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Biomass and Bioenergy 30 (2006) 83–104
BIOMASS & BIOENERGY
www.elsevier.com/locate/biombioe

Steps towards the development of a certification system for sustainable bio-energy trade

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Received 28 July 2004; received in revised form 7 November 2005; accepted 7 November 2005
Available online 10 January 2006

Abstract

It is expected that international biomass trade will significantly increase in the coming years because of the possibly lower costs of imported biomass, the better supply security through diversification and the support by energy and climate policies of various countries. Concerns about potential negative effects of large-scale biomass production and export, like deforestation or the competition between food and biomass production, have led to the demand for sustainability criteria and certification systems that can control biomass trade. Because neither such criteria and indicator sets nor certification systems for sustainable biomass trade are yet available, the objective of this study is to generate information that can help to develop them. For these purposes, existing certification systems, sets of sustainability criteria or guidelines on environmental or social sound management of resources are analyzed with the purpose to learn about the requirements, contents and organizational set ups of a certification system for sustainable biomass trade. First, an inventory of existing systems was made; second, their structures were analyzed. Key finding from the analysis of internationally applied certification systems was that they are generally led by an international panel that represents all countries and stakeholders involved in the biomass production and trade activities. In third and fourth steps different approaches to formulate standards were described and a list of more than 100 social, economic, ecological and general criteria for sustainable biomass trade was extracted from the reviewed systems. Fifth, methods to formulate indicators, that make sustainability criteria measurable, and verifiers that are used to control the performance of indicators are described. It is recommended to further develop the criteria and indicator (C&I) sets for sustainable biomass trade by involvement of the relevant stakeholders (e.g. biomass producer and consumer) and the analysis of local conditions (e.g. local production potentials and limits, and preferences of local people).

Keywords: Biomass trade; Certification; Sustainability criteria

1. Introduction

Traditionally, biomass is mainly used in the region where it is produced because transport costs are considered as high and its availability as limited. This changed in northern Europe in the 1990s with the introduction of biomass in district heating; Sweden and Denmark became the largest importers of bio-energy [1,2].[1] A review made in 2001 revealed that the trade with solid biofuels like wood residues, pellets and wood chips in Europe had reached a level of 50 PJ [3]. No actual numbers on bio-energy trade are available, but a continuous increase of biomass trade activities can be observed since then. The largest volumes of bio-energy are traded from the Baltic countries (Estonia, Latvia, Lithuania) to the Nordic countries (especially Sweden and Denmark). Some volumes are also traded from Finland to other Nordic countries or between

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[1]Here bio-energy is defined as any kind of solid, liquid or gaseous fuel that stems from or is produced by processing biomass. Biomass is here considered organic substance that was harvested from forestry or agricultural plants, either from dedicated biomass production, as residue (e.g. straw) or as waste from processing forestry or farming products (e.g. coconut shells).

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doi:10.1016/j.biombioe.2005.11.003

neighboring countries in Central Europe like The Netherlands and Germany. Sweden imports biofuels from Canada and Italy firewood from Northern Africa [1,2].

There are different reasons for international biomass trade. Most important drivers are the lower prices. For example the Latvian export prices were 2.6, 3.7 and 3.5 Euro/GJ in 1998 for wood chips, pellets and briquettes, respectively. These prices are lower (e.g. for wood chips about 1 Euro/GJ) than the average wood fuel prices in Sweden [1]. Different studies [4,5] for the Netherlands have shown that the import of residual wood or plantation wood from the Baltic States, Latin America or North America can be cheaper than the biomass that is produced in the Netherlands; this is also true when sea transport is included. Not only costs, also energy losses through international biomass transport were discussed critically. But energy balances and subsequent greenhouse gas balances show that international bio-energy trade is possible against a modest energy loss [6,7].

Bio-energy importing countries can benefit from lower prices and enhanced bio-energy supply security. Supply security, especially for large users of bio-energy, is equally important to the price of bio-energy [1]. The bio-energy exporting countries benefit from the opportunities that the production and export of bio-energy can provide, especially to rural communities, in terms of market access and enhanced socio-economic development [8].

Policies play an important role in the development of bio-energy trade. The demand for bio-energy is growing due to the climate policies of various countries that search for cost-effective strategies for the reduction of greenhouse gas emissions. In several countries the use of biomass is promoted by national policies and incentives. In Sweden, for example carbon taxes on fossil fuels have been a key factor in shifting the energy system towards renewables, respectively biomass [9]. Other examples are the German financial support for biodiesel and CHP, the Danish straw utilization program, The Austrian CHP program and the Finnish industrial approach on advanced boiler concepts [10]. Also on EU level high targets have been set for the use of biomass. In recent years three documents, which contain ambitious targets for the use of bio-energy in the EU, have been released. The so-called 'Green paper', which was adopted by the European Commission (EC) in 1996, envisages an increase of the use of renewable energy in the EU-15 to 12% of the primary energy use by 2010 [11]. In the so-called 'White Paper', adopted by the EC in 1997, a contribution of 5700 PJ from biomass in 2010 is projected [12]; and the Directive on biofuels, which was issued in spring 2003, strives for the increase of the consumption of biofuels to 2% of the diesel and gasoline consumption in 2005 and to 5.75% in 2010 [13]. It is expected that these EU documents, national support mechanisms (e.g. the Renewable energy law in Germany) and green certificates will boost bio-energy trading [2].

On the background of rising bio-energy trade activities, concerns arise on the potential negative impacts of these activities. Major concerns are that biomass production could compete with food production and lead to regional food and energy supply shortage in developing countries [6,8]. Experiences with the introduction of cash crops, for example soybean in Bolivia, showed negative impacts like deforestation (to gain agricultural land) and a shift of landownership to big farms being owned by foreign investors [14]. For this reason criteria and tools are searched for that help to avoid that biomass, unsustainably produced, is sold as 'sustainable resource' for the production of 'green electricity' in Europe. In the forestry sector certification was introduced in 1993 as a tool to avoid unsustainable forest management. The development of certification systems in forestry was a market-based response to address public concerns related to deforestation in the tropics, resulting in loss of biodiversity and the perceived low quality of forest management in areas where traded wood products are sourced from. The introduction of forest certification was spearheaded by the Forest Stewardship Council (FSC) and a range of other schemes have become operational by the end of the last decade [15]. Certification is the process whereby an independent third party (called a certifier or certification body) assesses the quality of management in relation to a set of predetermined requirements (the standard). The certifier gives a written assurance that a product or process conforms to the requirements specified in the standard [15]. The 'requirements' are mostly formulated as criteria that have to be fulfilled for the certification of a product or a production process. Certification is also applied in other fields than forestry, for example in agriculture. The first environmental label for organic agriculture was introduced in 1991 at the European level [16]. The initiative was taken from retailers, food processors, auctioneers and farmers to reduce the negative impact of intensive agriculture on environment and biodiversity [17]. Another important aim of certification in agriculture was to improve the marketability of the product and the transparency to the consumer. It was found that consumers prefer labeled products because they think that labeled products are safer and healthier [18]. It can be concluded that certification caters for many different peers and their interests (Table 1).

Essent and EUGENE (European Green Electricity Networks) were the first to take initiatives on the development of labels for green electricity from biomass. The 'Green Gold certificate' of the Dutch utility Essent Sustainable Energy is a track-and-trace system that provides control over the origin of traded biomass [19]. EUGENE defines which resources for renewable energy (including wind, sun, geothermal, water, biomass) are 'eligible' resources, but does not provide criteria on the production of these resources [20]. Therefore these systems cannot yet provide the demanded sustainability criteria that cover the whole bio-energy trade chain including the production of biomass.

The development of certification systems could be an important step towards the implementation and control of

Table 1
Stakeholder groups and their interests in certification, partly based on [15]

Stakeholders	Interests in certification
Industry and trade	Instrument for environmental marketing and market access Tool for controlling the origin and quality of raw materials, products or services
Buyers and consumers	Provides information on the impacts of products they purchase Improves confidence in products Provides information whether the product meets quality or technical standards
Producers and managers	Tool for market access or gaining market advantage Provides information for the optimization of production processes Allows for product differentiation
Governments	Policy instrument to promote sustainable management and sustainable consumption pattern Provides information for policy consultancy

sustainable biomass trade. Today neither such certification systems nor important information, like criteria or indicator to describe sustainable biomass trade, are available. Therefore, the objective of this study is to generate information that can help to develop a set of criteria and indicator and a certification system for sustainable biomass trade. For these purposes, existing certification systems, sets of sustainability criteria or guidelines on environmental or social sound management of resources are analyzed with the purpose to learn about the requirements, contents and organizational set ups of a certification system for sustainable biomass trade.

The study is structured into six parts.

1. Inventory of existing certification systems and management guidelines that provide insight in key elements for the development of certification systems for sustainable biomass trade.
2. Analysis of the structures of certification systems to learn about the contents, procedures and actors of international certification systems.
3. Description of the approaches for formulating certification standards.
4. List of criteria with relevance for sustainable biomass trade that has been extracted from existing certification systems, criteria and indicator systems and management guidelines.
5. Methods for the definition and formulation of indicators[2] and verifiers[3] that can be used to describe the criteria for sustainable biomass trade and make them measurable.
6. Recommendations for the development of a certification system for sustainable biomass trade.

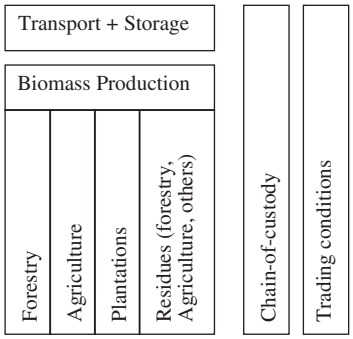

Fig. 1. Existing activity areas demanding for criteria and indicator development in sustainable biomass trade.

2. Inventory of existing systems

The basic activities included in the biomass trade chain are biomass production, trading, transport, storage and conversion (see Fig. 1).[4] Biomass can be produced in agriculture, in plantations, or in forestry either as dedicated product or as residues (see Fig. 1).

In Table 2, the systems selected for analysis in this study are listed. These systems belong either to the category of certification systems, to the category of criteria and indicator systems or to the category of management guidelines. Different categories of certification systems were inventoried.

2.1. General certification systems

The list starts with general certification systems, which are less specific to one of the biomass trade chain activities, but can provide insight into the structures of internationally operating certification systems. Most of these certification systems provide procedures for the development of quality standards (CEN, Eco-label, EMAS, ISO[5]) or sustainability standards (CREM[5]) for a range of products. CDM[2] is an international operating system, which contains methods to assess carbon credibility of projects and addresses environmental additionality.

The list in Table 2 is followed by certification systems that are specific to one of the areas in the biomass trade chain; these categories are 'biomass for energy', 'agriculture', 'forestry' and 'fair trade'.

[2]Indicators are measurable parameters which characterize a system by reduction of complexity and integration of information [21].

[3]A verifier is defined as data or information that enhances the specificity or the ease of assessment of an indicator [22]. Verifiers are needed for

(*footnote continued*)
indicator assessment and the control of the fulfillment of sustainability criteria.

[4]Certification of conversion systems is in this study not taken into consideration because this rather would have to analyze technical aspects and (existing) regulations on emissions than sustainability criteria.

[5]For explanations of abbreviations see Table 2.

Table 2
Overview on all organizations, systems and sources that were analyzed for this study

Organization or system	Explanations on the analyzed document (abbreviation)	Internet address/source
Certification systems general		
CDM	(Clean Development Mechanism); Project approval carbon credits	http://cdm.unfccc.int
CEN	(European Committee for Standardization)	http://www.cenorm.be/cenorm/index.htm
CREM	(Consultancy and Research for Environmental Management)	http://www.crem.nl
Eco-label	Certification of different products or services	http://www.eco-label.com/
EMAS	(Eco Management and Audit Scheme)	http://europa.eu.int/comm/environment/emas/index_en.htm
ISO	(International Standard Organization)	http://www.iso.org
Certification or criteria systems for Biomass for Energy		
EUGENE	(European Green Electricity Network) Certification system or green energy	http://www.eugenestandard.org
Green Gold certificate	Track and trace system for biomass; developed by Essent, energy utility in the Netherlands	http://www.skalint.com/
Certification or criteria systems for Agriculture		
EUREPGAP	(EUREP = Euro-Retailer Produce Working Group); EUREPGAP is a normative document for certification of farming products (fruits and vegetables) from integrated agriculture	http://www.eurep.org
EKO	Label for products from organic agriculture produced according to rules Council regulation (EEC) no. 2092/91	http://www.skal.nl/ [16]
IFOAM	(International Federation of Organic Agriculture Movements) Basic international standard for organic agriculture and accreditation criteria for organic certification programs	http://www.ifoam.org/about_ifoam/standards/ogs.html
SAN	(Sustainable Agriculture network) Coalition of local, nonprofit conservation groups; Rainforest Alliance-certified® label for bananas, coffee, cocoa, citrus, and flowers and foliage	http://www.rainforest-alliance.org/programs/agriculture/certification/index.html
SQF	Australian Certification system for farming products; Criteria for GAP (Good Agricultural Practice) in food production	http://www.agriholland.nl/dossiers/kwaliteitssystemen/sqf.html
USF (KUL)	(Umweltsicherungssystem) 'Environmental benign' label for farming systems	http://www.tll.de//kul/kul_idx.htm
UTZ KAPEH	Certification system for fair traded coffee; GAP guidelines for Coffee	www.utzkapeh.org
Certification systems Forestry		
ATFS	(American Tree Farming Systems) Forest certification system; initiated by the American Forest Foundation	http://www.treefarmsystem.org/cms/pages/26_19.html
CSA	(Canadian Standards Association's Sustainable Forest Management Standard) Forest certification system; Operating in Canada, CSA is an independent, non-profit organization	www.sfms.com/csa.htm/
FSC	(Forest Stewardship Council) Forest certification system; International, non-profit organisation set up by WWF; and chain-of-custody control system	http://www.fsc.org/en/getting_involved/become_certified/get_chain_of_custody
PEFC	(Pan-European Forest Certification), Forest certification system; initiated by 14 European countries, private national forest interest groups	http://www.pefc.org
SFI	(Sustainable Forestry Initiative) Forest certification system; Operating in US and Canada, initiated by the American Forest & Paper Association, the forest trade association	http://goodforests.com/
Certification or criteria systems for fair trade		
Agrocel	Agrocel® Pure & Fair Indian Organic Cotton Organization that co-ordinates the production of organic cotton and has developed Criteria for fair trade chains of cotton	http://www.agrocel-cotton.com/english/en_home.html
AgroFair	Importer and distributor of organic and Fairtrade tropical fresh fruit	http://www.agrofair.com/
FAIRTRADE	Certification of fair traded products	http://www.fairtrade.net/sites/standards/standards.html
OXFAM	Chain of world shops selling 'fair' products from developing countries; Criteria for selecting partners for fair trade	http://www.oxfam.org/eng/pdfs/strat_plan.pdf
Sustainability criteria		
Biomass Transitie Groep	Workgroup of the Dutch Ministry of Economy; Development of Criteria for sustainable biomass trade	[6]
Biotrade workshop	International workshop 2002; discussion of Criteria for sustainable biomass trade	[8]
GRAIN	Report, containing Criteria for sustainable biomass trade	[5]
Greenpeace	Environmental NGO; Ecological Criteria for Sustainability	http://www.greenpeace.org/international/campaigns/climate-change/solutions/bioenergy/

Table 2 (*continued*)

Organization or system	Explanations on the analyzed document (abbreviation)	Internet address/source
ILO	(International Labor Organization) Conventions that describe acceptable labor conditions	www.ilo.org
UN	(United Nations) Conventions and Agenda 21 provide Sustainability criteria for social, economic and ecological aspects	http://www.un.org/esa/sustdev/csd/csd.htm
WWF	(World Wildlife Fund) Environmental NGO; Ecological Criteria for Sustainability	http://www.wwf.org/
Indicator sets for sustainable Development		
IISD	(International Institute for Sustainable Development) Indicator for sustainable development	http://www.iisd.org/
OECD	(Organization for Economic Co-operation and Development) Indicator for sustainable development and Agro-ecological indicators	http://www.oecd.org/home/
UNDP	(United Nations Development Program) Indicator for Sustainable Livelihoods (SL)	http://www.undp.org/
Indicator sets for Assessment of sustainability of projects		
UN-CSD	(UN Commission of Sustainable Development) Method for development of sustainability indicators; Indicator for sustainable development; Assessment of Projects	http://www.un.org/esa/sustdev/csd/csd12/csd12.htm
Gold Standard	Gold Standard = tool for the Assessment of project sustainability. Best practice benchmark for CDM and JI greenhouse gas offset projects; developed by WWF (World Wildlife Fund)	http://www.panda.org/downloads/climate_change/cop8standards.pdf
World Bank	Assessment of sustainability of projects	http://www.worldbank.org/
Guidelines for sustainable or environmental sound management		
CCFM	(Canadian Council of Forest Ministers) Set of C&I for sustainable management of Canadian forests	http://www.ccfm.org/
CIFOR	(Centre for International Forestry Research) Criteria for sustainable forest management; manual for the development of locally adapted C&I sets	http://www.cifor.cgiar.org/acm/pub/toolbox.html
EU Council Regulation	Definition of organic farming and principles of organic production at farm level. Certification for organic farming logo	http://europa.eu.int/eur-lex/lex/LexUriServ/LexUriServ.do?uri=CELEX:31991R2092:EN:HTML
FARRE	(Forum de l'Agriculture Raisonnée Respectueuse de l'Environement) Common Codex for integrated Farming = Principles and indicator for GAP	http://www.farre.org/versionAnglaise/CommonCodex.htm
IKEA	Private company; developed strategy for environmental and social responsibility in the business.	http://www.ikea.nl/ms/nl_NL/about_ikea/social_environmental/enviromental.pdf
ITTO	(International Timber Trade Organization) Guidelines for the sustainable management of Natural tropical forests, criteria for the measurement of sustainable tropical forest management	http://www.itto.or.jp/live/index.jsp
OECD	(Organization for Economic Co-operation and Development) Guidelines for sustainable behavior of multinational enterprises	http://www.oecd.org/home/
Unilever	International company; developed GAP guidelines for sustainable agriculture	[26]
Worldbank	IFC (International Finance Corporation) guidelines for environment, health and safety	http://ifcln1.ifc.org/ifcext/enviro.nsf/e11ffa331b366c54ca2569210006982f/f067bebe3af7995e85256d87005087e9?OpenDocument

2.2. Certification or criteria systems for biomass for energy

In the category 'biomass for energy' only two systems were found that are dealing with criteria for 'sustainable' energy from biomass. Green Gold is a new certification system in operation for the Dutch utility Essent Sustainable Energy. EUGENE is an independent network of environmental (including WWF) and consumers organizations, and research institutes. EUGENE promotes green electricity labeling as a market tool to facilitate and stimulate additional production of renewables [20]. The label of EUGENE is applicable to geothermal, wind, solar electric, hydropower and biomass energy and is given to defined 'eligible sources'. Eligible sources for biomass are, for example, dedicated energy crops, residual straw from agriculture, etc. EUGENE, however, does not provide more specific criteria for eligible biomass resources, like e.g. on production methods.

2.3. Certification or criteria systems for agriculture

For the agricultural sector different certification systems exist that were implemented to ensure environmental benign or sustainable production methods that provide safer or healthier products to the consumer. In agriculture there are different definitions on sustainable production methods;

some consider organic agriculture as the only sustainable way of production, while others consider integrated or good practice agriculture most sustainable [24].[6] Certification in organic agriculture has the longest tradition, and a first label was implemented in 1991 at European level [16]. Systems for organic agriculture being analyzed here are EKO, IFOAM, SAN and UTZ KAPEH.[7] EKO is a European certification system; IFOAM provides general guidelines for organic agriculture. Both, SAN and UTZ KAPEH are certification systems for tropical products like coffee, bananas etc., and provide criteria for agricultural products that are produced for export. The EUREPGAP system is the most prominent system for the certification of agricultural products from GAP and integrated agriculture. The label was put in 2001 in operation and is applied to products from 25 countries in Africa, America, Asia, Europe and Oceania. The main aim of EUREPGAP certification is to ensure a good quality of the certified fruits and vegetables. Therefore, the EUREPGAP rules concentrate on quality management, the minimization of negative environmental impacts of crop production and on track-and-trace[8] control.

2.4. Certification systems for forestry

FSC, PEFC, CSA and SFI[9] are the four major operational forest certification systems. Recently, AFTS has been implemented for the US and together about 124 million hectares were globally certified under these systems in June 2002 [15].

2.5. Certification or criteria systems for fair trade

Certification systems for fair traded products were implemented with the aim to ensure a 'fair' payment of agricultural products, to enhance the quality of life of the producer, to improve their market access and to reduce their dependency from middlemen [25]. These systems can provide information on criteria for fair trading and were analyzed for its approaches to formulate a 'fair' price for a traded product.

2.6. Criteria and indicator systems

Different systems that can provide criteria and indicators with relevance for one or several areas of biomass trade were analyzed. These systems were categorized into such that contain (a) sustainability criteria, (b) indicators for sustainable development and (c) indicators to assess the sustainability of projects. According to their field of activities different organizations have developed sustainability criteria, e.g. ILO[10] for acceptable labor conditions or the WWF for ecological aspects. There are also activities on the development of criteria for sustainable biomass trade which are reported e.g. by the GRAIN[10] report or in the report on the Biotrade workshop. Criteria for sustainable development are developed by international organizations like OECD and UN[10] in order to provide information and tools to policy maker. The Worldbank and the UN formulated indicator sets to assess the results, success (also in comparison) and sustainability of their projects.

2.7. Guidelines for sustainable or environmental sound management

Table 2 also lists guidelines for the sustainable and/or environmental sound management of resources. The guidelines chosen here either describe the sound management of agricultural and forestry resources (CCFM, CIFOR, EU Council Regulation, FARRE, ITTO, Unilever, Worldbank[10]) or they describe rules for 'responsible' or 'sustainable' behavior of enterprises (IKEA, OECD[10]). These guidelines are here chosen to be analyzed for sustainability criteria and criteria with ecological, economic or social relevance for sustainable biomass trade.

3. Structures of international certification systems

All the internationally operating certification systems from Table 2, which are ISO, CDM, FSC, and EUREPGAP, were analyzed for their structures. Different bodies are involved in setting up and operating the

[6] *Good agricultural practice* (*GAP*): GAP is agricultural production that is performed in compliance with all relevant laws and regulations and according to 'best practice', i.e. by using actual knowledge and the best available techniques. In Germany, for example, good agricultural practice is described in laws like the law for soil protection (Bundesbodenschutzgesetz, 17.3.1998), the law for crop protection (Pflanzenschutzgesetz, 14.5.1998) and the prescription for fertilizer (Düngeverordnung, 26.1.1996).

Integrated agriculture: The aim of integrated agriculture is to balance ecological and economic demands of agricultural production (for a description of the principles of integrated agriculture see [23]). A practical example for integrated agriculture is the use of pesticides and fertilizer at an economic optimum (at the economic optimum the additional benefit of using another unit of input is at least as high as the costs for the additional unit of input). This approach stands in contrast to agricultural practice where farmers preventively apply high amounts of fertilizer and pesticides. Another approach of integrated agriculture is the development of more efficient technologies. These are, for example, fertilization techniques that reduce the fertilizer demand by better placing of the fertilizer, or spraying devices that reduce the amount of pesticides needed by producing finer spraying particles.

Organic agriculture: Production methods for organic agriculture are described in detail, e.g. in [16]. Generally, no use of agrochemicals like mineral nitrogen fertilizer and chemical-synthetic substances for crop protection are allowed. Nitrogen is introduced into the system by growing crops that can fix nitrogen (leguminosae) and by using manure. For crop protection only 'biological' substances (e.g. extracts from plants) are allowed. Therefore, yields in organic agriculture are generally lower than in integrated or GAP agriculture.

[7] For explanation of abbreviations see Table 2.

[8] A track-and-trace system controls the path of the product. By this control every product can be traced back form the retailor or supermarket to the producer.

[9] For explanation of abbreviations see Table 2.

[10] For explanation of the abbreviation see Table 2.

certification systems (see Fig. 2). The international panel chairs the system and is responsible for the nomination and control of the methodology panel, the national representatives and the certification body. The methodology panel develops the contents of the system. The national representatives and certification bodies are responsible for the carrying out of the certification process. The certification bodies are either nominated by the national representative or by the international panel (see Fig. 2). Those certification bodies generally are accredited, either by 'approved bodies' (e.g. EUREPGAP), which are private companies, or by bodies, which are operating as part of the certification system (e.g. FSC). Those certification bodies have to fulfill certain quality demands, for example on the qualification of their employees, their control and reporting procedures. National representatives or the certification bodies nominate national bodies for two purposes. They either help to support the certification body in controlling the fulfillment of certification criteria or they support the project team to prepare the documents needed to apply for certification. Generally, the project team starts the certification process by approaching the national representatives or certification bodies. In all analyzed international certification systems, project approval or certification is performed by the certification body; only in the CDM system the highest body, i.e. the international panel, approves the projects.

In most cases international certification systems have two major elements: (1) rules that describe needs and performance of the certification and (2) the standards and accreditation procedures (see Fig. 2).

The *rules for certification and accreditation* are similar for all kind of certification systems and can be adapted from ISO/IEC guidelines. The most important contents of these guidelines are:

- rules on the qualification of the validation/verification bodies and its personnel,
- description of the validation/verification bodies,
- description of the policy that shall ensure confidentially of the validation/verification,
- rules on how the independence, importability and integrity of the validation/verification bodies have to be demonstrated,
- validation and verification methods and procedures,
- rules on the reporting of validation and verification procedures.

The *standards* define the aim of certification and describe the product or production process specific requirements to be fulfilled for certification. Standards are either developed by the highest-level body, i.e. the international panel, or by an expert panel, which is appointed by the international panel. The more generic international standards are often specified for the national level by the help of the national representatives and by taking specific (national) conditions into account. In the following section, different kinds of standards and the process of formulating sustainability standards are described.

4. Standard formulation

4.1. Kind of standards applied

By analyzing the systems listed in Table 2, four different kinds of standards were identified.

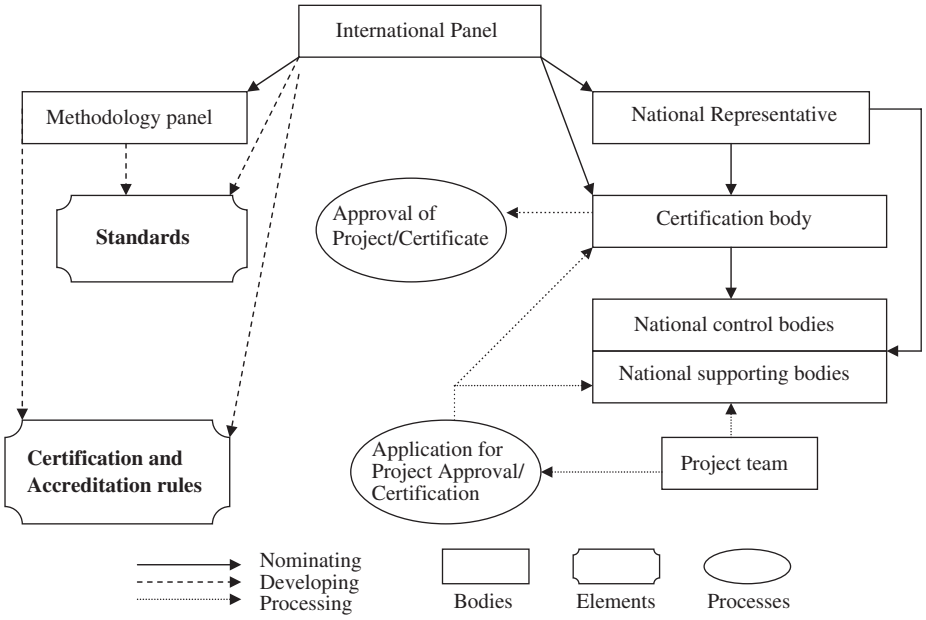

Fig. 2. Elements and bodies of international certification systems.

4.1.1. Technical standard

Technical standards describe the requirements on the physical or chemical characteristics of a product. These kinds of standards are found in ISO, DIN or CEN, i.e. systems which are sorted under 'general certification systems' in Table 2. An example for a technical standard is the CEN standard prEN 14214 on fatty acid methyl esters (FAME). This standard contains threshold values for the maximal content of sulfur, water, free glycerin and pollution and minimum values for oxidation stability and flame temperature.

4.1.2. Methodology standard

Methodology standards describe methodological requirements and the procedure for the production of a defined output. CDM contains for example the description of a standard methodology for the calculation of CO_2 emission reduction being attributable to a project. Methodology standards can also be found in ISO or CEN where standard methodologies for the performance of chemical analysis are described (ISO ICS field 71/040 Analytical Chemistry).

4.1.3. Good practice guidelines

Good practice guidelines describe the required performance of a production process.

All certification systems for agriculture and forestry, listed in Table 2, contain good practice guidelines. Agricultural good practice guidelines describe, for example, the desired handling and use of pesticides and fertilizer or good practice of soil cultivation. Good practice guidelines in forestry concentrate on desired harvest regimes and methods. The International Finance Corporation (IFC) guidelines for environment, health and safety contain good practice guidelines for the management of plantations.

4.1.4. Sustainability standards

Sustainability standards are sets of criteria and indicators, which describe the requirements to be fulfilled by a sustainable product or process. Examples for sustainability standards are the banana, coffee and citrus standards of SAN [27].

Technical, methodology and good practice guideline standards are generally developed by expert committees (see e.g. description of standard development by ISO [28]). The development of sustainability standards demands, besides expert knowledge, the involvement of different stakeholders [29].

4.2. Development of sustainability standards

Information about the development of sustainability standards was derived from [29] and from interviews [30]. All analyzed sources describe the development of sustainability standards as a multiple step procedure.

4.2.1. Formulation of a mission and sustainability definition

The first step of the development of a sustainability standard is the formulation of a mission including a sustainability definition (see [26,31]) because 'without such a clear definition, it will be difficult to formulate a policy that will definitely lead to an improvement in sustainability' [31]. UNDP [32] emphasizes that such a sustainability definition will have to be formulated context-specific because at local level sustainability will be defined according to the priorities and the expectations of the people in their regional setting.

4.2.2. Formulation of sustainability criteria and indicators (C&I)

The second step of the development of sustainability standards is the formulation of sustainability criteria and indicators to measure the performance of these criteria. The development of sustainability criteria requires the analysis of local conditions and, for the formulation of what is to be considered sustainable, the involvement of local stakeholders. Therefore, the relevant stakeholders have to be identified in the very beginning. The analysis of the local conditions the inquiries of the local people give insight into the aspects for which criteria are needed. For example criteria that address the prevention of erosion will most probably be selected in slope areas with erosion susceptibility, but can be meaningless in flat areas with no or low danger of erosion.

Most sustainability standards were developed by stakeholder involvement using different approaches like performing interviews and workshops. In an approach of CIFOR to develop criteria and indicators (C&I) of sustainability in community managed forest landscapes, experts from different disciplines (Ecology, Socio-economics and technical management) developed a set of generic C&I for forest management [33]. Interdisciplinary teams of experts, consultants and local representatives then locally adapt these criteria by performing an analysis of the ecological conditions and by inquiries with local people. A manual to assist community-based forest managers and/or practitioners and partners to develop an agreed and easily understood set of C&I built around shared knowledge and best practice has been written by Ritchie et al. [29].

4.2.3. Testing C&I sets in the field

As a third step, C&I sets are tested in the field. The functionality of the C&I sets is an important precondition for the success of a certification system. In this context, the following characteristics are important:

- the user of the C&I sets should understand them,
- clear guidelines for using the C&I sets should be produced,
- the stakeholders should accept the C&I set,
- the chosen indicators should be effective, i.e. be able to control what they should control, and deliver the information needed,

- enough information and data should be available for the use of the chosen indicators,
- the effort to use the C&I set should be appropriate, i.e. labor input and costs to apply these sets should not be too high.

4.2.4. Evaluation of field testing results and modification of the C&I sets

The fourth step is the evaluation of the feedback from field testing and the modification of the C&I set which then finally can be implemented. There is little information about the time needed for the development of a final set of C&I. For the field testing of a C&I set for sustainable forest management, Muhtaman et al. [34] planned 2 weeks. From their experience they concluded that this time was not enough, but they gave no recommendations for an appropriate period. De Lange [30] indicated that the time needed for the development of a sustainability standard also depends on the resources available. From this discussion and from [29,35], it was concluded that the operationalization of a standard on national to local level in 6–12 months is feasible, provided a generic C&I set is available.

All analyzed sustainability standards are C&I systems. For the development of a certification system for sustainable biomass trade, C&I sets will have to be developed that appropriately describe the requirements on sustainable biomass production, transport and trade and use. In the following chapter the systems from Table 2 are screened for criteria and indicators that can be of relevance for sustainable biomass trade.

5. Extraction of criteria with relevance for sustainable biomass trade

In discussions about criteria for sustainable biomass trade, the following major concerns on the impact of biomass trade are addressed [5,6,8,36]:

(1) Biomass can be produced in an 'unsustainable' way, either by harvesting wood from rain forests or by transforming forest into agricultural land. This is, for example, experienced in Bolivia where most of the 100,000 ha of natural forest cleared annually are replaced by export soybean production [14]. Biomass may also be considered unsustainable when it stems from agricultural production methods with negative environmental impacts. Agricultural products for the export are often produced with a high input of fertilizer and pesticides because higher yields and income can be achieved, or high-quality demands for exported products have to be fulfilled. The income from the cash crops provides the means for investing in these inputs.[11]

(2) Biomass trade can lead to (negative) leakage effects. Leakage can be defined as activity-induced changes in land use that occur outside the area in which the activity takes place. The net effect is that carbon benefits gained in one place are (partially) lost in (leak away at) another location [38]. In the context of biomass trade a somewhat broader definition of leakage is useful. Leakage could stand for an unwanted shift of activities from the area of biomass production to another area where it leads to negative effects on the environment.[12]

(3) It has to be avoided that 'unsustainable' biomass, e.g. wood from logging rain forests, enters the trade chain. This could happen at different stages where the biomass is either transferred from one transport step to the other (e.g. from inland lorry to overseas ship transport) or stored. Therefore, a control and documentation system has to be in place that makes sure, that the biomass is traceable from the production to its use.

(4) Negative effects in the biomass exporting regions should be avoided; instead, biomass trade should improve the economic situation in the regions of biomass production. There could be several reasons for a negative impact of biomass trade on the economic situation of a region. One example can be given by the production of export soybeans in Bolivia. Soybean production did not generate many jobs and 80% of the soybean farms in Bolivia are not owned by Bolivians, but by immigrants that bought huge land areas [14]. In this structure only a few wealthy people benefit from the soybean production [14].

(5) The production of cash crops in the agricultural sector can replace the production of food crops [40]. Biomass trade could lead to a shortage of regional food or energy supply in case landowners earn more money from selling biomass for export than from selling food or biomass to the local market.

(6) There are other important uses for forestry sources than bio-energy, e.g. in the pulp and paper industry or as building material. In these industries growing bio-energy demands raise concerns on potential resource scarcity, price increases for biomass and market distortions [41].

(7) Water is a scarce resource in several regions of the world. The production of bioenergy crops can lead to an increased water use. This can be due to the withdrawing of water for the irrigation of energy crops or to increasing evapotranspiration on the land where energy crops are cultivated. Bio-energy production could disturb the water supply situation in areas with an already stressed water situation [42].

There are more concerns about potential negative effects of biomass trade than listed above. The formulation of criteria for sustainable biomass trade should ensure that these concerns are addressed and strategies to overcome them are described.

It was found in the analyzed systems (from Table 2) that the criteria are either sorted under major principles (e.g. 'The legal and customary rights of indigenous

[11] Both, small and big farms, apply high levels of fertilizer and pesticides to cotton and asparagus produced in and exported from Peru [37].

[12] An example for a leakage effect is the shift of logging activities to Myanmar and Cambodia after the ban on logging forests in Thailand, instituted in 1989 [39].

people….shall be recognized' [43]) or under activity areas (e.g. soil and substrate management, [44]).

Here it was chosen to set the criteria under different 'areas of concerns'. It was found that all certification systems for agricultural or forestry products contain criteria that describe requirements on labor conditions. These criteria are here sorted into the area of concern 'Labor conditions' (see Table 3). In Table 3, the criteria are grouped into social, economic and ecological criteria or are put under general criteria when a clear classification was not possible. The social and ecological criteria, for which we formulated 12 and 11 areas of concern, respectively, dominate over the economic criteria for which only four areas of concern could be formulated. Table 3 lists all criteria with relevance for sustainable biomass trade, which were found in the analyzed systems. The low number of economic criteria therefore reflects that little economic criteria were addressed in the analyzed systems.

For some areas of concern the criteria are more descriptive than for others. The criteria for the area 'Protection of human safety and health' are very distinctive in pointing on certain aspects (e.g. hazardous substance,

Table 3
Criteria with relevance for sustainable biomass production and trading (sources [5,6,8,19,20,23,24,26,31,33,38,43,44,46–56] and all systems from Table 2)

Areas of concern	Criteria
Social criteria	
Labor conditions	Freedom of Association and collective bargaining
	Prohibition of forced labor
	Prohibition of discrimination and equal pay for equal work
	Least minimum wages
	No illegal overtime
	Equal pay for equal work
	Regulations are in place to protect the rights of pregnant women and breastfeeding mothers
Protection of human safety and health	Protection and promotion of human health
	Farmers, workers, etc. are not unnecessarily exposed to hazardous substances or risk of injury
	A safe and healthy work environment, with aspects such as machine and body protection, sufficient lighting, adequate indoor temperature and fire drills
	Availability of document routines and instructions on how to prevent and handle possible near-accidents and accidents
	Training of all co-workers is performed and documented; training ensures that all co-workers are able to perform their tasks according to the requirements formulated on health protection and environmental benign management or resources
Rights of children, women, indigenous people and discrimination	Elimination of child labor: a minimum age and a prohibition of the worst form of child labor
	Children have access to schools, work does not jeopardize schooling
	Indigenous people's and tribe's rights have to be respected
	Recognizing and strengthening the role of indigenous people and their communities
	Women should not be discriminated and their rights have to be respected
	Spouses have the right to search work outside the entity where the husband works
Access to resources ensuring adequate quality of life	Farmers are content with their social situation
	Access to potable water, sanitary facilities, adequate housing, education and training, transportation, and health services
	Promoting of education, public awareness and training
	Market access for small farmers and producer
	Equitable access to forest/farm certification among all forms of forest/farm users and tenure holders
	Establishment of a communication systems that facilitates the exchange of information
Food and energy supply safety	Enough food of sufficient quality is available
	Biomass production should not lead to severe competition with food production and the shortage of local food supply
	Energy supply in the region of biomass production should not suffer from biomass trading activities
Capacity building	Local organizations, institutions or companies should be involved in the process, e.g. control and certification
	Marginalized social groups should play and equitable role in certification processes
	Jobs should be generated
	Trade-related skills development and social justice oriented capacity building are facilitated through learning exchanges between trading partners
	Building and use of local labour and skills
Combating poverty	The activity should contribute to poverty combatement
Democratic participation	Stakeholder involvement in the decisions that concern them
Land ownership	Avoidance of land tenure conflicts
	Land ownership should be equitable

Table 3 (*continued*)

Areas of concern	Criteria
	Tenure and use rights shall be clearly defined, documented and legally established Projects should not exclude poor people from the land in order to avoid leakage effects
Community (institutional) well-being	Farms must be 'good neighbors' to nearby communities and a part of the economic and social development A basis is created for strengthening the mutual confidence between business and the society in which they are active Involvement of communities into management planning, monitoring and implementation
Fair trade conditions	Transparency and accountability of negotiations Direct and long-term trading relationships Fair and equal remuneration—all supply chain partners are able to cover costs and receive fair remuneration for their efforts through prices that reflect the true value of the product. Risk sharing mechanisms are actively encouraged Communication and information flow—supply chain partners communicate openly with each other showing a willingness to share information
Acceptance	Acceptance of the production methods by producer and consumer The activities do not lead to disadvantages for the local population like losses of jobs or food shortage The activity carries advantages for the local population
Economic criteria	
Viability of the business	The business has to be economically viable Minimization of costs to ensure competitiveness There is sustained and adequate funding for running the operation, i.e. the liquidity of cash flow to support infrastructure development, acquisition of machines and to meet day-to-day running of the operation
Long term perspective	Long-term commitments, contracts and management plans
Strength and diversification of local economy	The activity should contribute to strengthening and diversifying the local economy Local labor and skills should be usable Professional and dedicated human resources are enhanced
Reliability of resources	Minimization of supply disruptions Supply security for the biomass consumer No overdependencies on a limited set of suppliers should be created
Yields	Sustainable rate of harvesting—Forests should only be harvested at the rate that they regrow Agricultural yields should be maintained on an economic viable and stable level A management plan that describes the operational details of production is in place A comprehensive development and research program for new technologies and production processes is in place
No blocking of other desirable developments	The activity should not block other desirable developments
Ecological criteria	
Protection of the atmosphere	Reduction and minimization of greenhouse gas emissions Efficient use of energy Use of renewable resources Low nitrogen emissions to the air No use of persistent organic pollutants (POPs) and substances that deplete the ozone layer
Preservation of existing sensitive ecosystems	Avoidance of pollution of natural ecosystems neighboring the fields Prevention of nutrient leaching Plantations should not replace forests Maintenance of high conservation value forests
Conservation of biodiversity	No use of GMOs Careful/no use of exotic species, their monitoring and control Prevention of spreading of diseases Environmentally sound management of biotechnology Consideration of the needs of nature and species protection The development and adoption of environmentally friendly non-chemical methods of pest management should be promoted and it should be strived to avoid the use of chemical pesticides Preservation of habitats
Conservation and improvement of soil fertility—avoidance of soil erosion	No impoverishment of the soil; nutrient balances should remain in equilibrium Optimized utilization of the soil's organic nitrogen pool Measures to prevent soil erosion are applied and described in a management plan No accumulation of heavy metals in soil No irreversible soil compaction; measures to prevent soil compaction are taken and described in a management plan No pesticide residues in the soil

Table 3 (*continued*)

Areas of concern	Criteria
Conservation of ground and surface water	No depletion of ground and surface water resources Protection of the quality and supply of freshwater resources Avoidance of pollution of ground and surface water No eutrophication of surface water by phosphorus emissions No pesticide residues in the water
Combating of deforestation	Plantations should not replace forests Sustainable harvest rates—harvest at the rate the forest regrows Limitations for the size of the harvested areas No logging activities in protected forests
Combating desertification and drought	Measure to comate desertification and drought are taken and described in a management plan
Landscape view	Increase and improvement of the variation of the landscape Conservation of typical landscape elements
Conservation of non-renewable resources	Efficiency in the use of natural resources, including energy Positive energy balance Minimization of the use of raw material, resources and land Focus on increased efficiency by increasing filling rates, decreasing fuel consumption and by using transport modes that release less greenhouse gases Minimization of phosphorus extraction from non-renewable deposits
Waste management	Minimization of wastes Sorting of wastes Proper handling and disposal of waste Recycling of waste where possible Recycling of ashes from biomass combustion Environmental training of employees, to facilitate waste sorting and initiate energy saving Environmental checklist on waste management, training of employees, etc.
Environmental additionality	Projects have to be environmental additional by improving the environmental situation against a baseline (status quo) scenario
General criteria	
Compliance with laws and international agreements	Activities have to comply with national laws and international agreements All applicable and legally prescribed fees, royalties, taxes and other charges shall be paid In signatory countries, the provisions of all binding agreements such as CITES, ILO Conventions, .. (others)…shall be respected
Traceability	Biomass has to be traceable Biomass from non-certified resources cannot enter the trade chain A chain-of-custody control system is in place
Avoidance of leakage effects	(Negative) leakage effects should be avoided People should not involuntarily be driven from their land The biotrade activity provides local people with income opportunities that are at least equivalent in quality and quantity to the baseline situation (i.e. situation without biomass trade activity)
Strengthening the role of non-governmental organizations	The role of non-governmental organizations should be strengthened
Improvement of conditions at local level	Generation of jobs Generation of education opportunities Capacity building Support of infrastructure development Enhancement of democratic development Increase of (farmers) income Improvement of environmental management at local level

machine use) that are relevant for human health and safety. For other areas like 'food and energy safety supply' or 'Strength and diversification of local economy' the criteria found only point to the fulfillment of a demand (e.g. the activity should contribute to strengthening and diversifying the local economy) but they do not describe ways and means that show how the demands can be fulfilled. Before the derived set of criteria can successfully be applied to a certification system of sustainable biomass trade, more descriptive criteria will have to be developed. This is especially true for the areas of concern 'Food and energy supply safety', 'Combating poverty', 'Environmental additionality' and 'avoidance of leakage effects'.

The list in Table 3 contains all criteria that were found in the systems reviewed (see Table 2) and that we consider as relevant for sustainable biomass trade. There is more experience with the application of some and no experience with the application of other sustainability criteria. There are, for example, several systems for agriculture available (see Table 2) that contain rules for sustainable or environmental benign food production, but none of the agricultural systems addresses the sustainable integration of biomass production into systems that traditionally produce food crops. Little experience is available in the application of sustainability criteria to the transport sector, too. For this sector, investigations were only performed with regard to the energy use and greenhouse gas emission [7,45].

6. Measuring sustainability criteria by indicators and verifiers

The criteria listed in Table 3 summarize all criteria found with relevance for sustainable biomass trade. To use such criteria for the formulation of a certification standard they have to be operationalized and measurable. For this purpose indicators and verifiers are used.

There are different definitions of the term indicator. Lewandowski et al. [57] define indicators as 'measurable parameters, which characterize a system by reduction of complexity and integration of information'. According to Merkle et al. [58], they shall give quantitative and qualitative information about the condition or the development of systems and should serve as decision aid. Mendoza et al. [22] give a more specific indicator definition for the forestry sector. They define an indicator as 'any variable or component of the forest or the relevant management systems used to infer attributes of the sustainability of the resource and its utilization'.

A verifier is defined as data or information that enhances the specificity or the ease of assessment of an indicator [22]. Verifiers are needed for indicator assessment and the control of the fulfillment of sustainability criteria.

6.1. Indicators

The description of every criterion requires specific indicators. Here not for all criteria listed in Table 3 indicators can be shown because that would have resulted in an extensively long list. To deal with this problem it is more generally described how indicators for sustainability criteria could look like and some illustrative examples are given. Eight methods for formulating indicators, which we here call indicator tools, were identified in the reviewed systems. These are described in the following chapter. For every indicator tool, examples were extracted from the systems listed in Table 2.

6.1.1. State indicators

State indicators describe the state of the protected good, the desired state of the situation for the stakeholders or the envisioned effect of the actions to be taken within the system. All certification systems use state indicators of which some examples are given in Table 4.

Table 4
Examples of state indicators and the criteria they describe

Criteria described	Example state indicators	Source
Compliance with laws and international agreements	The licensee can demonstrate compliance with the national and local regulations and discharge any (administrative) obligations arising there from	[43]
A safe and healthy work environment	First aid boxes must be present at all permanent sites and in the vicinity of fieldwork	[44]
No illegal overtime	A working hours and overtime regulation is put in place	[46]
Market access for small farmers and producers	The majority of the members of the organization are small producers providing more than 50% of the total production of the fairtrade products	[46]

The example indicators are only one of several needed for the description of the criteria mentioned.

6.1.2. Management rules or guidelines

Most of the indicators, which are formulated in certification systems for forestry, agriculture and plantation management, are management rules. They describe a sustainable or environmental sound production process by describing which management measures are allowed or prohibited, and how these measures have to be performed. Such management rules include, for example, information about the kind of pesticides that are allowed, how much nitrogen fertilizer can be applied, how the soil has to be cultivated to avoid erosion, etc. These management rules are often sorted into activity categories like 'soil cultivation', 'crop protection', etc.

The major challenge in formulating good practice or management guidelines is the definition of what is to be considered as 'good practice'. In the agricultural sector guidelines are available for different forms of farming, like organic agriculture (e.g. [49]), high input or integrated agriculture (e.g. [44]). In integrated agriculture pesticides and fertilizer are used according to the economic optimum but not at the ecological optimum. The definition of integrated agriculture is so far only qualitative, and the criteria and thresholds holding for the various environment labels currently in use can cover a wide range [17]. Fairtrade certification systems often recommend agricultural production according to rules of organic agriculture, i.e. without the use of pesticides and mineral fertilizer, with the aim to protect the workers' health. In the 'sustainable' production of oil palms in plantations of Unilever [26], pesticides and mineral fertilizer are used to ensure a high

Table 5
Indicators for the avoidance of soil erosion, according to different systems

Indicator	Source
The management plan has to include information on measures taken to prevent erosion, improve soil conditions, etc.	[43]
Avoid practices that aggravate erosion and favor practices that conserve soil	[53]
Field cultivation techniques that minimize soil erosion must be adapted	[44]
Clear-cuts in areas susceptible to erosion (e.g. directly next to rivers or steep slopes) are prohibited	[43]
A soil conservation plan to minimize erosion must be implemented. The plan must consider the topography, type of soil, climatic conditions and agricultural practices of the area. Windbreaks, vegetative barriers, cover crops and contour planting must be employed where conditions warrant	[53]
There is visual or documented evidence of crossline techniques on slopes, drains, sowing grass or green fertilizers, trees and bushes on borders of sites, etc.	[56]

and stable yield. Here it has to be recognized that both, health items and high yields, are sustainability criteria. This example shows the conflicts of interest that can occur when several sustainability criteria have to be fulfilled simultaneously.

By the example of management rules for describing the criterion 'Conservation and improvement of soil fertility—avoidance of soil erosion' in Table 5 it can be seen that the degree of preciseness of an indicator can vary. The second indicator mentioned is more general and only demands to favor practices that avoid erosion. By this indicator it is, however, left open what kind of measures are to be taken. The fourth indicator is more precise in this respect and mentions specific measures that have to be taken, like contour planting.

6.1.3. Procedure description

Similar to management rules, procedure descriptions give clear guidelines how a certain process has to be performed. However, they do not focus on single measures but on a whole process chain. An example is the chain-of-custody description (e.g. [59]) that ensures traceability of the biomass. Fig. 3 shows a possible scheme for a chain-of-custody for biomass trade, which was developed here by using elements of [59,60]. The main element is an elaborated reporting system covering all steps of the chain. This system, which demands reporting at all steps where biomass is transferred from one partner or enterprise in the chain to another, is the tool to ensure traceability.

6.1.4. Documentation systems

There are different documentation tools that are part of the indicators in certification systems. Bookkeeping is a tool to document financial transactions and the economic viability of entities. Other examples for documentations are mapping of ecosystems and endangered species in a project or biomass production area. In agricultural certification systems documentation is demanded for the use and handling of chemicals. Many certification standards give precise information on how documentation has to be performed (see Table 6).

6.1.5. Labor contracts

By labor contracts the conditions of employments, the employer's rights, working time and salary can be specified. Many of the social criteria from the areas 'labor conditions' and 'rights of woman and children' can be described and specified by working contracts. Table 7 shows examples for indicators that refer to working contracts.

6.1.6. Formulation of statements

The formulation of statements is especially used for the description of social and ecological criteria. These statements contain the aims that an entity is willing to strive for, e.g. to respect indigenous peoples rights or to keep track of the conservation of sensible ecosystems. The formulation of statements is often used for criteria that cannot be described in terms of 'hard' indicators. The FSC has elaborated the 'Social Strategy' [16]. It shows how to elaborate a social statement and which aspects should be included in the forestry sector.

An example for the contents of such a statement is given from [43]: 'As to labor rights, the licensee shall include the following items in a social statement:

- measures for upholding or developing cultural values,
- a detailed plan of the ban of discrimination…,
- the availability of drinking water for employees,
- a ban on enforced labor,
- housing for employees and provisions for cultivating food,
- measures with regard to protection of children,….
- opportunities for training and schooling,
- ……'

6.1.7. Compliance with national laws, international agreements or conventions and other legal agreements

Laws or international agreements cover different aspects of production and transport and other processes, which are of relevance for the biomass trade chain. Examples are national and EU laws on the admittance and use of pesticides or international agreements. Some of the international agreements, like (the Convention on International Trade in Endangered Species (CITES) of Wild Fauna and Flora), contain indicators which can directly be applied in a certification system for sustainable biomass trade. Others, like the International Labor Organization (ILO) conventions, first need an adaptation to the specific

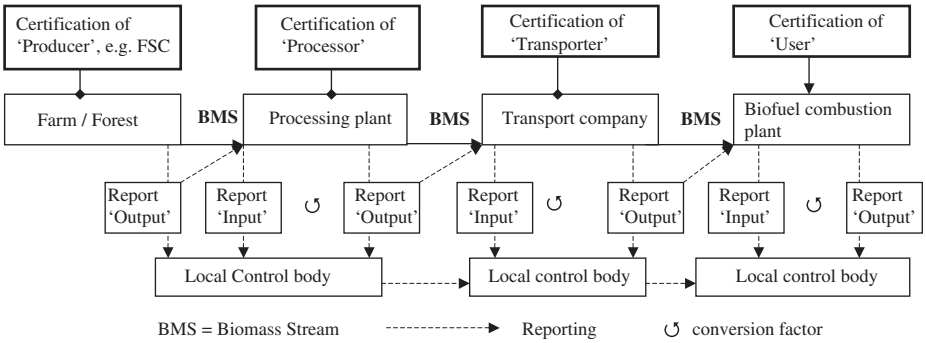

Fig. 3. Theoretical example for a physical separation chain-of-custody system for a biomass trade chain.

Table 6
Examples for indicators that demand for and describe the performance of documentation systems

Criteria described	Example state indicators	Source
The business has to be economically viable	The bookkeeping documents all money transactions and cost control. Costs are discriminated according to type of costs (harvest, weed control, skidding, etc.). Additional discrimination according to origin of costs (wages, plants, and machines) gives additional information	[43]
Prohibition of discrimination and equal pay for equal work	Payment must be made regularly and in legal tender and properly documented	[46]

Table 7
Indicators that refer to the formulation of working contracts

Criteria described	Example indicators	Source
Prohibition of forced labor	Enforced labor is prohibited. The licensee shall demonstrate that all employed persons have valid labor contracts	[43]
Women should not be discriminated and their rights have to be respected	Regarding other conditions of employment like maternity leave, social security provisions, non-monetary benefits, etc. at least the provisions as laid out in the Collective Bargaining Agreement or the Agreement signed between the workers' committee must be fulfilled	[46]

conditions of the relevant sectors for a certification system. Table 8 lists examples of such indicators.

6.1.8. Risk inventory

For describing the performance of criteria like 'Promotion and Protection of human health', 'Farmers, workers, etc. are not unnecessarily exposed to hazardous substances or risk of injury', 'minimization of supply disruptions', 'preservation of habitats', 'avoidance of soil erosion', risk inventories are used. Examples are:

- Environmental impact assessment (EIA) for analyzing the potential impacts of intensification of agriculture or forestry actions on different ecological aspects.
- Assessment of health risks and injury dangers for workers in certain production processes.
- Integral Biodiversity Impact Assessment System (IBIS), a more specific impact assessment tool developed by CREM to assess the impact of (agricultural) production processes on biodiversity [61].

IBIS is explained here as an example for a risk inventory system. IBIS applies a four-step assessment procedure [61]. In the first step it is analyzed whether the production system has an unacceptable environmental impact. 'Unacceptable' environmental impacts are extreme, negative land use conversions (e.g. from forest to agricultural land) or the use of unacceptable (e.g. not permitted) chemicals. Production systems with an unacceptable environmental impact will be rejected. Only an acceptable production system will be further analyzed in a second step where several biodiversity impact parameters are determined. For each parameter a checklist with specific criteria is used.[13] The impacts are linked to scores from 1 (no impact) to 4 (high impact).

In a third step, the importance of each parameter is determined by granting weighing factors to the indicators.[14] In the fourth and last step, the negative impact is related to the positive impact to come to an overall impact valuation. This overall impact can reach seven levels from strongly negative to highly positive.

All these indicator tools are methodological means to describe criteria and to make them measurable. For every criterion, that is relevant for sustainable biomass trade,

[13]For example, the checklist of habitat degradation covers several aspects related to the use of agrochemicals, fertilizers, aspects influencing erosion and activities that may lead to disturbance [61].

[14]The general weighing factors reflect the importance of parameters for biodiversity. Habitat destruction is, for example, weighed with an impact factor of 3, the introduction of an invasive species with 1.4.

Table 8
Examples for indicators describing the compliance with laws and agreements

Example indicators	Source
The licensee can demonstrate compliance with the national and local regulations and discharge any (administrative) obligations arising there from	[43]
All employment conditions must comply with local and regional regulations with regard to wages, workers age, working hours, working conditions, job security, unions, pensions and all other legal and health requirements	[44]
The employment conditions regarding freedom of association are in accordance with all the national and local legislation and ILO convention 87 (Freedom of Association and Protection of the Right to Organize Convention)	[56]
Chemicals that are banned in the European Union must not be used on crops destined for sale in the European Union	[44]
The producers live up to national and international legislation regarding the use of pesticides, handling pesticides (storing, filling, cleaning, administration, etc.), the protection of natural waters, virgin forest and other ecosystems of high ecological value, erosion and waste management	[46]

specific indicators will have to be chosen or to be developed. Most criteria are described by several indicators, which can from different indicator tool categories.

Some certification systems differentiate their indicators into categories of different importance. UTZ KAPEH and EUREPGAP formulate 'major must', 'minor must' and 'should' indicators. This differentiation allows for indicating the importance of fulfillment of indicators and could also serve for different 'certification levels' as is practiced by EUGENE. This system has a 'silver class' label and a 'gold class' label; the gold class label contains higher requirements for the share of green power from new plant, and eco-investments [20]. The Fairtrade certification system contains 'minimum requirements' and 'process requirements'. All producers must meet minimum requirements from the moment they join Fairtrade. On process requirements the producer organizations must show permanent improvement. This categorization allows for the participation of producer in the certification system when they fulfill a lower level of demands and to benefit from the system to have the resources to reach fulfillment of the process demands over time.

6.2. Verifier tools

The means of checking and controlling the performance of indicators are here called verifier tools. Verifier tools, that were identified in analyzing [43,44,46,49,56] are listed and explained in Table 9. The first four of them are on a 'presence level', which means that an auditor has to visit the location. There is also a range of administrative verifier tools, which can be used without visiting the location. The 'presence level' verifiers require more effort (travel expenses, time) than the 'administrative level' verifiers and can therefore be considered more expensive. However, the use of most administrative verifiers, like the checking of statements or of management plans, will have to be complemented by 'presence level' verifier like inquiries and visits of the facilities or fields. This is necessary because it needs to be checked whether the promises made in a statement, for example about the social situation of the workers, are really kept and whether planned management measures, for example soil erosion prevention, are taken in the actual management system.

7. Key results and recommendations for the development of a certification system for sustainable biomass trade

The objective of this study is to generate information that can help to develop a set of criteria and indicators and a certification system for sustainable biomass trade. For this purpose, existing certification and criteria systems and management guidelines in the areas relevant for biomass trade were reviewed and analyzed. Key results from this review are:

- Not for all areas of biomass trade certification systems are available.

Forestry, agriculture, plantations, transport, chain-of-custody control and trade are the areas of biomass trade for which systems were reviewed. Only for the forestry sector certification systems are available (e.g. FSC) which can directly be applied to or be integrated into a certification system for sustainable biomass trade.

For the agricultural sector several certification systems exist. They refer to different forms of farming, i.e. organic, integrated or GAP. All of them use criteria and indicators. Most of these indicators are formulated as management rules. None of them addresses how to integrate biomass production into conventional production methods in a sustainable way. Although EUREPGAP provides a good example for a feasible certification system in agriculture, it cannot just be transferred to biomass production. EUREPGAP contains management rules for the production of fruits and vegetables and focuses on the aspect of food quality management.

The FSC certification system also contains criteria and indicators for sustainable management of plantations [43]. Useful guidelines and criteria for sustainable management of plantation can also be found in IFC guidelines [48] and [63].

Standards for chain-of-custody controls are made available for sawn wood, chips and fiber products by FSC [59]. Other examples for chain-of-custody standards are given for agricultural products [44] or in waste treatment chains [60]. A major tool of these systems is effective reporting for every step of the chain.

Table 9
Tools for the verification of indicator performance; contained in different systems

Level:			
Verifier tool	Explanations	Examples for indicators being verified	Source
Presence:			
Field visits	Part of verification in nearly all certification systems from the agricultural and the forestry sector Only tool for controlling whether the documentation is in accordance with the real performance of a production process	There is visual or documented evidence of crossline techniques on slopes, drains, sowing grass or green fertilizers, trees and bushes on borders of sites, etc. Current diversity shall ..be preserved. This ..shall be considered when selecting trees for felling…	[56] [43]
Visits of facilities	Tool to check the availability and quality of required facilities, like for example separate rooms for the storage of chemicals, required technical equipment, safety of the working environment, etc.	All non-organic fertilizers… should not be stored in a manner which poses a risk of contamination to water sources, i.e. liquid fertilizer stores must be bunded…… Workplaces, machinery and equipment are safe and without risk to health…	[56] [46]
Measurements in the field	Delivers information about physical conditions, e.g. the growth rate in the forest as information needed to determine the sustainable rate of harvesting Delivers chemical information, e.g. about nitrogen residues in agricultural soils; needed for the determination of appropriate fertilization strategies Very sharp and precise verifier tool	The application levels of fertilizers should be based on nutrient requirements of the crop and on appropriate routine analysis of nutrient levels in the soil, the crop or in the nutrient solution	[44]
Inquiries	With worker, employer, farmer, forest manager and other persons involved in the processes Are for many social indicators the only valid verifier and the only mean to control if, for example, written statement on the quality of life, rights, etc. are respected	The organization allows trade union organizers to meet all the workers, and allows workers to hold meetings and organize themselves without the interference of the management	[46]
Administrative:			
Availability and performance of a management plan	Are written by the biomass producer when the production process is planned and describes how the production process has to be performed Is used to specify measures with relevance for the environmental impact of the production process The biomass producer has to document if the measures taken are in accordance with the management plan	The licensee is obliged to include ..in the management plan… – current or future protection measures for flora and fauna.. – measures taken to prevent erosion, improve soil conditions, etc…… Each grower should have a management of wildlife and conservation policy plan on their property	[43] [44]
Checking of book keeping and other documentations	Tool used verifying the performance of economic criteria, like the economic viability of the entity, and the compliance with laws and agreements Tool to check traceability of biomass Tool to check whether the performance of a production process is in accordance with the management plan or the management requirements	The common name of the pest(s), disease(s) or weed(s) treated is documented in all crop protection product application records The company maintains accurate, accessible and up-to-date processing/manufacturing records sufficient to permit SKAL international inspector to trace back from any given certified sale to the records of the certified inputs	[56] [59]
Checking statements	Applicable for verifying the performance of those indicators, which were addressed in statements on social or environmental criteria	The licensee shall demonstrate that local organizations directly involved in forest operations have been given the opportunity to take part in forest management	[43]
Checking availability and contents of working contracts	Suitable for verifying the performance of a range of indicators for social criteria, describing for example payment or working conditions	Salaries are in line with or exceeding regional average and official minimum wages for similar occupations. The employer will specify wages for all functions	[46]
Checking availability and contents of safety plans	Safety plans contain information about the potential danger for human health arising from the production process, like potential harm from the use of pesticides and dangerous machines, and about preventions taken to overcome the dangers	A risk assessment should be used to develop an action plan to promote safe an healthy working conditions	[44]

Table 9 (*continued*)

Level:			
Verifier tool	Explanations	Examples for indicators being verified	Source
	Safety plans are especially relevant for the verification of indicators describing criteria in the areas of labor conditions and human health		
Checking availability and contents of maps and up to date GIS tools	Especially relevant for the description of sensitive ecological areas that are either to be protected or be managed with special care	Sites of special archaeological, historical, religious, cultural or ecological significance to the regions shall be identified as such, designated as 'protected areas' and included in maps in the forest management plan	[43]
	Can be used to verify whether the management plan refers to these maps and the safe management of the designated ecosystem areas GIS can be used for precise positioning	Land use boundaries are delineated and demarcated	[62]
Checking availability and contents of legal agreements	For some criteria, like equal access to land, legal agreements can be laid down and serve as verifier for the performance of these criteria	Owner/forest manager demonstrates clear evidence of legal land use by having legal land title, customer right or lease agreement	[43]

No certification systems are found available for the transportation sector. Some criteria with relevance for the sustainability of transport processes can be derived from studies performed to assess the energy use, greenhouse gas emissions and cost effect of long-distance biomass transportation [7,4]. Also, the document by IKEA contains criteria for more efficient transport, e.g. by keeping transport volumes as low as possible [50].

- Not all aspects with relevance for sustainable biomass trade are described by criteria and indicators yet.

The selection of criteria for sustainable biomass either reflects the targets to be reached, e.g. 'The activity should contribute to strengthening and diversifying the local economy', or the undesired effects to be avoided, e.g. 'no depletion of ground and surface water resources'. Some of the targets or concerns related to sustainable biomass trade cannot sufficiently be described by criteria and indicators yet. In this context not sufficiently means that they are not operational for use in certification systems, which requires measurable indicators. Key examples for aspects, that are not addressed by existing C&I systems are avoidance of leakage effects, food and energy supply security, local benefits of biomass trade, combatement of poverty, greenhouse gas impacts and additionality.

- Lack of 'hard' and quantitative indicators.

Many of the indicators found in certification systems for the agricultural and forestry sector are not formulated precisely. The indicators 'farmers, workers, etc. are not unnecessarily exposed to hazardous substances or risk of injury', 'Minimization of wastes' and 'It should be strived to avoid the use of chemical pesticides' can be handled very flexible, because the terms 'unnecessarily', 'strive to' and 'minimization' leave room for different interpretations. Therefore, it is not always clear for the biomass producer or the auditor what kind of measures are exactly to be taken or to be avoided.

Socio-economic criteria like 'the activity should contribute to strengthening and diversifying the local economy' and 'generation of jobs' demand for indicators that quantify the economic benefit for the region or the number of jobs being generated. The sources analyzed here do not contain quantitative indicators on these kinds of criteria. Generally, a situation where the activity leads to any improvement against a baseline scenario (the situation that would be without the implementation of the activity or project) is accepted.

For most ecological criteria, like 'avoidance of soil erosion' or 'preservation of habitats' no quantitative indicators are given. Instead, management rules are formulated, which describe how to avoid or minimize unwanted effects like soil erosion.

The formulation of indicators for many social sustainability criteria requires normative decisions. Examples for such criteria are 'land ownership should be equitable', 'the farmers are content with their social situation', 'Fair and equal remuneration'. Formulating indicators for these criteria would require a definition of 'equitable land ownership' and 'fair payment'. It has to be found out how to make farmers content and it has to be decided to which extend the landscape has to be improved. The description of these criteria cannot only be performed by scientific exercises, but requires normative decisions.

- Stakeholder involvement is required.

The development of sustainability standards requires stakeholder involvement, because sustainability definition has to be performed context specific and according to the priorities and the perceptions of the people towards sustainability. Second, many social sustainability criteria

require normative decisions (see above). Where such decisions have to be failed, the relevant stakeholders to answer these questions have to be involved into the discussion and decision process.

On the background of these results the following recommendations are given for the development of a certification system for sustainable biomass trade:

- Forming an international panel that represents all stakeholders.

Biomass trade activities have already started. Therefore, urgent demand for the development of a certification system for sustainable biomass trade is given. A panel that includes representatives of all relevant stakeholders should guide the development of such a certification system. In this panel the countries that buy and use and those that produce the biomass should be represented. Important stakeholder groups that should be involved are the biomass producer (e.g. forest owner, farmer), biomass user (e.g. the energy companies), the consumer of 'green electricity', NGOs like WWF and Greenpeace and legislative bodies.

- Use available certification systems with care.

For those areas of biomass trade where credible certification systems are already available and well perceived it can be considered to use these systems. This means that biomass, which is certified by these systems, will be accepted as sustainable source. But before these systems are taken over, a careful analysis of them should be performed. In the forestry sector some certification systems like PEFC are criticized because they represent the interest of some stakeholder groups only; in the case of PEFC, these stakeholder groups are private forest owner and the wood industry. As a result, PEFC certification is considered 'weak' because forests were certified that were never seen by an auditor [64,65]. This means that existing certification systems should, on the background of the quality differences, carefully be chosen to avoid becoming the availability of a label per se the most important purpose. The driving force and motivation of the certification process should not be any certificate label but the wish towards more sustainability.

- Performance of case studies.

By reviewing existing certification and criteria systems and management guidelines in this study, a set of sustainability criteria relevant for sustainable biomass trade has been developed. This set can be used as input for the development of a certification system for sustainable biomass trade, but is not considered 'ready for use'. It is too long and indicators have to be selected or developed for specifying and quantifying these criteria.

As next step in the development of a C&I set for sustainable biomass trade, we recommend case studies in regions or on projects which are actual or potential biomass producer and exporter. Such case studies will serve several purposes. First relevant stakeholders can be involved in the process. The discussion with stakeholders will help to prioritize the criteria identified as relevant for sustainable biomass trade and help to shorten the list to key criteria. Second, the criteria and indicators can be specified for the region for which the case study is performed and for the production and trade conditions and/or problems encountered in that region. This will help in the sorting out and prioritization of criteria and indicators, too. Third, in case studies it can be analyzed how feasible the chosen criteria and indicators are. Such feasibility studies can investigate whether the indicators are applicable (can the people use the indicators?, do the indicators provide the needed information?, are enough data available?) and the costs of their application.

- Indicators need to be developed for several aspects in sustainable biomass trade.

For those important aspects that are not yet covered by available certification or C&I systems (leakage effects, food and energy supply security, local benefits of biomass trade, combatement of poverty, greenhouse gas impacts and additionality) indicators have to be developed. As a first step towards the development of indicators, methods to assess the performance of the criteria that describe these aspects have to be found.

For greenhouse gas emissions such assessment methods become available, for example, through the development of standardized greenhouse gas balances methods (see e.g. the IEA task 38 activities on http://www.joanneum.ac.at/iea-bioenergy-task38/).

Leakage effects are difficult to assess because they are indirect effects of biomass production and export systems and can reach global dimensions. CDM approaches the assessment of leakage effects by defining clear physical project borders and by including one step upward and downward in the chain analysis. But the system borders would have to be drawn wide enough to cover leakage effects; for the example of shifts of logging activities from one to another countries even whole countries would have to be considered within the project region. Such kind of analysis could be done by modeling countrywise the supply and demand for raw materials. An example for such a modeling approach is the assessment of land use and global food supply and demand done by the FAO [66]. These kind of modeling approaches can also be applied to assess the regional food and energy supply over time.

- Development of precise and strong indicators.

In a certification system for sustainable biomass trade the indicators should be formulated as specific and quantitative as possible. This helps avoiding that the people using the certification system do not understand or

wrongly interpret these indicators. There are several possibilities for clear formulations of indicators:

(A) Use scientifically sound or legislative threshold values where available (see [57]). Threshold values are available, for example, for the loads ecosystems can bear [58] (e.g. nitrate residues) or for the amounts of inputs (e.g. slurry fertilization) in agricultural production.
(B) Develop clear instructions and management rules. For some indicator, like the 'acceptable' amount of soil erosion, it is difficult to develop a threshold value. The 'best possible' result can be obtained by giving very clear instructions or by describing management rules that help to avoid soil erosion.
(C) Definition of the indicators together with stakeholders. Many indicators are formulated as management rules. It will be easier to understand and use them when they have been formulated together with people who will apply them (e.g. biomass producer) and who are familiar with the regional options and constraints of biomass production.
(D) Definition of site-specific management rules for agriculture and forestry. That helps to concentrate on the most relevant criteria (e.g. on erosion in a slope area, on child labor where it occurs, etc.). So a selection of the most important criterion can be done and for these criteria indicators can be described that reflect the regional demands and constraints.

- Development of strict and loose criteria and indicator sets and investigation of their impact on biomass production costs.

C&I systems can be formulated stricter or looser. Strictness here refers as well to the demands set by certification as to the precision of indicator formulation. A criterion demanding that the children of all employees of a biomass plantation can go to school (i.e. a school must be available and the schooling costs are reimbursed by the employer) is more demanding than the criterion 'work does not jeopardize schooling'. A more precise and thus stricter indicator for sustainable biomass production will control what kind of measures are exactly taken (e.g. contour plowing, mulch systems, etc.) to control erosion. By a weaker indicator it will only be controlled whether the farmer addresses erosion control in his management plan. How strict indicators are formulated can have impact on the costs of the traded biomass [67]. An assessment of the impact of the strictness of indicator sets can be performed in case studies to receive information on the 'costs' for 'more sustainable' biomass production.

Strict indicators may become a hurdle for the participation of organizations that cannot fulfill them because they have not enough financial means. The use of process indicators, as done by the Fairtrade certification system, can be recommended. Process indicators are indicators on which the participant has to show continuous improvement. Such process indicators set the hurdle for the initial participation in the system lower to give organizations the chance to improve their performance towards sustainability while participating in the activity.

Acknowledgment

This research was performed within the research project Fair(bio)trade (Possibilities, constraints and frame conditions for large-scale sustainable import of (energy from) biomass), funded by the Netherlands Agency for Energy and Environment NOVEM, and the Dutch utility Essent Sustainable Energy.

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