biomass potentials (Vis et al. 2010), distinguishing between:

- Types of biomass: forestry & primary forest residues, Energy crops and agricultural residues, waste, and whether the biomass is the main product or a residue.
- Method: statistical, spatially explicit and cost-supply

Another related project is the SRCplus project⁷. Dimitriou et al. (2014) elaborated a list of recommendations for Short Rotation Woody Crops plantations. These requirements are not indicators per se but might helpful to delineate specific sustainability indicators for this feedstock in task 2.4. For this reason, relevant recommendations of this project to be included in the BioTrade2020plus sustainability approach are given in the annex.

These recommendations deal with land use changes, zoodiversity, phytodiversity, soils, water, and landscape change.

⁷ www.srcplus.eu

5. CONCLUSIONS AND RECOMENDATIONS

As seen in Sections 3 and 4, sustainability might correspond to very different purposes and respective approaches might broadly vary depending on the goal. Keeping this mind facilitate the understanding and avoid confusion.

Given the different purposes and respective approaches, many different indicators, requirements and recommendations can be found in different schemes and regulations.

To facilitate the understanding and integration of the information compiled in Section 4 (and respective annex), practical indicators of interest for BioTrade2020plus project are depicted in Table 2. This table compiles various specific indicators and recommendations that might apply to the sustainability assessment of lignocellulosic biomass beyond those requirements already stated as mid-point indicators.

The information reflected in Table 2 has been derived from the schemes and regulations stated in Section 4, including efforts in other research projects⁸.

The indicators and recommendations for lignocellulosic biomass provided in Table 2, distinguish between those indicators that can be related to mid-point criteria already considered in the project (i.e. resource use or protected areas and land with significant biodiversity or high conservation values) and other indicators that regard to other (cross-cutting) criteria that are not explicitly included in the mid-point criteria proposal under the BioTrade2020plus project (i.e. Land Use, Land Use Change and indirect Land Use Change or Social Wellbeing).

When harvesting forest residues, the amount of forests residues to be left on the ground to protect soils and biodiversity is a very controversial issue, as discussed by Tuomasjukka et al. (2014). This is because there is not a strong scientific evidence on the understanding of the potential impacts.

Then “one-size-fits-all” might not be the most appropriate strategy. However, findings from Fritsche et al. (2014) based on an extensive literature revision suggested to keep at least 1/3 of the forest residues on the ground. This threshold might be applied as a first order estimate that could be better contextualize when more specific data are available.

⁸ The recommendations stated in the SRCplus project have been translated to indicators to the extent possible.

Table 2 Sustainability Recommendations and Implementable Indicators for Selected Lignocellulosic Biomass Feedstocks

BioTrade2020plus indicators	Mid-point indicators	Sustainability Recommendations and Implementable Indicators	Forest		Agric.		Waste
			Roundwood	Primary Residues	Energy crops	Agricultural residues	
Mid-point directly related indicators	Use of renewable and non-renewable materials	Volume of renewable materials in total, of which a) wood-based (or lignocellulosic) material in total - of virgin and recycled origin b) other renewable materials in total - of virgin and recycled origin	√	√	√	√	
		Efficiency of systems of production and transformation	√	√	√	√	√
		Intensity of fossil fuel use	√	√	√	√	√
		Intensity of material use	√	√	√	√	√
	Greenhouse gas emissions and carbon stock	Carbon stock in a) forests [classes as per IPCC guidelines] b) wood products c) landfill	√	√			
		Implemented practices to diminish GHG emissions	√	√	√	√	√
		Implemented practices to increase carbon dioxide sequestration	√	√	√	√	√
	Protected areas and land with significant biodiversity values	Identify high biodiversity/high value conservation value areas from national legislation/other relevant international data sources	√	√	√	√	
		Exclude legally protected areas - national (e.g. nature reserves, national parks) and international (e.g. Biosphere reserves (UNESCO MAB), Ramsar sites)	√	√	√	√	
		Adapt management on areas designated for the protection of rare, threatened or endangered ecosystems or species recognized by international agreements or included in lists drawn up by intergovernmental organisations or the IUCN	√	√	√	√	

BioTrade2020plus indicators	Mid-point indicators	Sustainability Recommendations and Implementable Indicators	Forest		Agric.		Waste
			Roundwood	Primary Residues	Energy crops	Agricultural residues	
		No drainage / use of land that was wetland (including peatlands) in January 2008	√		√		
		Establish buffer zones between cultivated land and areas of high biodiversity value (protected areas and wetlands)	√		√		
		Adapt management practices (i.e. crop choices and yields) on areas under agroenvironmental support			√		
		Adapt management practices (i.e. crop / tree choices) on agricultural areas under organic farming and in certified forestry areas	√	√	√		
		Adapt management practices (i.e. crop choices and yields) on extensively cultivated areas			√		
	Biodiversity conservation and management	Adapt management practices (i.e. crop/tree choices and yields) to local bio-physical conditions	√		√		
		Restrict use of genetically modified organisms (GMO)	√		√		
		Maximum extraction rates for primary agricultural and forestry residues		√		√	
		Minimum number of crop species and varieties as well as structural diversity within the cropping area			√		
		Maximum slope limits for cultivation	√		√		
		Only perennial crops on sites susceptible to soil erosion			√		
		Practices to diminish spread of invasive introduced species and new pests or diseases	√		√		
		"Responsible" application of agrochemicals (in the case of forestry minimize or eliminate) and biological control agents	√		√		
		Avoid harvesting of threatened or endangered plant species	√		√		

BioTrade2020plus indicators	Mid-point indicators	Sustainability Recommendations and Implementable Indicators	Forest		Agric.		Waste
			Roundwood	Primary Residues	Energy crops	Agricultural residues	
		Promote conversion of abandoned agricultural and treeless land into forest			√		
		Promote the use of fallow areas			√		
		Minimum separation of production areas from natural terrestrial ecosystems			√		
		Fallen dead wood, hollow trees, old groves and special rare tree species shall be left in quantities and distribution necessary, considering: a) standing deadwood b) lying deadwood	√	√			
		Process of residue removal minimizes harm to ecosystems.		√		√	
		Use of locally adapted varieties and breeds	√		√		
		Promote the development of Forest Management Plans	√				
		Ash recycling: Sweden has guidelines with recommendations on amount and quality of ashes to be recycled when forest residues are harvested (Swedish Forest Agency 2008).		√			
	Soil	Avoid planting in certain areas to protect soils	√		√		
		SRC could be cultivated in fields with low initial soil organic matter content to increase this content and with this the fertility and C storage of the soil.			√		
		SRC should be cultivated especially in areas with a high risk of erosion (wind or soil)			√		
		Application of municipal residues such as sewage sludge for recycling of nutrients to SRC can be encouraged			√		
		Limit Soil compaction from machine operations	√	√			
	Water availability	Adapt management practices (i.e. crop/tree choices and yields) to local bio-physical conditions (especially for rain fed agriculture)	√		√		

BioTrade2020plus indicators	Mid-point indicators	Sustainability Recommendations and Implementable Indicators	Forest		Agric.		Waste
			Roundwood	Primary Residues	Energy crops	Agricultural residues	
	and regional water stress	For irrigation, adapt water consumption to regional resources; if no data are available, exclude irrigation as a precautionary principle			√		
		Water use of the forest ecosystem a) evapotranspiration from the forest ecosystem Groundwater recharge	√	√			
Cross-cutting indicators	Land Use, Land Use Change and indirect Land Use Change	Avoid a massive conversion of permanent grassland to arable land; no conversion of highly biodiverse grassland			√		
		Allow afforestation of permanent grassland if it is compatible with the environment (exclusion of highly biodiverse grassland)	√				
		Exclude continuously forested areas and wooded land from conversion into arable land	√		√		
		Preference of using surplus land	√		√		
		Area of forest and other wooded land and related growing stock classified by type and by availability of wood supply	√	√			
		Rehabilitate degraded ecosystems	√		√		
	Landscape	Natural continuation in the landscape by means of planting SRC in agricultural fields close to forest stands.			√		
		Avoid SRC plating near cultural sites of importance			√		
		SRC is very suitable to be grown alongside roads with heavy traffic			√		
		SRC should be in general planted in areas with the less perceived landscape impact			√		
		Maintain (or create) diverse land structures for farming	√		√		
	Sustainability Assurance	Material produced under Sustainable Forest Management (for instance, FSC, PEFC or equivalent) or sustainable agriculture management	√		√		
Waste	Waste management and reduction, recycle and re-use of waste	√		√			

BioTrade2020plus indicators	Mid-point indicators	Sustainability Recommendations and Implementable Indicators	Forest		Agric.		Waste
			Roundwood	Primary Residues	Energy crops	Agricultural residues	
		Waste generation per ton of product	√		√		
	Best Environmental Practices	Responsible management infrastructural development, transport activities and silviculture	√				
	Cascading use of materials	Exclude certain biomass when it can be used by the wood processing industry	√		√		
		Exclude certain biomass for energy purposes such as roundwood	√				
		Assure that waste cannot be used for other purposes than fuel	√				
		Chemical composition of wastewood when it is for combustion	√				
	Competition and displacement	Promote the use of local biomass for energy (Pelkmans et al. 2012)	√		√		
		Competition with food and local applications of biomass (NEN 2014), including: Local prices, Promote iLUC low risks	√		√		
	Sustainable harvesting of forest products and non-wood forest products	Harvest products and services from the Management Unit at or below a level which can be permanently sustained	√				
	Social wellbeing	Availability of a mutually agreed and documented system for dealing with complaints and grievances, which is implemented and accepted by affected parties	√	√	√	√	√
		Use local processing, local services, and local value adding.	√	√	√	√	√
	Benefit sharing mechanism	Support to vulnerable people	√	√	√	√	√
	Rights of indigenous	Rights of indigenous peoples & local communities -defined in the United Nations	√	√	√	√	√

BioTrade2020plus indicators	Mid-point indicators	Sustainability Recommendations and Implementable Indicators	Forest		Agric.		Waste
			Roundwood	Primary Residues	Energy crops	Agricultural residues	
	peoples & local communities	Declaration on the Rights of Indigenous Peoples (2007) and ILO Convention 169 (1989).					
		Existence of conflict management mechanisms	√	√	√	√	√
	Traditional knowledge	Traditional knowledge	√	√	√	√	√
	Documented system for participatory processes	Negotiations concerning compensation for loss of legal, customary or user rights are dealt with through a documented system that enables indigenous peoples, local communities and other stakeholders to express their views through their own representative institutions as free, prior and informed consent and negotiated agreements	√	√	√	√	√
	Employment and labor conditions	Fair pricing and transparent contracts	√	√	√	√	√
	Training of workers	Training and requalification of the workforce	√	√	√	√	√
	Frequency of occupational accidents and occupational diseases	Occupational accidents classified by: non-fatal occupational accidents fatal occupational accidents	√	√	√	√	√
		Occupational diseases	√	√	√	√	√
Economic	Value of products (includes value and volume of production and/or value added per ton)	√	√	√	√	√	

Source: own compilation

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