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BIOFUELS AND BIODIVERSITY: FURTHER INFORMATION ON THE WORK IN RESPONSE TO DECISION X/37

Note by the Executive Secretary

I. INTRODUCTION

1. In paragraph 12 of decision X/37, the Conference of the Parties requested the Executive Secretary to compile information on gaps in available standards and methodologies, identified in the work undertaken in paragraph 11[1] of that decision, and bring it to the attention of relevant organizations and processes. In paragraph 13 of decision X/37, the Conference of the Parties requested the Executive Secretary to contribute to and assist with the ongoing work of relevant partner organizations and processes. The Executive Secretary was requested to report on progress in these regards to a meeting of the Subsidiary Body on Scientific, Technical, and Technological Advice (SBSTTA) prior to the eleventh meeting of the Conference of the Parties.

2. Accordingly, the Executive Secretary has prepared this information note for the consideration of the sixteenth meeting of the Subsidiary Body. This information note provides the primary source for presession document UNEP/CBD/SSTTA/16/14 and further details the work undertaken, including the analysis of information submitted by parties and collected from recent scientific literature.

* UNEP/CBD/SBSTTA/16/1.

[1] In summary, paragraph 11 of decision X/37 requested the Executive Secretary, subject to the availability of financial resources, to compile, assess and summarize information on tools for voluntary use to assess direct and indirect effects and impacts on biodiversity of the production and use of biofuels, in their full life cycle as compared to that of other types of fuels, and impacts on biodiversity that affect related socio-economic conditions, taking into account the work of, and in collaboration with, relevant partner organizations and processes, building on relevant decisions taken and guidance developed by the Convention on Biological Diversity.

II. INFORMATION SUBMITTED BY PARTIES AND ORGANIZATIONS ON EXPERIENCES AND RESULTS FROM RELEVANT ASSESSMENTS

3. In paragraph 14 of decision X/37, the Conference of the Parties invited Parties, other Governments and relevant organizations to submit to the Executive Secretary experiences and results from assessments of the impacts of biofuel production and use on biodiversity and impacts on biodiversity that affect related socioeconomic conditions, as well as activities identified in paragraphs 7, 8 and 9 of decision X/37, to support the actions requested to the Executive Secretary in paragraph 13 and requested the Executive Secretary to make such experiences and results available to Parties through the clearing-house mechanism.

4. In response to this request, the Executive Secretary issued notification SCBD/STTM/JM/DCO/76500 (2011-121) on 16 June 2011, indicating that submissions can be received at any time but noting relevant timelines for inclusion in the documentation for the sixteenth meeting of the Subsidiary Body. As of the date of this note, submissions had been received from Brazil, the European Union (EU) (on behalf of the European Union Member States Belgium, Finland, France, Germany, the Netherlands and the United Kingdom), Norway and Switzerland. Submissions were also received from the following organizations: the European Centre for Nature Conservation (ECNC), United Nations Environment Programme-World Conservation Monitoring Centre (UNEP-WCMC), the Swedish Board of Agriculture, the United Nations University – Institute of Advanced Studies (UNU-IAS), and Word Wildlife Fund for Nature International. Submissions, as they are received, are being posted in full at https://www.cbd.int/agro/biofuels/responses.shtml. A number of these submissions contain information explicitly on tools, and this has also been made available at https://www.cbd.int/agro/biofuels/tools.shtml, together with other information sources on this subject (in response to the request to the Executive Secretary in decision X/37, paragraph. 11 (c)). Since the information supplied through this notification is available through the aforementioned sources, it is not summarized separately in this note but has been incorporated, as feasible, as information in subsequent sections of this note (as referenced).

5. An advanced copy of this note was posted for peer review from 05-29 February, 2012. Comments were received from the secretariats of Global Bioenergy Partnership and the Roundtable on Sustainable Biofuels.

III. OVERVIEW OF SCIENTIFIC PROGRESS AND SOME KEY ISSUES AND GAPS

6. There has been considerable attention to sustainable biofuels, both in the scientific literature and by many Parties and processes, since the science of the topic was first discussed under the Convention on Biological Diversity; that is, since discussions at the twelfth meeting of SBSTTA in 2007. A useful recent analysis of biofuels, particularly regarding "first generation" biofuels and emerging alternatives, has been provided by UNEP[2] (2009), which is one of the first reports of the International Panel on Sustainable Resources Management, based on consultations of its Working Group on biofuels. Campbell and Doswald[3] (2009) and Stromberg[4] *et al*. (2010) provide reviews of scientific literature on the impacts of biofuels on biodiversity. Working Group III of the Inter-Governmental Panel on Climate Change (IPCC) has recently provided a comprehensive assessment and analysis of renewable energy technologies, including bioenergy, and their current and potential role in the mitigation of greenhouse-gas emissions (IPCC 2011).

7. A recent report on the ethics of biofuels by the Nuffield Council on Bioethics (2011) concludes there is an ethical duty to support biofuels that can satisfy five ethical principles simultaneously and to discourage biofuels that fall short on meeting one or more (Buyx and Tait 2011). These principles are that biofuels should: not be at the expense of people's essential rights; be environmentally sustainable;

[2] Submitted by UNEP-WCMC.

[3] Submitted by UNEP-WCMC.

[4] Submitted by UNU-IAS.

contribute to net reduction of total greenhouse-gas emissions (GHG) and not exacerbate global climate change; recognize the rights of people to just reward; and, costs and benefits of biofuels should be distributed in an equitable way. Buyx and Tait (2011) point out that most biofuels production currently does not meet all these principles. However, the current note identifies some ongoing processes to use these or similar principles to guide their efforts.

8. Decisions IX/2 and X/37 recognize the potential for biofuels to have both positive and negative impacts on socio-economic conditions, including for indigenous and local communities. Limited information on socioeconomic aspects of biofuels was provided in submissions received, including on monitoring and reporting of implications for indigenous and local communities, and on socio-economic impacts occurring through changes in biodiversity associated with biofuels production and use. Consideration of human rights and socio-economic impacts of biofuels has been incorporated into some regulatory mechanisms, such as: the EU Renewable Energy Directive (RED); voluntary certification standards, such as the Roundtable on Biofuels and the Global Bioenergy Partnership's (GBEP) indicators for sustainable energy (discussed in more detail in Section V); and a limited number of tools, such as the UN-Bioenergy Support Tool (Module 6: People and Processes). The Nuffield Council on Bioethics (2011) calls for regulations to ensure biofuels produced and imported meet human rights standards and monitoring systems to be put in place to detect abuses. A common criticism is with some new developments driven by multi-national companies and/or foreign investment: local communities often lack knowledge, legal experience and capacity to negotiate equitable terms and ensure accountability (Gilbert 2011). Important gaps remain concerning implications of biofuels investments (including foreign investments) for local communities in developing countries, and ensuring their full and effective participation. Solutions suggested include more widespread and enforceable corporate social responsibility, improved government oversight, and support and incentives for smallholder biofuel schemes (Gilbert 2011).

9. Scientific and other awareness of biofuels has rapidly advanced in recent years. Relevant key issues are not yet resolved but more comprehensive attention to achieving sustainability is emerging. However, the information landscape is becoming quite complex, as would be expected in a healthy discussion of what is a complex topic. Polarized views on the benefits of biofuels also continue and scientific information can be found to support over positive or over negative positions, although some of this is of questionable quality in both cases. The more robust scientific assessments continue to generate wide variations in projections of impacts, mostly because of the uncertainties with underlying assumptions made. Such science also allows conclusions to be contested (either positively or negatively) by changing the assumptions made. But most of the more comprehensive and independent reviews undertaken conclude that the enthusiasm for biofuels, as a large scale long-term solution for renewable energy, has been over-optimistic (if constraints are factored in) although they also mostly confirm that opportunities do indeed exist provided that the broader issues of sustainability can be addressed and changing opportunities are factored into flexible renewable energy policies in the longer-term.

10. Much of the discussion regarding sustainability for biofuels, including in the context of the CBD, is based on an assumption that policies are driven largely by climate change mitigation considerations. However, much informal expert opinion is that the key driver of policy is often energy security where sustainability issues may not necessarily be different but priorities and trade-off decisions are. This is likely a factor explaining why some biofuels policies persist despite concrete proof of lack of sustainability on environmental or economic grounds or benefits in terms of climate change mitigation. Widely quoted examples, amongst others, include corn-ethanol production (largely in North America), rape-seed biodiesel in Europe and oil-palm/biodiesel in South-East Asia, especially when based on peat forest conversion (FAO 2008; Searchinger *et al*. 2008; UNEP-Grid Arendal 2011). No submission received assesses biofuels in any detail with regards to energy security, whereas most include considerable attention to climate change mitigation, despite specific reference to energy security in decisions IX/2 paragraph 3(b) and X/37 paragraphs 2, 3 and 4. This gap in current knowledge limits a full appreciation of the relevant drivers of biodiversity loss. The energy security benefits of biofuels can be expected to differ significantly according to scale and national circumstance.

11. In order to better address issues of biofuel sustainability, Gasparatos[5] *et al*. (2011) provide a critical review of drivers, impacts and trade-offs of biofuel production using the concept of ecosystem services and the Millennium Ecosystem Assessment framework. Biofuels can provide certain ecosystem services (e.g. fuel, climate regulation, and erosion control) but also compromise other ecosystem services (e.g. food, water). The authors argue that the concept of ecosystem services can offer explanatory power to assist policy makers in identify trade-offs in biofuel production, and can aid in a coordinated action for development and enforcement of biofuel sustainability. A major knowledge gap identified was the lack of literature linking biofuels, ecosystem services and human well-being. Gasparatos *et al*. (2011) also cite a lack of consistent language on the diverse trade-offs with biofuels that could better frame the biofuel debate, and lack of tools and toolkits for assessing the sustainability of various biofuel practices, taking into account their full lifecycle.

12. The Convention on Biological Diversity itself is a “tool” for the promotion of sustainable approaches to biofuels with regards to biodiversity. There is evidence that the Convention has already contributed in this regard. Although this note is not a comprehensive review, reference to the Convention on Biological Diversity, and particularly deliberations of SBSTTA-12 and decision IX/2, are explicitly made in a number of relevant reviews including Campbell and Doswald (2009), Delbaere[6] *et al*. (2009), Hennenberg *et al*. (2009), UNEP (2009), Buyx and Tait (2011) and IPCC (2011), as well as incorporated into some relevant sustainability processes (examples are given below).

A. Dedicated energy crops versus integrated bioenergy approaches

13. Although there is a broad spectrum of biofuel technologies, for the sake of discussion it can help to identify two approaches each at the end of this spectrum. The first is the production of dedicated bioenergy feedstocks through intensive or semi-intensive means, usually involving mono-cultures. With these, energy is the primary objective or end result of growing the crop, even though a crop may be also grown elsewhere, even nearby, for other purposes (e.g. food). The benefits of such approaches remain the most controversial and, for some examples, conflicts with food security, lack of sustainability, significant biodiversity loss and limited, if not negative, greenhouse-gas benefits are well proven. But this is not always the case (see the example of sugarcane in Brazil below). The second approach is to look at opportunities for bioenergy benefits from "waste" products, or "surplus" biomass, especially when integrated into existing systems. These include, as the simplest and clearest example, recycling used cooking oil to supply local biodiesel, but also the integration of bioenergy into existing local farming and forestry systems. One of the features of submissions received (re. notification 2011-121) both in terms of government experience and scientific information supplied, is the increasing interest in this second, integrated, approach and waning enthusiasm for the first (intensive) approach.

14. As examples of more integrated approaches: an analysis of integrating climate and biodiversity into milk and meat production in Sweden is provided by Kumm[7] (2011); the WWF Living Forests Report (WWF International[8] 2011) includes chapter 2 which discusses integrating forests and bioenergy. But such approaches are not without constraints. For example, the Finnish Environmental Agency modelled the carbon impact of increased forest biomass use finding that: using more wood for bioenergy is leading to decreasing carbon stocks in the Finnish forests, because soil carbon levels are lower and burning wood releases more carbon more quickly than leaving dead wood to decay slowly; both transport and chipping of wood cause emissions; and different parts of a tree have different GHG benefit (Liski *et al*. 2011).

15. The integration of co-products from biofuels refineries can produce large savings in GHG emissions (varying greatly by fuel type), and boost revenues and value of a feedstock (Fairley 2011; UNEP-GRID Arendal 2011). For example, a biorefinery co-product that can be used as protein for animal feed replaces the need for soy cultivation, avoiding associated land-use and reducing GHG emissions

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[5] Submitted by UNU-IAS.

[6] Submitted by ECNC.

[7] Submitted by the Swedish Board of Agriculture.

[8] Submitted by WWF-International.

(Gallagher 2008). The development of bio-refineries can increase resource efficiency by producing solid residues that can provide the bio-refinery with "free" power, and produce chemicals or other fuels (Fairley 2011). The economic value of co-products from biomass is critical and should be part of an economic feasibility study of biofuels production (UNEP-GRID Arendal 2011).

B. New technologies for bioenergy production

16. One area of rapid advancement has been regarding so called "second generation" biofuels, or ligno-cellulose technology, often accompanied by genetic modification of biological agents required to break down cellulose. However, there is still much need for research on an effective, economical and large-scale chemical transformation process for cellulosic biofuels (Nigam and Singh 2011). This offers the opportunity to move away from using foods (essentially plant oils and carbohydrates) to increasing bioenergy derived from non-food crops or the non-food components of food crops (usually "waste" cellulose) as a way to integrate energy and food production. However, the extent to which "waste" (cellulose) is available in farming and forestry systems is debated. Much of it is actually required to support soil functions and fertility and often directly supports other biodiversity.

17. IPCC (2011) concludes, based on climate change mitigation objectives, that: ligno-cellulosic biofuels to replace gasoline, diesel and jet fuels, advanced bio-electricity options and bio-refinery concepts can offer competitive deployment of bioenergy for the 2020 to 2030 timeframe; and combining biomass conversion with carbon capture and storage raises the possibility of achieving GHG removal from the atmosphere in the long term - a necessity for substantial GHG emission reductions. Ligno-cellulose technology is often regarded as a means to minimize direct and indirect land-use change (because productivity gains reduce overall land pressures from biofuels) but further science on its application suggests that this is very much case specific. Some studies have suggested that ligno-cellulose derived biofuels may require a larger land area (on a global scale) than first generation biofuels (Gallagher 2008; Gurgel *et al*. 2008; Rubin 2008; FAO 2008). This is largely due to the fact that many second generation biofuels do not produce beneficial co-products such as animal fodder, which would need to be grown separately (Farrell *et al*. 2006; Eickhout *et al.* 2008; Gallagher 2008). The potential of 'second generation' biofuel for climate change mitigation could also be considered doubtful if it involves the large areas of land use change projected (Gallagher 2008). Biemans[9] *et al*. (2008) provide an assessment of biofuels production on biodiversity in Europe with particular attention to ligno-cellulosic technologies noting positive or negative impacts depending on the technology and feedstocks.

18. There is much interest in algal biofuels and some optimism (UNEP 2009). This has been cited as the only renewable biofuel source that has the potential to completely displace petroleum-derived transport fuels (Chisti 2008). Research has shown that the oil content of algae could be 200 times more productive per hectare than a land-based crop (Nigam and Singh 2011). However, the argument that algae present options to reduce land pressures (e.g. UNEP 2009) because they can be produced in aquatic environments (wetlands) illustrates the need for more impartial and broader ecosystem-based approaches (because algae based systems actually shift pressures between biomes and do not necessarily reduce them).

C. Sustainability criteria and certification schemes

19. Many Governments and initiatives are applying and/or developing criteria as a tool to achieve the sustainability of biofuels. At least 29 initiatives (as of 2009) were being led by national agencies, NGOs, and associations to create, verify, and certify performance standards for the sustainable production of biomass and biofuels (UNEP 2009). To be fully effective, they must be based on comprehensive life-cycle analyses (LCA) (see section on LCA, p.8), and will not be able to ensure sustainability without effective criterion on indirect land-use change (iLUC) (see section on iLUC, p.14), necessitating a precautionary approach in developing and sourcing biofuels. The International Energy Agency (IEA)

[9] Submitted by ECNC.

cites 67 initiatives developing criteria for biofuel sustainability (IEA 2011). Further discussion is provided by Helldin[10] *et al*. (2009) and van Dam (2010).

20. Through the Renewable Energy Directive (RED), the European Commission has developed regulatory standards that apply to all biofuel feedstocks used to meet the renewable energy targets, whether grown in or imported to the EU. The European Commission (2010) provides a brief on sustainability requirements for the use of solid and gaseous biomass sources in electricity, heating and cooling. However, as stated above, certification schemes and sustainability criteria need to be based on comprehensive LCAs to be fully effective. For example, in the EU RED, fertiliser use has hardly been mentioned and involves on-site N_2O emissions but not necessarily off-site emissions, other considerations are also currently weak, for example water use (EU 2009).

21. In terms of managing certification processes, Germany (in its submission to notification 2011-121) reports the development of a web-based electronic system to minimize bureaucratic procedures and to check at each stage the plausibility of proofs of sustainability and already recognizes three certification systems and 29 certification bodies.

22. Voluntary standards and their associated certification schemes are under development by various initiatives, industry or other interested groups such as NGOs, and often promoted by multi-stakeholder alliances. They typically set out criteria or principles that producers can adhere to in order to get accreditation to that standard. They lack the legal clout of regulatory standards, but can be applied across a wider geographic area. The Netherlands Agency (2011) provides guidance on selection of certification schemes, tools and information for biomass actors, and outlines a variety of voluntary certification schemes that have become operational for the production, processing and trade of biomass, for the agricultural and forestry products (e.g. International Sustainability and Carbon Certification (ISCC), Forest Stewardship Council (FSC), Roundtable on Sustainable Biofuels (RSB)). Crop-specific voluntary initiatives such as the Better Sugar Cane Initiative, the Roundtable on Responsible Soy (RTRS) and the Roundtable on Sustainable Palm Oil (RSPO) have developed or are developing voluntary standards that consider, amongst other things, the biodiversity impacts of biofuel production. A comparison of these initiatives can be found in Hennenberg *et al*. (2009) and UNEP (2009). More detailed examples of sustainability standards under development by the Global Bioenergy Partnership and the Roundtable on Sustainable Biofuels are provided in section IV.

23. Some Governments are already applying their own and often more stringent standards. Switzerland, for example, has set standards whereby all biofuels derived from oil palm, cereals and soybeans are banned outright (although exemptions can be applied for if users can show a sustainable source) whereas others can only be used after they are evaluated against a range of criteria addressing GHG emissions, social, and environmental performance (see the Swiss submission to notification 2011-121 for further information).

24. Standards and certification and accompanying mechanisms need to be further developed to consider all relevant environmental and social impacts, including iLUC. Product and production-chain specific criteria need to be combined with findings at the macro level (e.g. projections of overall biomass and related land use of a new importing country) (UNEP 2009). It has been suggested that the current diversity of standards calls for harmonization to ensure agreed environmental aims are met. Some of the schemes mentioned above are making good progress in developing consensus on standards and tools for monitoring and certification. But there are concerns regarding the effectiveness of voluntary frameworks, especially under globalized conditions. Buyx and Tait (2011), for example, point out that each member state of the EU setting its own standards would lead to 27 variations. Market-based certification usually only covers a fraction of the product market creating the appearance of sustainability whilst unsustainable production continues (UNEP 2009). There are therefore numerous calls international agreed standards and frameworks: for example, the Cramer Commission[11] (2007), UNEP (2009), Buyx and Tait (2011),

[10] Submitted by the Swedish Board of Agriculture.

[11] Submitted by the Netherlands.

and the International Energy Agency (IEA 2011). Robbins (2011) suggests the development of a standard for biofuels by the International Organization for Standardization (ISO). One reviewer noted that the ISO is already developing sustainability criteria for bioenergy; however limited information is currently available. Most recognize the need to implement international standards without creating unwanted trade barriers, especially for developing countries, and call for a mandatory regulatory framework under a UN agency or instrument.

25. Certification standards for the sustainability of biofuels could be found to be discriminatory and hence illegal under international trade law, if sustainable biofuels are treated more favourably than non-sustainable biofuels (GSI 2007; de Gorter and Just 2009). Discriminating between domestic and imported products based on processes or production methods used to produce them is prohibited to members of the World Trade Organization (WTO) (de Gorter and Just 2009). For example, a country may be challenged by the WTO if it were to treat imports differently based on a LCA of GHG savings, supporting a mandatory certification scheme. Criteria also must be flexible enough for developing countries to meet under their prevailing local conditions, and not act as a trade barrier. If countries or world regions impose different GHG emissions requirements for biofuel production, this could also exclude certain regions or crops from trading with certain countries or regions. The GSI (2007) states that international consensus on sustainability standards for biofuels is necessary or they may not form a legitimate basis for regulations applied by importers. Most of the iLUC impacts caused by biofuels are actually driven by trade in biomass commodities (although biofuels are by no means unique in this regard). Trade, biofuels, sustainability, iLUC and biodiversity are therefore intimately linked.

26. Land expansion, and other impacts, from energy or food crops are similar. Food security has a tendency to dominate agricultural objectives and is also dependent on sustainability. But a significant proportion of agricultural production does not support food security and can be challenged on ethical grounds even more so than for biofuels. Whilst some argue that biofuels should be regulated more stringently than other agricultural products others, backed by most scientific evidence and argument, support equal standards being applied to all agricultural commodities (see FAO 2008; Gallagher 2008; de Gorter and Just 2009). De Gorter and Just (2009), argue that regulating GHG emissions for some uses of crops and not others is illogical from an economic viewpoint. For example, corn is used for beef, bourbon, high-fructose corn syrup and chemical products, but these uses do not generate energy. Therefore, there is no reason that corn ethanol should be more stringently regulated than other products made from corn.

27. De Gorter and Just (2010) also state that ethanol in itself is carbon neutral by definition; it is the practices used in biofuel production that cause a net increase or decrease in CO_2 emissions. Rather than regulating biofuels emissions using sustainability standards, they suggest that GHG emissions should be regulated through a Pigouvian subsidy (subsidising positive externalities and encouraging production) or by providing a carbon offset for agricultural practices that result in CO_2 mitigation activities, such as no-tillage crop production, and that it be extended across all crop production, not just for biofuel crops. Practices that result in a net increase in CO_2 emissions should require a Pigouvian tax (taxing a market activity that generates negative externalities). They propose that a comprehensive framework be developed to mitigate GHG emissions from agriculture, land use and land-use change.

28. De Gorter and Just (2009) argue that sustainability standards based on LCA, with or without the consideration iLUC, are ineffective, provide little guidance to policymakers and may discourage biofuel production. They state that sustainability standards can be misleading because they divert attention away from other more important biofuel policy issues, such as the contradictions and inefficiencies of ethanol import tariffs, tax credits, mandates, and subsidies, all of which exist whether ethanol is sustainable or not. Furthermore, they criticize sustainability standards for ignoring a shuffling effect: if incentives are used to encourage ethanol producers to use cleaner inputs (e.g. natural gas) for ethanol production, the dirtier inputs (e.g. coal) will be diverted to other uses with no net reduction in GHG emisions.

D. Assessing biofuels against renewable energies as well as fossil fuels

29. Energy demand is projected to increase significantly in the coming decades (IEA 2009). As a result, an integral part of energy strategies for both developing and industrialized nations is abundant, cheap, renewable and environmentally friendly energy (Gasparatos *et al*. 2011). However, much of the literature on biofuels implicitly assumes that biofuel production and use is an objective in itself simply because it is "renewable". But biofuels are one amongst many potential renewable options and comparisons should therefore be made amongst those options. There is of course attention to this in forums discussing wider energy interests and IPCC (2011) provides such a broader review of renewable energy as a whole. Nevertheless, life-cycle comparisons currently made in the biofuels literature and processes are usually against the performance and impacts of fossil fuels and rarely, and as would be more appropriate, against the performance of other renewable energies.

30. The science and technology for other energy sources is also rapidly advancing, including for alternatives to biofuels, and the economics is rapidly changing. This needs to be factored into biofuels policy. For example, biofuels are essentially life-based solar energy systems and the most immediate comparison could be with artificial "solar power". Biomass has the lowest power density of all renewable energies, and therefore requires the largest amount of land per unit of energy derived. Biomass in land cover (agriculture or forestry) can generally store only about 1 to 6% of the solar radiation input (Woods *et al.* 2009) and still requires transformation into useful energy. Technologies such as photo-voltaics (PV) and solar thermal power do far better; already, they can make use of 9 to 24% of the radiation input, with recent averages of about 15% (Lightfoot & Green 2002; Green *et al*. 2007; World Energy Council 2007). Furthermore, solar systems can be installed on buildings requiring no additional land. However, biomass in the form of agricultural wastes and residues generally also does not require additional land.

31. Millions of motor vehicles require a compatible liquid fuel to the existing technology for the short-medium term (Robbins 2011; Fairley 2011). Liquid fuels must therefore be included in any attempts towards sustainable energy for transportation. To enable independence from imported petroleum in the longer term, it has been suggested that light vehicles become electric and biofuels be used for heavy vehicles (Savage 2011). There is a particularly strong argument for alternative liquid fuels for aviation transport due to the difficulties of re-engineering aircraft engines. But in the longer term even these applications need not necessarily be based on liquid biofuels. Technologies already exist to produce artificial liquid fuels without a biomass feedstock (although an energy source is still required). Kubiak and Sathrum (Science 2011) and Rosen *et al*. (2011) report simple artificial technologies to capture energy from the sun, convert it to electrical energy and "split" carbon dioxide into carbon monoxide and oxygen. Reece *et al.* (2011) report the development of a simple "artificial leaf" to further mimic photosynthesis and split water into oxygen and hydrogen. These are further examples of first steps in producing artificial fuels that could potentially replace biofuels.

32. Despite advancing science and technology, cost efficiencies and deployment are of course primary concerns. But here too rapid changes are occurring. IPCC (2011) notes the exponential decreases being achieved in the costs of production of energy from PV cells whereas costs for liquid biofuels, based on current technology, show meagre improvements by comparison. For these, and other, reasons the IPCC (2011) concluded that the literature indicates that long-term objectives for renewable energy and flexibility to learn from experience would be critical to achieve cost-effective and high penetrations of renewable energy.

33. Other aspects of renewable alternatives to biofuels are also relevant including, for example, their GHG savings, environment and biodiversity impacts and economic and social issues. In decision IX/2, the Conference of the Parties well recognizes the need for a comprehensive understanding of the relevant and comparable impacts of other fuel types so that the performance of biofuels *vis-a-vis* alternatives can be fairly and reasonably assessed. Such considerations would generally fall under much needed comprehensive life-cycle analysis (see below). More emphasis in the biofuels debate on the broader renewable energy debate, and broader comparisons between energy options, would help achieve this.

E. Life-cycle analysis (LCA)

34. There has been considerable attention to LCA in recent years and the primary driver of this has been the need to assess, and compare, GHG emissions and the environmental footprint of fuel types, taking into account all stages of the biofuel lifecycle from seed to wheel. This is of direct relevance to biodiversity considerations because GHG benefits are a factor in biodiversity trade-offs and in some cases, particularly with land-use effects, the GHG emissions in question arise directly from biological resources (e.g. forests). Land-use change should be a central element in LCA, including for GHG assessments, and is discussed further below.

35. Cherubini[12] *et al*. (2011) note that bioenergy systems, in terms of the carbon content of the energy itself, are often considered climate neutral because the CO2 released from biomass combustion approximately equals the amount of CO2 sequestered by biomass re-growth. Hence, these biogenic CO2 emissions are *de facto* ignored in many LCAs. But this underestimates the importance of the time perspective: before it can be captured by re-growth, this CO2 emission remains in the atmosphere for a certain number of years and it actively contributes to climate change. They provide a case study of a bio-refinery system producing transportation biofuels, biochemicals and bioenergy from forest wood. When the delay factor is included in the assessment, the GHG savings of the bio-refinery are drastically reduced and its contribution to climate change becomes approximately similar to that of the respective fossil reference system. Similarly, Holtsmark[13] (2010), for example, concludes that wood harvesting and combustion are not carbon-neutral activities, even if "sustainable" and not involving land-use change, and that increasing the use of wood from otherwise sustainably managed boreal forest to replace coal in power plants will create a carbon debt that will only be repaid after 150 years. If the wood is used to produce second-generation liquid biofuels and replaces fossil diesel, the payback time of the carbon debt is 230 years. Different wood sources in the forest also have different implications for GHG emissions in LCA. However, the GHG saving from bioenergy obtained through increased use of waste from different forest-related industries can deliver positive benefits. The challenge is to measure these GHG contributions with unit based indicators to be included in LCA. The inherent difficulties to quantify this effect have so far hindered accurate estimation. The European Energy Agency (EEA) Scientific Committee (2011) recommends that accounting standards for GHG emissions fully reflect all changes in the amount of carbon stored by ecosystems, including the ecosystem carbon uptake and loss, resulting from production and use of biofuels.

36. UNEP-GRID Arendal (2011) illustrates (fig. 3.1.4, p. 22 and 3.1.5, p. 23) that a biofuel's carbon footprint varies greatly by type of land converted to biofuel, and the type and yield of the feedstock. It is therefore key that LCAs of biofuels include impacts from land-use change and include impacts along the entire life-cycle. Searchinger *et al* 2008, pointed out the fundamental flaw in LCA was ignoring GHG emissions due to indirect land-use change (iLUC) (see section on iLUC, p.14). However, expanding LCA to account for all indirect changes would mean measuring indirect effects in the oil sector for a fair comparison (de Gorter and Just 2010). For example, the indirect effects of oil production in the Ecuatorial jungle, or the indirect emissions from military expenditures protecting gasoline produced from Middle East petroleum would have to calculated, where a conservative estimate for the latter would double GHG emissions from gasoline (de Gorter and Just 2010). Furthermore, when conducting LCA on ethanol, it is assumed that ethanol replaces gasoline, but de Gorter and Just (2009) state that instead ethanol displaces gasoline; for example, gasoline, in turn, may replace something else like coal. Similarly, biofuels may also displace wood burning, used for home cooking in developing countries, reducing human health risks and environmental costs. Therefore, a fossil fuel chosen as a reference point in LCA may not always serve as the best comparison.

37. However, LCA should include much more than GHG considerations; a broad range of assessment impact categories are necessary for a more holistic assessment (UNEP-GRID Arendal 2011).

[12] Submitted by Norway.

[13] Submitted by Norway.

UNEP (2009) assessed a representative sample of LCA studies on biofuels and concluded that less than one third presented results for acidification and eutrophication, and only a few for toxicity potential (either human toxicity or eco-toxicity, or both), summer smog, ozone depletion or abiotic resource depletion potential, and none on biodiversity. France submitted (to notification 2011-121) a recent national-level LCA report comparing biofuels against fossil fuels used in France. The LCA included an analysis of eutrophication, photo-oxidation and human toxicity potential for all biofuels, and took into account potential N2O emissions using simulations (BIO Intelligence Service 2010).

38. LCA methodologies are under development, not adequately standardized and have inconsistent assumptions between studies, which does not allow for comparable results between fuel types (Mandil and Shihab-Eldin 2010). UNEP (2009) recommends: (i) to further develop biofuel certification, and accompanying mechanisms to better consider indirect land-use change, GHG effects and other impacts, such as eutrophication, more comprehensively, in particular to combine product and production-chain specific criteria with findings on the macro level (e.g. projections of overall biomass and related land use of a net importing country); (ii) harmonize rules on how to carry out LCAs on biofuels, setting reasonable guidelines and assumptions for methodological issues, determining how to deal with the associated uncertainty of key parameters (e.g. allocation rules of impacts on co-products, N2O emission rates, land use, carbon stocks, technology progress, etc.), including water-consumption and pollution issues; and (iii) develop technologies and political mechanisms to reduce the demand of energy, material, and land intensive activities. McKone *et al*. (2010) identify seven grand challenges for applying LCA to biofuels: understanding farmers, feedstock options, and land use; predicting biofuel production technologies and practices; characterizing tailpipe emissions and their health consequences; incorporating spatial heterogeneity in inventories and assessments; assessing transitions as well as end states; and confronting uncertainty and variability. Guidance and best-practice is needed to address uncertainty and variability in LCAs with respect to data quality; data corroboration and validation; and temporal, spatial and technological variability (McKone *et al*. 2010). LCA is an on-going process that can provide useful insight by organising and prioritising information needs, but is not necessarily a final product (McKone *et al.* 2010). Some argue (e.g., Pfromm *et al*. 2011) that an engineering mass balance/unit approach may be a more robust method to assess sustainability of biofuels than the LCA method, which is in essence an accounting procedure that has been criticized for lacking a coherent scientific foundation.

F. Land use

39. Biofuel production has increased, yet land is a resource that is declining globally (UNEP-GRID Arendal 2011). As the world population continues to grow and food demand is expected to rise, many sectors are competing for the same land. Biofuels is only one of the competing industries. Several reports have projected that biofuels could fill 20-50% of the world demand in energy in the coming decades. This would require double or triple the amount of plant material currently being harvested on earth (EEA Scientific Committee 2011). Biofuels' land requirements often exceed a country's own resources, creating a spill-over onto other countries and regions (UNEP-GRID Arendal). For example, it has been estimated that most European countries do not have sufficient land area to fulfill current biofuels blending mandates in the European Union (EU) Renewable Energy Directive (RED) (UNEP-GRID Arendal 2011). In the United Kingdom's submission, it was reported that in 2008, 90% of the biofuel used in the UK was coming from overseas feedstock requiring an estimated 1.4 million hectares of land overseas for its production. By 2020, it is projected that demand for imported biofuels would require an additional 4-8 million hectares of land. Use of water is also a critically limiting factor for the development of biofuels; the agricultural sector uses over 70% of available freshwater resources. UNEP-Grid Arendal (2011; figure 3.3.1) shows that the global trade in biofuel crops has created a "virtual water exchange" where some countries with limited water resources export their water in the form of biofuels.

40. The best use of land depends on a country's specific conditions and trade-offs between policy objectives. Different feedstocks and fuels, local variables and production practices have different energy input and output, and land use impacts. UNEP-GRID Arendal (2011; figure 3.2.1.) illustrates the land required for biofuels by feedstock: Sugarbeet in Europe requires 0.27 hectares of land to produce one ton of oil equivalent in ethanol, whilst soybean in the United States of America requires 2.63 hectares to

produce one ton of oil equivalent in biodiesel. In terms of land required to drive 100 km, wind energy requires 1 square meter of land and hydrogen from ligno-cellulose requires 5.3 square meters, while rapeseed biodiesel requires 53.6 square meters.

41. Land-use change from biofuel production exacerbates the risk of losing biodiversity and ecosystem services. The impact varies according to location of cultivation and agricultural practices. UNEP-GRID Arendal (2011; figure 3.2.5.) shows that the most negative short term impacts on biodiversity come from conversion of undisturbed natural vegetation. Beneficial impacts on biodiversity were only expected from conversion of existing formerly intensive farmland to grass or woody biofuel feedstocks. Neutral impacts were recorded on set aside, marginal and abandoned land for only grass or woody feedstocks.

42. The bulk of GHG emissions from biofuels may be due to land-use change and emissions vary greatly by energy crop: Peatland tropical rainforest in Southeast Asia emits 1797 tonnes of CO2 per hectare converted to oil palm, while on degraded land, there are savings of 90 tonnes of CO2 (but see section below). Ecosystem payback time is the time it can take to offset carbon emissions generated by converting land for biofuels. Depending on the type of land, it can take decades to centuries: UNEP-GRID Arendal (2011; figure 3.1.6) illustrates that biofuels grown on peat forest can have impacts that span many millennia.

43. Improving the efficiency of feedstock production, conversion and use can help decrease pressure on land, water and other resources. UNEP-Grid Arendal (2011) stresses that different biofuels have different efficiencies in growth, conversion and end-uses. The “chain of efficiency”, considering input and outputs required for a feedstock can also help national planning processes identify the most suitable feedstock for a country, region or local context.

1. Growing Biofuels on Degraded lands

44. Much has been made of the potential to reduce local land pressures, and in some cases also improving biodiversity, by growing energy crops on "degraded", “marginal”, “abandoned” or “waste" land. Whilst intuitively this approach is attractive, recent work on the topic is showing it to be not so simple. Not least of the issues is lack of consensus on definitions of this kind of land; for example, should secondary forest be included? Some "degraded" lands support high conservation value species and the livelihoods of local communities. What may be considered marginal or degraded in one country may constitute the primary source of livelihoods in developing countries, especially for the rural poor. Moreover, degraded lands undergoing restoration can be important carbon sinks.

45. An internationally agreed upon definition for degraded and marginal lands is necessary to identify sustainable land for biofuel production (UNEP 2010a). According to Gopalakrishnan *et al*. (2011) current definitions of marginal land incorporate a single criterion: agroeconomic profitability. They suggest multiple criteria in classifying marginal land using soil health indicators, current land use and environmental degradation. This definition could further be broadened to incorporate the production history of the land/soil, as well as social and cultural values. There are, however, database limitations in terms of the quantification and classification of degraded and marginal lands such as resolution of satellite imagery needed at the farm scale and better quantification of environmental data at the field level. Furthermore, when considering economic, soil health and environmental criteria, some land could be considered marginal for conventional crops but not marginal for biofuel crops. Land may also be productive from an environmental standpoint but still be agroeconomically productive; or not agroeconomically productive but still provide ecosystem services and have biodiversity value (Gopalakrishnan *et al*. 2011). Land use and quality may also change over function, time and space. For example, land that is productive for a purpose in one location may be considered marginal for another use at a different location (Dale *et al*. 2010). Practices that increase land productivity may also result in significant land degradation (see Gopalakirshnan 2011). A definition and classification of marginal or degraded land would therefore need to capture the environmental degradation caused by agriculture, and land and water use.

46. However, appropriate cultivation measures could indeed enhance the quality of degraded soil and the vegetation structure, and therefore habitat quality could be enhanced (Tilman *et al*. 2009), but outcomes differ between crop and land types used. For example, soybean cultivation in Argentina exhibits greater soil erosion potential and greater negative effect on soil nutrients than switchgrass, and soil erosion potential is further increased if soybean is cultivated on degraded grassland rather than abandoned cropland (van Dam[14], 2010). However, some fast-growing ligno-cellulosic feedstocks, such as switchgrass and jatropha, that can grow on wide range of soils and climates, and may enhance the quality of the soil, have the potential to become invasive (UNEP 2010b). Potential benefits from enhanced productivity and the ability to improve soil need to be weighed against the greater risk of becoming invasive and damaging ecosystems, livelihoods and the economy (UNEP 2010b). The economics of production is also an important issue. By definition some degraded lands are potentially less productive and may require incentives for bringing them under production and/or the use of further inputs, particularly fertilisers and water, each with their own implications for relevant LCAs. More detailed discussion of the topic is provided by Campbell and Doswald (2009), UNEP (2009) and Stromberg *et al.* (2010).

47. Two broader issues with using degraded lands for energy crops appear to be receiving limited attention. The first is that, globally, there is competition for degraded land for other uses in particular food but also for forestry and as space for urbanization. This competition for degraded land, at the global scale, essentially delivers potentially significant indirect land-use impacts of energy crops grown there; although the Netherlands Agency (2011) and UNEP (2010) consider that the extent of degraded or "unused" land currently existing might make this competition less significant in the short-term. The second is regarding GHGs where there is currently very limited attention to the option of restoring degraded lands (e.g. through reforestation, including approaches like REDD+) *versus* the GHG benefits of growing energy crops; and it is highly likely that for GHG objectives restoring natural vegetation, and soils, on degraded lands might be more efficient. In the Strategic Plan for Biodiversity 2011-2020, the Aichi Biodiversity Target 15 calls for the restoration of at least 15% of all degraded ecosystems by 2020. There are of course other co-benefits, and disadvantages, of each approach that need to be considered. But a policy of wholesale use of degraded lands for energy crops as the panacea for solving either indirect land-use impacts or to mitigate climate change could not be supported without further research and analysis involving comprehensive LCAs of all relevant options.

2. Direct land-use change and "high conservation areas"

48. Direct land-use change (LUC) is, in theory, a relatively easily addressed issue (compared to indirect effects) and for this guidelines, or regulations, are well advanced in many forums. These usually involve identification of areas where biofuels are inappropriate, as reflected in decision X/37 paragraph 7, including areas with "high conservation value" (HCV) or similar terminology. For example, the EU Renewable Energy Directive (RED) and Roundtable on Sustainable Biofuels (RSB) (RSB 2010) sets out a number of criteria intended to, among other things, protect valued land. There are however some constraints with this approach. An assessment of the requirements relating to the protection of highly biodiverse grasslands under the RED, for example, revealed lack of understanding of grassland issues, their biodiversity value and associated land-use change risks and voluntary schemes relying exclusively on HCV to identify areas of biodiversity value are therefore considered not to be consistent with the requirements of the RED (Bowyer[15] *et al*. 2010). Campbell and Doswald (2009) noted little discussion in the literature of the relationship between the various standards and their varying levels of protection for 'high biodiversity' lands and little consensus on how they should be defined and identified, leaving HCV lands open to interpretation. Even if criteria for HCV lands can be agreed the problem remains that many countries have limited capacity to undertake the necessary inventories or monitoring.

[14] Submitted by the Netherlands.

[15] Submitted by the United Kingdom.

49. Land suitability and availability assessment is a tool that has been widely used to select appropriate lands for biofuel production and optimal yields, whilst minimising social and environmental impacts (UNEP 2010a). These assessments can identify both high-risk areas for land conversion and areas where bioenergy production could be acceptable. Land suitability assessment goes beyond agroeconomic considerations, and analyses competing land uses and land cover. Suitability and availability assessments should consider a range of variables such as temperatures and water balance, topography, soil types, climate change projections, screening of environmentally sensitive areas, impact on ecosystem services, current land cover and use, conflict zones and land tenure (UNEP-GRID Arendal 2011). Land suitability and availability mapping should also include a bottom-up approach (rather than just mapping), taking into account land tenure and customary rights (UNEP 2010a).

50. Various freely available tools have been developed by stakeholders to enable identification of HCV areas and produce suitability and availability assessments: The HCV Resource Network Toolkits (available at http://www.hcvnetwork.org/), were developed by ProForest for the WWF-Ikea Co-operation on Forest Projects; the World Database on Protected Areas (available at http://www.wdpa.org/) is the most comprehensive global spatial dataset on marine and terrestrial protected areas; and Globcover (http://ionia1.esrin.esa.int/) is a land cover database developed by the European Space Agency. Module 1 of the Bioenergy and Food Security Project of the FAO provides methods for a suitability and availability assessment for biofuel feedstock production (available at www.fao.org/bioenergy/foodsecurity/befs).

51. The UN-Energy Bioenergy Decision Support Tool was developed jointly by the Food and Agricultural Organization of the United Nations (FAO) and the United Nations Environment Programme (UNEP) under the framework of UN-Energy. It provides stepwise guidance to decision makers in governments to develop sustainable bioenergy policies and strategies, and to assess investment proposals (http://www.bioenergydecisiontool.org/about.htm). The European Centre for Nature Conservation, European Commission and partners developed BioScore: the European biodiversity impact assessment tool (available at http://www.bioscore.eu/) to evaluate possible impacts of changing environmental variables and policy measures on over 1000 species, by taxonomic group and geographic region (Delbaere *et al.* 2010). Using BioScore, Louette[16] *et al*. (2010) demonstrated that large-scale expansions of woody biofuel plantations in Europe could have a potential net negative effect on the species set covered, with considerable differences among species groups. Eggers[17] *et al*., (2009) assessed potential land-use changes on habitat size and species composition, resulting from what may happen if the European Union doubled its current EU biofuel target and what would happen if it abolished its current biofuel target. A doubled biofuels target would most likely result in increased habitat loss and negative effects on species, while abolishing the target would have mainly positive results on biodiversity and associated habitat (results vary spatially and with crop choice) (Eggers *et al*. 2009).

52. Proposed long-term solutions for LUC include reductions in bioenergy feedstock demand through greater efficiency in technologies, end-use and feedstock choices (UNEP 2010a). Biodiversity can also be better protected through sustainable agriculture, reducing agricultural inputs and restoring degraded lands (UNEP 2010a). Enhancement in the efficiency of yields and production of biofuels, rather than expanding onto more land to meet energy demands, has also been suggested (Savage *et al.* 2008; Fairley 2011). In the longer term, comprehensive land-use planning and management systems, incorporating multi-functionality and multi-level planning (global, regional and local) could integrate land use across many sectors, while still providing for biodiversity and ecosystem services. This approach could also support informed decision-making, as well as a cross-sectoral and participatory approach through community involvement and stakeholder consultations. The next step would be calculating trade-offs between the economics of redesigned landscapes and current practices at the field/farm scale to determine more efficient ways of integrating biofuel feedstock production into current land management practices.

[16] Submitted by ECNC.

[17] Submitted by ECNC.

3. *Indirect land-use change (iLUC)*

53. Indirect land-use change (iLUC) remains the key unresolved biodiversity-related issue with biofuels, including for GHG LCA assessment, and there has been much attention to it recently in scientific literature. ILUC occurs when biofuel feedstock production displaces previously productive land (e.g. for food production) to other areas, causing land-use change and potentially negative impacts on carbon stocks and biodiversity (Dehue *et al*. 2011; Cornelissen *et al.* 2009).[18] The Netherlands submitted (to notification 2011-121) extensive and detailed experiences and results from iLUC including methodological background and ways to avoid land-use change effects.

54. Key characteristics of iLUC that need to be taken into account by mechanisms that aim to resolve iLUC issues include: displacement effects across national borders (see UK example cited above); displacement effects across substituting crops (e.g. if the EU diverts rapeseed oil from food to feed, this could increase vegetable oil imports); and competition for land between non-substituting crops (e.g. planting more corn and less soy due to high prices and demand could trigger an expansion of soy in other world regions) (Cornelissen et al. 2009; Dehue *et al*. 2009; Dehue *et al*. 2011).

55. Because iLUC is a result of larger macroeconomic market dynamics, establishing links between the potential displacement and biofuel production is difficult to quantify (UNEP 2009). However, some tools and resources do exist that should account for some of iLUC due to biofuels (see UNEP 2010a). Dehue *et al.* (2011) reviewed the various approaches used to quantify iLUC and compare outcomes and underlying assumptions. Most quantification work has only focussed on GHG emissions from iLUC from liquid biofuel production. Dehue *et al*. (2011) found no clear consensus on the size of the total emissions from LUC or iLUC, due to large ranges of results and differences of methodologies and key assumptions. The study recommends a more comprehensive documentation of assumptions and intermediary results for a better comparison between models, as well as their similarities and differences.

56. Dehue *et al*. (2011) note that unwanted effects from iLUC from bioenergy are a by-product of direct LUC from the food and feed sector. Preventing unwanted direct LUC could in theory eliminate iLUC, or at least help limit or mitigate it. However, because of the international nature of iLUC and competition for land from various sectors, global implementation of integrated land-use planning and monitoring in all land-based sectors would be necessary for this strategy to be effective. As LUC can be addressed by certification, all biomass products would have to be certified to prevent iLUC from happening (Dehue *et al*. 2011). Although this measure could be effective in the long term, Dehue *et al.* (2009; 2011) suggest intermediate solutions be implemented in the short to medium term that acknowledge the lack of control of the biofuels sector on the sustainability of other biomass-consuming sectors. Dehue *et al.* (2011) review various initiatives that have proposed or are developing proposals for measures to mitigate indirect effects of biofuels such as the United States (US) Renewable Fuels Standard, the EU Renewable Energy Directive and the Low Indirect Impacts Biofuels (LIIB) Certification Module (based on the Responsible Cultivation Areas (RCA) methodology; explained below), a private sector initiative coordinated by Ecofys. This is being developed into a Certification Module for Low Indirect Impact Biofuels, which is one of the few initiatives working on practical solutions to mitigate iLUC at the project level. The small amount of mitigation measures existing for iLUC are not yet fully operational. Most focus only on GHG effects of biofuels by incorporating a LCA of feedstock-based biofuel pathways (Dehue *et al*. 2011).

57. As already noted above there has been much attention to iLUC regarding GHG emissions, including in LCA. Other aspects of iLUC, especially biodiversity implications, are poorly addressed. Bertzky[19] *et al.* (2011) provide a review of iLUC with regards to biodiversity impacts concluding, for example, that the direct effects of the EU Renewable Energy Directive (RED) on land use will be small, but indirect effects may be considerable: the areas that will be mostly affected are areas with semi-natural vegetation, whereas plantation areas are projected to increase, with most impacts occurring outside the

[18] Both reports submitted by the Netherlands.

[19] Submitted by UNEP-WCMC.

EU. The study also concludes that existing and developing sustainability standards and criteria for biofuel production are to date unable to avoid iLUC in ecosystems that are not of high carbon value – and thereby encourage it. JNCC[20] (2009) provides similar observations specifically for an assessment of the footprint of bioenergy use in the United Kingdom. The complexities of iLUC make the assessment of iLUC impacts on biodiversity extremely challenging, and have impeded the development of safeguards that might limit them. Nevertheless, these gaps are being increasingly recognized, and although iLUC cannot be entirely avoided or adequately measured, efforts are underway to mitigate iLUC (see examples in Section IV of this note).

58. However, iLUC impacts can also occur through intensification effects where total cultivated area remains the same: for example, an energy crop is planted in one area, there is no net increase in total cultivated area, and crop production elsewhere intensifies to compensate for the additional energy crop. Intensification iLUC has received far less attention and its impacts can be positive or negative. Intensification can reduce overall land required thus potentially avoiding, even reversing, conversion, but the increased agricultural inputs it might require, particularly water, fertilisers and other chemicals, can have major GHG implications and other detrimental impacts on biodiversity (e.g. pollution). Further discussion on intensification impacts on water is provided by UNEP/Oeko-Institute/IEA[21] (2011).

59. Intensification is often cited as a solution to mitigate iLUC impacts. For example, Lapola *et al* (2010) analysed the impact of biofuels expansion in Brazil at reasonably fine spatial scales. The simulations show that direct land-use changes will have a small impact on carbon emissions because most biofuel plantations would replace rangeland areas. However, indirect land-use changes are potentially significant with sugarcane ethanol and soybean biodiesel, each contributing to nearly half of the projected indirect deforestation of 121,970 km^2 by 2020. This would create a carbon debt that would extend the payback time for sugarcane ethanol by an additional 40 years and for soybean biodiesel by 211 years, when considering carbon emissions from iLUC, if using these biofuels instead of fossil fuels. However, if cattle production is sustainably intensified, with an increase of 0.13 head per hectare in the average livestock density throughout the country, the iLUC caused by biofuels (even with soybean as the biodiesel feedstock) can be avoided, while still fulfilling all food and bioenergy demands. This, and other points, are well made in Brazil's submission (to notification 2011-121) which highlights, for example, various relevant national plans for agro-energy, including measures specific to key crops, supported by significant investment in research and development in a number of relevant areas, to promote sustainable bioenergy, including building a mutually beneficial relationship between biofuels and biodiversity. These examples illustrate the importance of integrating planning for bio-energy and other production activities, which centre on a more holistic framework of land-use planning (including other relevant inputs onto land such as water and chemicals etc.). Theoretically, a combination of intensification of cattle production and restoration of rangeland into forests could generate potentially greater reductions in iLUC and GHG emissions, than solely using intensification for the purpose of biofuel and food production. However, this may not be feasible from a socioeconomic perspective.

60. The consensus on the best ways in which to deal with the iLUC problem have shifted from trying to monitor and directly manage land-use change to pro-active mitigation of iLUC (Oorschot[22] *et al*. 2010). ILUC cannot be quantified accurately enough to support decision-making but it is possible in the short-term for assessments to identify levels of risk of iLUC and develop policies accordingly by rewarding low-risk strategies and discouraging high-risk ones. For example, the Global Bioenergy Partnership (GBEP) indicators (see section V below) provide a great deal of information to guide decision-making to mitigate the risk of iLUC. GBEP's LUC indicator incorporates metrics that identify the shares of no ILUC risk, low ILUC risk and high ILUC risk bioenergy feedstock production in a country's bioenergy mix. Their GHG LCA methodology also allows users to calculate emissions from iLUC, if they choose to do so. Another example is the EU RED, which provides a bonus for biofuels

[20] Cited in the United Kingdom's submission.

[21] Submitted by UNEP-WCMC.

[22] Submitted by the Netherlands.

made from bioenergy feedstocks that have not displaced food production and have been cultivated on severely degraded or heavily contaminated land, provided that there is proof of an increase in carbon stocks and a decrease in erosion, and that soil contamination is reduced. The Roundtable on Sustainable Biofuels (http://rsb.epfl.ch) created an Indirect Impacts Expert Group to recommend a strategy to be integrated into the standard. The various options to be considered by the RSB include the Responsible Cultivation Area (RCA) approach, which offers practical and field tested methods to reduce the risk of iLUC effects (see full report: Dehue *et al.* 2009). Ecofys launched the RCA methodology in 2010, which was further developed by Conservation International and WWF International. At the project level, the RCA methodology proposed four main solutions to expand biomass usage for biofuels that do not cause iLUC: 1. Biomass production on "unused land" ("land that does not provide provisioning services"). This leads to direct LUC, which can be controlled by certification, unlike iLUC, which is largely uncontrollable. However, there are many uncertainties in this approach, as explained in the section on degraded lands above; 2. Introducing energy crop cultivation without displacing the original land use through increased land productivity or integration models, especially in developing countries; 3. Bioenergy production from residues; 4. Bioenergy production from aquatic biomass (Dehue *et al*. 2009). The RCA focuses on the first two mitigation options, which are the first two modules of the RCA methodology: Module 1: Distinguishing bioenergy feedstock production with a low risk of indirect effects. Module II: Identification of Responsible Cultivation Areas.

61. Bertzky *et al.* (2011) note that sustainability standards and criteria for first generation biofuel crops aim at preventing biofuel production encroaching on areas of importance for biodiversity and ecosystem services. They represent a mechanism to control where conversion for biofuel production will take place in the future. For example, the EU RED incorporates two sets of sustainability criteria (Article 17), one for GHG emissions savings and another for land-use requirements (but they do not consider iLUC). However, because of its complexities, there are currently no standards or criteria that can prevent iLUC from happening. ILUC cannot be entirely avoided but can only be mitigated by standards, guidelines and certifications that can reduce drivers. This presents a gap in the sustainability standards: by banning biofuel crops from certain areas, their cultivation on existing agricultural land is encouraged, thereby encouraging food crops or feedstock in the areas that biofuel crops are banned from hence promoting iLUC (Searchinger *et al*. 2008). The logical conclusion is that sustainability standards and criteria for biofuel production will not be able to ensure sustainability without a criterion on iLUC, necessitating a precautionary approach in developing and sourcing biofuels; noting that the EU, amongst others, is attempting to develop solutions to this well recognized problem. Finland (in its submission to notification 2011-121) refers to the outcomes of a workshop on iLUC which notes, amongst other things, the problem that full estimation and accounting for iLUC is complex, with high transaction costs – but policy-makers are looking for generalizations.

62. In conclusion, there are already many tools and approaches that with further application and development can limit direct land-use change caused by biofuels themselves. But this does not address iLUC, and in fact probably escalates it. Many tools and approaches are attempting to mitigate indirect effects and some offer potential. But iLUC cannot be eliminated (under realistic medium-term scenarios). This leads to the problem that individual biofuels projects can be assessed on a case by case basis, using environment impact assessment related tools and approaches, but the central problem is their cumulative displacement effects. Sustainability for biofuels depends largely on sustainability in land (and other resource) use across the board. Hence, the only tools and approaches that can properly address biofuels sustainability are those which include assessing the problem in a more holistic fashion. That is, assessing, planning and managing all biomass consumption and production sectors collectively. In the CBD context, this means regarding biofuels, not separately, but as one of many multiple pressures on resources that need to be managed in order to achieve the Aichi Biodiversity Targets collectively. Essentially, this requires a significant shift in the debate towards a more strategic assessment approach. This goes beyond tools and approaches for biofuels alone. The key current knowledge gap is with regards to the availability of tools and approaches to meet these needs, and experiences in their application. This is one of the most important gaps to be filled and knowledge on this issue is considered essential to better understanding of how Parties can implement the Strategic Plan for Biodiversity (2011-2020).

G. Targets, subsidies, tariffs and other economic measures

63. The development of biofuels has been largely fuelled by governments through mandates, targets and various mechanisms of support, such as subsidies, which have come under scrutiny as being insufficiently supported by science (e.g. UNEP 2009). Subsidies and tariffs tend not to take into account whether the biofuel is sustainable or not, and can obscure the connection between a biofuel's sustainability and cost (Robbins 2011). De Gorter and Just (2010) indicate that most countries use several biofuel policies in concert; however, certain combinations of biofuel policies can be contradictory, where the effects of the policies are reversed. Adverse interactions between policies can occur when adding subsidies to mandates, or when adding biofuel policies to farm subsidy programmes. Benefits from biofuel policies can be offset by inefficiencies of tariffs, production subsidies and sustainability standards. In their analysis, they find that mandates are clearly superior to all other policies, and that no biofuel policies complemented each other; they either cannibalized each other or had no effect. The blending quota is the policy with the largest impact on biofuel production globally because it provides a huge stimulus to biofuel demand (Robbins 2011).

64. However, expanding biofuels carries net land-use change, whether direct or indirect, which suggests an inherent obstacle in achieving sustainability for the production of biofuels. Large increases in global coarse grain area, a 14% increase in the harvested area of sugarcane and a 35% increase in oil palm area by 2017/18 were projected due to targets set by the EU and the United States of America (USA) and the likelihood of increased biofuel targets in Brazil, China, Argentina and India (FAPRI 2008). Bertzky *et al.* (2011), focussing especially on EU targets, found that the impact of targets varies spatially and according to the crop, noting that cultivating woody instead of arable crops would have an overall positive effect (but see analysis by Louette et al. (2010) above, where the expansion of woody biofuel crops created a negative effect using BioScore), and that different biofuel policies have the potential to alter the status of biodiversity considerably by 2030, favourably or negatively.

65. Subsidies for biofuels have increased dramatically in the last decade. In 2007, the IAE estimated the global biofuels subsidies were at US 14$ billion, increasing to US 20$ billion in 2009 (IEA 2009; GSI 2011). The USA and the EU are the top supporters of biofuels globally, with estimates of about US 8$ billion each in 2009, according to limited information available (GSI 2011). Brazil abolished production quotas and ethanol subsidies in 1990, and sugar and ethanol prices were left to the free market, which brought along considerable efficiency gains (Moraes 2011).

66. The GSI (2011) study reports of significant information gaps and inconsistent monitoring and reporting for biofuels subsidies (see http://www.globalsubsidies.org/research/biofuel-subsidies for many detailed studies on national subsidies for biofuels by the GSI). Adequate reporting and evaluations of the effectiveness of subsidies could better determine when they are found to act contrary to the aims of sustainable development, so that governments can subsequently reform or eliminate them (GSI 2011). In the case of the EU, GSI (2010) highlights the urgent need for yearly, mandatory and standardized reporting of Member States to the European Commission on their biofuel policies. There is also a need for strategic environmental assessments (SEA) and economic assessments on policies and subsidies with regards to sustainable biofuels objectives.

67. Biofuels to-date have performed poorly, in some cases negatively, in terms of climate change mitigation and costs are exceedingly high. According to the OECD (quoted by UNEP 2009), subsidies in the US, Canada and the EU represent between US$ 960 -1,700 per tonne of CO2eq avoided in those countries, far exceeding the carbon value at European and US carbon markets. The Gallagher Review (Gallagher 2008) highlighted considerable uncertainties as to the greenhouse-gas reduction benefits of biofuels. Consequently, for example, an EU biofuel target has been delayed until 2013/14 to allow governments to establish the sustainability of the introduction of biofuel sources in the UK (JNCC 2009). Decision-makers and stakeholders should also set realistic targets based on the planet's capacity to generate additional biomass without jeopardizing ecosystems and their services (EEA Scientific Committee 2011).

68. Caution also needs to be taken with so called "carbon taxes". These may in themselves be an appropriate means of incentivising moves towards carbon neutral economies, but care needs to be taken that they apply to emissions from all relevant sources, not just fossil fuels. Wise *et al*. (2009), for example, compare global land use patterns under different three scenarios: business as usual; a global carbon tax applied to all carbon dioxide emissions including iLUC, which favours forest expansion; and, incentives that apply to carbon dioxide emissions from fossil fuels and industrial emissions, without applying them to other energy sources based on LCAs including an iLUC factor. The latter has dramatic implications for increases in land use for biofuels resulting in significant loss of natural land cover (particularly unmanaged forest), and therefore probably also a significant increase in GHG emissions. This study was included in the Third Global Biodiversity Outlook (SCBD 2010, page 77). It is critical that land-use needs to be taken into account when designing policies to combat climate change (SCBD 2010).

69. Given that markets, financing and behavioural change by producers are key factors, the economic assessment of biofuels policies with regards to sustainable biofuels objectives is an important tool to assist policy development. Ernst and Young (2011), for example, explore the four existing policy options being considered by the European Commission for dealing with iLUC arising from the use of biofuels under the EU Renewable Energy Directive (RED), based on their potential positive, uncertain or negative impacts on: encouraging action to mitigate iLUC; improving GHG performance; fulfilling mandates cost-effectively; and, improving investor confidence. All four current policy options (take no action and further monitor; increase GHG savings threshold for all biofuels; sustainability requirements for selected biofuels; and, an iLUC factor for all biofuels in varying degrees) perform negatively in terms of encouraging practices to mitigate iLUC and three reduce investor confidence. Ernst and Young (2011) propose an alternate fifth policy option, which is to reward feedstock producers for mitigating iLUC with the credit offsetting additional costs of production. They estimate that if 10% of all biofuels used in the EU in 2020 qualified for a 29gCO2eq/MJ iLUC mitigation credit, financial value of up to $1.6 billion could be created as incentive.

70. Biofuel subsidies are an expensive way to manage fossil fuel use while cutting GHG emissions. It has been recommended by GSI (2010) that costly subsidies for biofuels be phased out and to transition to climate policy that is focused on the “polluter pays principle” (this was in the context of the EU, in the report, but could be applied generally for large biofuel producers). Rather than subsidizing biofuels, fossil fuels should be restricted with pollution and carbon taxes or a cap-and-trade system. Increasing the price of fossil fuels would make renewable energy more marketable without expanding national budget deficits. This solution is much more economical and can help rehabilitate public debts, while making the polluter pay the burden of environmental protection. One step in the right direction is the EU’s Fuel Quality Directive which requires reductions of GHG emissions but leaves the strategy to accomplish this to suppliers and fuels. Mandatory blending requirements may have a positive short-term fiscal effect compared to tax exemptions but they have large distorting effects on the market, they are less controllable, measurable and reversible for governments than tax exemptions, which are more transparent.

71. Promoting domestic biofuels and maintaining barriers to cheaper imports through tariffs can lead to global inequities, depriving developing countries of opportunities to participate in new markets (GIS 2007; Harmer 2009). Moreover, once in place, trade-distorting subsidies are difficult to reform. The interaction between trade rules and biofuel subsidies can also cause tensions amongst the major producers of biofuels, and often does not allow imports on cheaper and more sustainably produced biofuels. For example, Brazil disputes a USA ethanol tariff, at 54-cent per gallon, as it prevents Brazil from selling its unsubsidized and more sustainably produced ethanol to the USA (Harmer 2009). However, certain Caribbean countries under its Caribbean Basin Initiative can export a certain quota of ethanol to the USA tariff-free. Most of these Caribbean countries do not produce ethanol themselves but buy it from Brazil and dehydrate it so that it meets the USA requirement that products qualifying under the tariff quota be “substantially transformed” if they do not originate from the countries themselves (GSI 2007). The EU also imposes high tariffs on Brazilian ethanol: a study by the International Food Policy Institute (2011) concluded that opening biofuel trade in the EU would further improve the emission reduction

performance of the EU's biofuels policy mainly because there would be more sustainable ethanol imports from Brazil. If African countries can bring up their agricultural yields, the increased demand for ethanol could be met by African countries if global trade were freed from the tariffs and subsidies imposed by the USA and EU.

72. It is recommended by GSI (2010) that all tariffs on biofuels be abolished (except anti-dumping measures on U.S. biodiesel in the case of the EU) as they are an undesired form of protectionism from more cheaply produced ethanol, mainly from Brazil. For many countries, the reality is that a significant portion of biofuels and feedstocks will have to be imported.

Incentivising research and development

73. An important knowledge gap may be the relative investments in solutions to addressing biofuels sustainability constraints (that is, in the current context, achieving the objectives of the CBD including decision IX/2) relative to those in supporting known inefficient, and often detrimental, practices (including perverse incentives that support them). Diverse biofuels approaches are good for creating efficiency and innovation but incentives need to support progress in the right direction and not reward practice in the wrong direction. This issue requires further assessment.

74. Biofuels research and development can deliver breakthroughs applicable across many sectors of the economy (GSI 2010). It can be said that subsidies towards research and development have a great potential to deliver a public good. Less beneficial are subsidies that only target one sector (e.g. demonstration plants). Perhaps allowing private investors to choose their project of interest, through research and development tax credits, is a more effective method to promote progress in the right direction. It has also been suggested that governments should encourage innovation and competition in the marketplace to find the best solutions regarding projects targeting GHG emissions (GSI 2010).

75. There are a multitude of specializations involved, from agronomy to combustion, and various government funded programs aiming to develop different stages of the supply chain (GSI 2011). Many examples are available in reports by Global Subsidies Initiative (GSI) available at http://www.globalsubsidies.org/research/biofuel-subsidies. A clear pattern across countries is an increasing amount of funding towards second-generation biofuels, especially cellulosic ethanol, a better alternative to first generation biofuels. For example, in 2006, Denmark fostered the development of second-generation biofuel technology with almost 27 million Euros in grants through the Energy Technology and Demonstration Programme (EUDP) (GSI 2010). From 2007-2009, the Danish government also funded 8.5 billion Euros for pilot projects involving the use of biodiesel in “fleets” of vehicles. The Finnish Funding Agency for Technology and Innovation’s (Tekes) program BioRefine has a budget of 137 $ million Euros for five years dedicated to the development of second generation biofuels (GSI 2010). In Canada, the NexGen Biofuels CAD 500 $ million fund has been providing interest-free loans since 2007, for large-scale demonstration facilities producing second generation biofuels (GSI 2009).

76. The Nuffield Council on Bioethics (2011) recommends that policy-makers create incentives for research and development of biofuels that require less land and resources, avoid environmental and societal harms, and reduce GHG emissions. UNEP-GRID Arendal (2011) stresses that technological development must prioritize optimal resource use and allocation, minimising waste and inefficiencies, increasing the biofuels industry’s economic efficiency. The European Energy Agency Scientific Committee (2011) recommends that policies encourage biofuel production from by-products, wastes and residues that reduce GHG emissions and promote integrated production of biomass without displacing ecosystem services, such as food and fibre production.

IV. THE PRIMARY NEED: BROADER LAND AND RESOURCE USE PLANNING

The consideration of biofuels under the broader scope of overall resource use

77. The key issue regarding sustainable biofuels production and use, with regards to biodiversity, concerns the broader issue sustainable consumption and production under multiple pressures. Most of the

major unresolved issues with biofuels centre on the need for sustainable land, and other resource use and planning. The extent to which sustainable biofuels can be achieved depends upon the progress in achieving sustainability with other land use activities, particularly by agriculture. For this reason, many forums, including the FAO, consider biofuels under the broader framework of sustainable agricultural (and as appropriate, forestry) production. An information gap is whether the current attention to sustainability for biofuels is matched in agriculture in general and the extent to which the tools and approaches for biofuels are being applied beyond biofuels, where arguably they are required even more urgently

78. Competition of biofuels for resources with food and inter-relationships with food security is widely discussed. But biofuels are not alone in having an ethical dimension. Much of the world's agricultural production has little to do with food security, including food that supports lifestyles (not essential food), unhealthy diets and over consumption and a considerable level of resources are used to produce fibres (much of which caters to the whims of "fashion") and cosmetics. Furthermore, Gustavsson et al. (2011) suggest that about one-third of food is wasted; others have suggested that as much as half of all food grown is lost (Lundqvist et al. 2008); and some perishable commodities have post-harvest losses of up to 100% (Parfitt et al. 2010).

79. In essence, the key need is for sustainable land and other resource use planning under multiple demands. Under the CBD this broader context is that biofuels be considered, together with other drivers and pressures, under the Strategic Plan for Biodiversity (2011-2020) and achieving the Aichi Biodiversity targets collectively; in particular targets 3, 4, 7, 8, 11, 14 and 15. This requires an ability to assess multiple drivers, and their interactions amongst multiple targets and objectives, and to generate practical policy relevant guidance. This encompasses, inter alia, effective Strategic Environmental Assessment, or related approaches, and, in particular, requires a responsive policy and management framework. Very limited specific information on this was provided in submissions. Relevant gaps have not therefore been comprehensively explored, and to do so extends well beyond the issue of biofuels alone. This note does, however, conclude that assessing gaps in tools and approaches within this broader context is a primary requirement.

V. THE WORK OF THE ROUNDTABLE ON SUSTAINABLE BIOFUELS (RSB) AND GLOBAL BIOENERGY PARTNERSHIP (GBEP)

80. This section serves to provide further details to the ongoing work of two relevant processes and the contributions of the Executive Secretary to them (re. decision X/37, para. 13).

A. The Global Bioenergy Partnership (GBEP)

81. The GBEP (http://www.globalbioenergy.org/) was established to implement the commitments taken by the G8 in the 2005 Gleneagles Plan of Action to support "biomass and biofuels deployment, particularly in developing countries where biomass use is prevalent" and has received renewed support at various summits since. As of 30 November 2011, GBEP Partners comprise the all G8 nations plus Argentina, Brazil, China, Colombia, Fiji Islands, Ghana, Mauritania, Mexico, Netherlands, Paraguay, Spain, Sudan, Sweden, Switzerland and Tanzania, as well as the: Economic Community of West African States (ECOWAS), European Commission, FAO, Inter-American Development Bank (IDB), IEA, UNCTAD, UN DESA, UNDP, UNEP, UNIDO, United Nations Foundation, World Council for Renewable Energy and the European Biomass Industry Association. A further 22 countries are participating as observers along with the: African Development Bank, Economic Commission for Latin America and the Caribbean, European Environment Agency, Global Environment Facility (GEF), IFAD, IRENA, West African Economic and Monetary Union (UEMOA), World Bank, and the World Business Council on Sustainable Development. Italy and Brazil are currently Co-Chairs of the Partnership. The initiative is supported by the GBEP Secretariat, hosted at FAO Headquarters in Rome. Priority areas for the immediate programme of work of the GBEP include: facilitate the sustainable development of bioenergy; test a common methodological framework on GHG emission reduction measurement from the use of bioenergy; facilitate capacity building for sustainable bioenergy; and, raise awareness and facilitate information exchange on bioenergy.

82. Following decision X/37, the Secretariat commenced informal collaboration with the GBEP in January 2011, initially providing inputs on sustainability themes and indicators for water related impacts via the GBEP Secretariat, and was officially included as an observer on the Task Force on Sustainability in March 2011, and thereafter contributed to the work on other indicators, focussing on biodiversity aspects, as detailed further below. For current purposes, the most relevant current activities of the GBEP relate to this work on sustainability indicators. Consistent with CBD decision IX/2, the GBEP has framed the topic of sustainability under the three pillars of sustainable development: environmental, social and economic. As of 30 November 2011, 24 indicators for these three pillars have been identified and agreed (by consensus among GBEP partners) as listed in Table 1. Furthermore, a full report on the indicators, including methodology sheets was endorsed by the GBEP Steering Committee in November 2011 and published on the GBEP website the following month.[23] These note that considerable work is still required on methodologies for some of the indicators.

Table 1: GBEP Sustainability Indicators for Bioenergy. Comments refer to relationships between this work and the objectives of the Convention (as reflected mainly in decisions IX/2 and X/37). "ABT" refers to actual or potential linkages with suggested indicators for the Aichi Biodiversity Targets (as per UNEP/CBD/SBSTTA/15/2; https://www.cbd.int/doc/meetings/sbstta/sbstta-15/official/sbstta-15-02-en.doc) with the targets to which they apply.

Indicator name/Indicator description	**Comments**
ENVIRONMENTAL PILLAR THEMES: greenhouse-gas emissions, productive capacity of the land and ecosystems, air quality, water availability, use efficiency and quality, biological diversity, land-use change, including indirect effects	
1. Lifecycle GHG emissions Lifecycle greenhouse-gas emissions from bioenergy production and use, as per the methodology chosen nationally or at community level, and reported using the GBEP Common Methodological Framework for GHG Lifecycle Analysis of Bioenergy ' Version One'	The methodological framework developed by the GBEP GHG Taskforce is intended to provide a flexible tool for communicating and comparing methodologies used in GHG LCA of bioenergy systems. Currently iLUC factors are not adequately addressed, though users are free to include GHG emissions due to iLUC as calculated by the methodology of their choice, which they are encouraged to describe transparently using the GBEP methodological framework. Further details of GHG methodologies are available at: http://www.globalbioenergy.org/toolkit/clearing-house-on-ghg-methodologies/en/ ABT: Trend in emission to the environment of pollutants relevant for biodiversity; Trends in climate change impacts on extinction risk; targets 8, 10, 12
2. Soil quality Percentage of land for which soil quality, in particular in terms of soil organic carbon, is maintained or improved out of total land on which bioenergy feedstock is cultivated or harvested	Includes four key factors: loss of soil carbon, leading to decreased soil fertility; soil erosion, leading to the loss of fertile top-soil; accumulation of mineral salts from irrigation water (salinization), causing excessive soil salinity that may adversely affect plant growth; and soil compaction, reducing water flow and storage, and limiting root growth. ABT: Trends in sediment transfer rates; Trends in area of forest, agricultural and aquaculture ecosystems under sustainable management (decision VII/30 and VIII/15); targets 2, 4, 5, 7, 8, 10, 14
3. Harvest levels of wood resources Annual harvest of wood resources by volume and as a percentage of net growth or sustained yield, and the percentage of the annual harvest used for bioenergy	ABT: Trends in area of forest, agricultural and aquaculture ecosystems under sustainable management (decision VII/30 and VIII/15); targets 2, 4, 5, 7, 14
4. Emissions of non-GHG air pollutants, including air toxics Emissions of non-GHG air pollutants, including air toxics,	ABT: Impact of pollution on extinction risk trends; Trends in pollution deposition rate (decision VII/30 and VIII/15); targets 8, 10, 12

[23] http://www.globalbioenergy.org/fileadmin/user_upload/gbep/docs/Indicators/Report_21_December.pdf

Indicator name/Indicator description	Comments
from bioenergy feedstock production, processing, transport of feedstocks, intermediate products and end products, and use; and in comparison with other energy sources	
5. Water use and efficiency Water withdrawn from nationally-determined watershed(s) for the production and processing of bioenergy feedstocks, expressed as the percentage of total actual renewable water resources (TARWR) and as the percentage of total annual water withdrawals (TAWW), disaggregated into renewable and non-renewable water sources Volume of water withdrawn from nationally-determined watershed(s) used for the production and processing of bioenergy feedstocks per unit of useful bioenergy output, disaggregated into renewable and non-renewable water sources	ABT: Trends in production per input; Trends in proportion of total freshwater resources used; targets 14, 7, 4
6. Water quality 6.1 Pollutant loadings to waterways and bodies of water attributable to fertilizer and pesticide application for bioenergy feedstock cultivation, and expressed as a percentage of pollutant loadings from total agricultural production in the watershed 6.2 Pollutant loadings to waterways and bodies of water attributable to bioenergy processing effluents, and expressed as a percentage of pollutant loadings from total agricultural processing effluents in the watershed	ABT: Trends in production per input; Trends in water quality in aquatic ecosystems (decision VII/30 and VIII/15); Trends in pollution deposition rate (decision VII/30 and VIII/15); Trends in Nitrogen Footprint of consumption activities; Trends in proportion of wastewater discharged after treatment; targets 4, 5, 7, 8, 10
7. Biological diversity in the landscape 7.1 Area and percentage of nationally recognized areas of high biodiversity value or critical ecosystems converted to bioenergy production 7.2 Area and percentage of the land used for bioenergy production where nationally recognized invasive species, by risk category, are cultivated 7.3 Area and percentage of the land used for bioenergy production where nationally recognized conservation methods are used	Indicator 7.1 mainly relates to direct land-use change. See discussion in the text of this note about direct and indirect land-use change and approaches using high biodiversity value/critical ecosystem (and "HCV") approaches. Indicator 7.2 is based in part on information from the Global Invasive Species Partnership. The methodology sheet includes an assumption that risk of invasion is related to area of invasives cultivated, which is probably a minor factor compared to actual presence of invasives. The indicator is based at the species level and does not appear to capture invasions at the genetic level, including living (genetically) modified organisms. For indicator 7.3 the methodology sheet provides an indicative list of relevant kinds of conservation measures and farmers are targeted as one source of information on this. ABT: Trends in extent of selected biomes, ecosystems and habitats (decision VII/30 and VIII/15) ; Trends in the impact of invasive alien species on extinction risk; Trends in number of invasive alien species (decision VII/30 and VIII/15); Trends in invasive alien species pathways management; Trends in policy responses, legislation and management plans to control and prevent spread of invasive alien species; Trends in awareness and attitudes to biodiversity; Trends in public engagement with biodiversity; targets 1, 2, 3, 4, 5, 9, 10, 12, 14, 17, 19
8. Land use and land-use change related to bioenergy feedstock production 8.1 and 2 Total area of land for bioenergy feedstock production, and as compared to total national surface and agricultural and managed forest land area 8.3 Percentages of bioenergy from yield increases, residues, wastes and degraded or contaminated land 8.4 Net annual rates of conversion between land-use types caused directly by bioenergy feedstock production, including the following (amongst others): o arable land and permanent crops, permanent	The indicator does not attempt to measure indirect effects of bioenergy – such as iLUC – but partially addresses indirect effects by measuring: i) the contribution made by certain bioenergy production pathways that pose a low risk of displacing other uses of the same feedstock or land (8.3); and ii) certain forms of direct land-use change due to bioenergy that pose a high risk of displacing other agricultural activities (8.4). See discussion in the text of this note regarding direct and indirect LUC and degraded/contaminated land. ABT: Trends in area of forest, agricultural and aquaculture ecosystems under sustainable management; Trends in production per input; Status and trends in extent and condition of habitats that provide carbon storage; Trends in area of

Indicator name/Indicator description	Comments
meadows and pastures, and o managed forests; natural forests and grasslands (including savannah, excluding natural permanent meadows and pastures), peatlands, and wetlands	degraded ecosystems restored or being restored; targets 4, 5, 7, 14, 15
SOCIAL PILLAR THEMES: price and supply of a national food basket, access to land, water and other natural resources, labour conditions, rural and social development, access to energy, human health and safety	
9. Allocation and tenure of land for new bioenergy production Percentage of land – total and by land-use type – used for new bioenergy production where: o a legal instrument or domestic authority establishes title and procedures for change of title; and o the current domestic legal system and/or socially accepted practices provide due process and the established procedures are followed for determining legal title	ABT: possibly relevant to Trends in land-use change and land tenure in the traditional territories of indigenous and local communities (decision X/43); targets 18, 5
10. Price and supply of a national food basket Effects of bioenergy use and domestic production on the price and supply of a food basket, which is a nationally-defined collection of representative foodstuffs, including main staple crops, measured at the national, regional, and/or household level, taking into consideration: o changes in demand for foodstuffs for food, feed, and fibre; o changes in the import and export of foodstuffs o changes in agricultural production due to weather conditions o changes in agricultural costs from petroleum and other energy prices; and o the impact of price volatility and price inflation of foodstuffs on the national, regional, and/or household welfare level, as nationally-determined	ABT: not directly linked to targets but relevant to assessing the efficiency of bioenergy production *vis-a-vis* impacts on food production (indirectly relevant to target 7).
11. Change in income Contribution of the following to change in income due to bioenergy production: o wages paid for employment in the bioenergy sector in relation to comparable sectors o net income from the sale, barter and/or own-consumption of bioenergy products, including feedstocks, by self-employed households/individuals	ABT: Trends in benefits that humans derive from selected ecosystem services; Trends in economic and non-economic values of selected ecosystem services; Trends in inclusive wealth; targets 2, 14, 15
12. Jobs in the bioenergy sector Net job creation as a result of bioenergy production and use, total and disaggregated (if possible) as follows: o skilled/unskilled o temporary/indefinite Total number of jobs in the bioenergy sector and percentage adhering to nationally recognized labour standards consistent with the principles enumerated in the ILO Declaration on Fundamental Principles and Rights at Work, in relation to comparable sectors	ABT: Trends in benefits that humans derive from selected ecosystem services; Trends in economic and non-economic values of selected ecosystem services; Trends in inclusive wealth; targets 2, 14, 15
13. Change in unpaid time spent by women and children collecting biomass Change in average unpaid time spent by women and children collecting biomass as a result of switching from traditional use of biomass to modern bioenergy services	ABT: Trends in benefits that humans derive from selected ecosystem services; Trends in economic and non-economic values of selected ecosystem services; Trends in inclusive wealth; targets 2, 14, 15

Indicator name/Indicator description	Comments
14. Bioenergy used to expand access to modern energy services Total amount and percentage of increased access to modern energy services gained through modern bioenergy (disaggregated by bioenergy type), measured in terms of energy and numbers of households and businesses Total number and percentage of households and businesses using bioenergy, disaggregated into modern bioenergy and traditional use of biomass	ABT: Trends in benefits that humans derive from selected ecosystem services; Trends in economic and non-economic values of selected ecosystem services; targets 14, 15
15. Change in mortality and burden of disease attributable to indoor smoke Change in mortality and burden of disease attributable to indoor smoke from solid fuel use, and changes in these as a result of the increased deployment of modern bioenergy services, including improved biomass-based cookstoves	ABT: Trends in benefits that humans derive from selected ecosystem services; Trends in economic and non-economic values of selected ecosystem services; targets 2, 14, 15
16. Incidence of occupational injury, illness and fatalities Incidences of occupational injury, illness and fatalities in the production of bioenergy in relation to comparable sectors	ABT: Trends in benefits that humans derive from selected ecosystem services; targets 14, 15
ECONOMIC PILLAR THEMES: resource availability and use efficiencies in bioenergy production, conversion, distribution and end-use, economic development, economic viability and competitiveness of bioenergy, access to technology and technological capabilities, energy security/diversification of sources and supply, energy security/infrastructure and logistics for distribution and use	
17. Productivity Productivity of bioenergy feedstocks by feedstock or by farm/plantation Processing efficiencies by technology and feedstock Amount of bioenergy end product by mass, volume or energy content per hectare per year Production cost per unit of bioenergy	ABT: not directly linked to targets but relevant to assessing the efficiency of bioenergy production (indirectly relevant to target 7).
18. Net energy balance Energy ratio of the bioenergy value chain with comparison with other energy sources, including energy ratios of feedstock production, processing of feedstock into bioenergy, bioenergy use; and/or lifecycle analysis	ABT: Trends in benefits that humans derive from selected ecosystem services; Trends in economic and non-economic values of selected ecosystem services; targets 2, 14, 15
19. Gross value added Gross value added per unit of bioenergy produced and as a percentage of gross domestic product	ABT: Trends in benefits that humans derive from selected ecosystem services; Trends in economic and non-economic values of selected ecosystem services; targets 2, 14, 15
20. Change in the consumption of fossil fuels and traditional use of biomass Substitution of fossil fuels with domestic bioenergy measured by energy content and in annual savings of convertible currency from reduced purchases of fossil fuels Substitution of traditional use of biomass with modern domestic bioenergy measured by energy content	ABT: Trends in benefits that humans derive from selected ecosystem services; Trends in economic and non-economic values of selected ecosystem services targets 2, 14, 15
21. Training and re-qualification of the workforce Percentage of trained workers in the bioenergy sector out of total bioenergy workforce, and percentage of re-qualified workers out of the total number of jobs lost in the bioenergy sector	ABT: Trends in benefits that humans derive from selected ecosystem services; Trends in economic and non-economic values of selected ecosystem services; targets 2, 14, 15
22. Energy diversity Change in diversity of total primary energy supply due to bioenergy	ABT: Trends in benefits that humans derive from selected ecosystem services; targets 14, 15
23. Infrastructure and logistics for distribution of bioenergy Number and capacity of routes for critical distribution systems,	

Indicator name/Indicator description	Comments
along with an assessment of the proportion of the bioenergy associated with each	
24. Capacity and flexibility of use of bioenergy Ratio of capacity for using bioenergy compared with actual use for each significant utilization route Ratio of flexible capacity which can use either bioenergy or other fuel sources to total capacity	

83. The GBEP work on sustainability indicators pre-dates the adoption of the Strategic Plan for Biodiversity (2011 – 2020) and the Aichi Biodiversity Targets. Although the indicators are not explicitly linked to the Aichi Biodiversity Targets, nevertheless there is good coherence with them as indicated in Table 1. The discrete elements of the indicators can be seen to support most of the targets (and act as indicators for them regarding biofuels). In addition, the sustainability indicators collectively can be regarded as a significant contribution to the Strategic Plan for Biodiversity, particularly regarding trends in area of forest, agricultural and aquaculture ecosystems under sustainable management (target 7 but also targets 2, 4, 5 and 14, amongst others).

84. Even though "biodiversity" is explicitly mentioned only under indicator 7, all of the others listed under the "environment pillar" are also directly relevant because they reflect an ecosystem service, sustainable use of biodiversity or a driver of biodiversity loss (table 1). However, all of the sustainability indicators are regarded as relevant to biodiversity, including those under the social and economic pillars, because biodiversity issues regarding biofuels are about trade-offs. Linkages to Aichi Biodiversity Targets and indicators are also included under the latter (see table 1) on the grounds that bioenergy is an ecosystem service.

85. The work of the GBEP on sustainability indicators is concluded to represent excellent progress towards clarifying the meaning of "sustainability" and includes good attention to biodiversity/environment considerations. The work is a significant contribution to assisting implementation of decisions IX/2 and X/37 as well as for the Strategic Plan for Biodiversity (2011 – 2020). Much of this work, particularly in its earlier stages, was also influenced by outcomes under the CBD (pre-dating any involvement of the CBD Secretariat), including deliberations at SBSTTA-12. This represents significant evidence of impact of the CBD process. Likewise discussions and development towards consensus within the GPEB Sustainability Task Force resulted in impacts upon the CBD discussions related to biofuels, since there is some overlap in participation at the level of individual delegates as well as the level of countries.

86. The GBEP work on sustainability continues and some significant gaps remain in the sustainability indicators framework including:

(a) Most significantly, the issue of indirect land-use change impacts (identified as a key biodiversity issue in section III of this note) is yet to be adequately addressed. The GBEP, and its task force on sustainability, is well aware of this problem and efforts are underway to address it. The sustainability indicators contain a footnote to this effect which notes "In light of discussions on the issue and considering the state of the science on quantifying possible indirect land-use change (ILUC) impacts of bioenergy, it has not yet been possible to include an indicator on ILUC. GBEP notes that further work is required to improve our understanding of and ability to measure indirect effects of bioenergy such as ILUC and indirect impacts on prices of agricultural commodities. GBEP will continue to work in order to consolidate and discuss the implications of the current science on these indirect effects, develop a transparent, science-based framework for their measurement, and identify and discuss options for policy responses to mitigate potential negative and promote potential positive indirect effects of bioenergy". However, there is a significant school of thought within the debate on indirect effects of bioenergy of the view that, rather than quantification, mitigation of negative and promotion of positive indirect effects should be the priority: seen from this perspective, the GBEP indicators, which highlight the contribution of low and high risk production practices, combined with the outputs of the GBEP workstream on indirect effects, which include an inventory of mitigation measures, represent a significant tool for policymakers in addressing this complex issue in a practical manner;

(b) The indicators conspicuously lack attention to indicators for policies and subsidies (including perverse incentives regarding biodiversity). Whilst these topics are indeed politically charged, section III of this note points out that these factors currently have the major influence on biofuels development. However, indicators of governance or the institutional aspect of sustainable development are generally considered difficult to devise and these aspects tend to be addressed in sustainability indicator frameworks through alternative means. In the case of the GBEP work on bioenergy sustainability, the report on the indicators sets out a list of issues of a cross-cutting, but mainly policy and governance related, nature, which should be taken into account when interpreting the indicator values. It is also specifically suggested that it “could also be useful to take into consideration the level of government support offered for bioenergy production and/or use, in order to perform a cost-benefit analysis of a national bioenergy programme.” Furthermore, an indicator of the existence of a policy might not be a good proxy for an indicator for the outcome of this policy. Indeed, the whole set of indicators are intended to inform policy development based on the measurement of the actual outcomes of current biofuel policy and practice; and

(c) It remains unclear how the indicators collectively can be assessed in terms of identifying progress towards "sustainability" because individually they measure different parameters, quantified in different ways, and comparisons of trends in one against another involve a high degree of subjectivity (although this is a common problem with all indicator processes – including that for the Aichi Biodiversity Targets). Part of the problem is that the indicators for the "environment" pillar tend to be less tangible than those for the social and economic pillars (which tend to relate more directly to human benefits, which makes comparisons to biodiversity/environment impacts very subjective). A longer term solution to this problem is to attempt to convert the environment indicators to impacts on "ecosystem services" (either directly or through subsequent analysis) thereby improving quantification of comparisons. But certainly in the short-term it is unlikely the sustainability indicators will be used as a rigorous quantifiable basis for decision making and more likely used as an indication of general directions in which development is heading. Such a discussion is already taking place for the iLUC indicators whereby current science is unlikely to provide robust quantified indicators, and a more sensible and practical approach may be to identify more generally which developments have high or low risk of iLUC and managing accordingly. The GBEP indicators are intended to inform a participatory domestic decision-making process, where the relative importance of different themes and indicators and the extent to which identified trade-offs are considered acceptable will depend upon the national context.

87. The GBEP is currently moving actively into capacity building including supporting dissemination of sustainability approaches.[24] The GBEP has set three activity groups under the new Working Group on Capacity Building for Sustainable Bioenergy: 1) West African Regional Forum on Sustainable Modern Bioenergy; 2) Raising awareness, and sharing of data and experience on the implementation of GBEP indicators; and 3) Study tour for capacity building and training. Further capacity building programmes will likely be implemented from 2012. These present some opportunities for exploring synergies with capacity-building for National Biodiversity Strategies and Action Plans.

B. The Roundtable on Sustainable Biofuels (RSB)

88. The Roundtable on Sustainable Biofuels (RSB) (http://rsb.epfl.ch) is an international multi-stakeholder forum hosted by the Swiss Federal Institute of Technology in Lausanne (EPFL), Switzerland. Its aim is to develop a global sustainability standard and to implement a practical certification system guaranteeing the social and environmental performance of biofuels. Presently, the RSB has over 130 member organizations from more than 30 countries. Membership is open to any organization working in

[24] http://www.globalbioenergy.org/programmeofwork/working-group-on-capacity-building-for-sustainable-bioenergy/en/

areas relevant to bioenergy, including oil companies, fuel makers, large and small farmers, investors, governments, non-governmental organizations, United Nations agencies and research institutes.

89. The RSB includes a Secretariat, a Steering Board and expert groups. The Steering Board is composed of an Executive Secretary and two representatives from each of the seven membership chambers which are organized by constituencies. For some chambers, these representatives include one RSB member from a country from the global north and one from the global south, representing the range of different stakeholders involved in sustainable biofuels production and use. The Steering Board makes all the decisions via consensus regarding the RSB strategy, any changes to the RSB standards, and approves the various options for certification. The RSB has also organized expert groups composed of both RSB members and non-members on select issues that remain active until the issue has been adequately addressed. The RSB currently maintains expert groups on Greenhouse-Gas Emissions and iLUC (as for the GBEP, and there is cross-referencing between the work of the two initiatives) but also on Genetically Modified Organisms.

90. The RSB’s global certification standards (http://rsb.epfl.ch/page-67254-en.html) describe requirements for sustainably produced biomass and biofuels, and are used as a framework for RSB certification. These voluntary standards are applicable to any region, feedstock or biofuel type, and cover the entire biofuel supply chain, from biomass to end-user. The RSB standards continue to be updated and expanded as new technologies and knowledge become available.

91. The RSB’s global certification standards are ever-evolving documents developed by the RSB’s members through an open and transparent multi-stakeholder process. Decisions are made by consensus where equal weight for decision-making is given to the private sector, public sector and civil society. The RSB is also a full member of the International Social and Environmental Labelling and Accreditation (ISEAL) Alliance.

92. The RSB’s global certification standards contain 12 Global Principles and various Criteria addressing legality; impact assessment and stakeholder consultation; greenhouse-gas emissions; human and labour rights; local development and food security; conservation of biodiversity and ecosystem services; soil, water and air protection; use of hazardous technologies; and land rights (table 2). The RSB’s global certification standards also include compliance indicators, a guidance document and a glossary of terms, as well as greenhouse-gas emissions calculation methodology and fossil fuel baseline calculation methodology. The RSB has agreed on a 50% reduction in GHG emissions for a blend of biofuels compared to fossil fuels. RSB certified operators (biofuels-related organizations and stakeholders are referred to as “operators” by RSB in the context of certification) must also abide by GHG requirements in the country/region where they operate.

93. The RSB criteria most directly related to biodiversity refer to Principle 7 (Conservation) with the following sub-criteria: conservation values of local, regional or global importance within the potential or existing area of operation shall be maintained or enhanced; ecosystem functions and services that are directly affected by biofuel operations shall be maintained or enhanced; biofuel operations shall protect, restore or create buffer zones; ecological corridors shall be protected, restored or created to minimize fragmentation of habitats; and biofuel operations shall prevent invasive species from invading areas outside the operation site. Each of these is accompanied by definitions of scope and requirements together with agreed indicators (many of which refer to the information applicants need to supply to obtain certification). As described for the GBEP sustainability criteria (above) most of the other RSB Principles and criteria are also relevant to biodiversity, including direct relevance for soil (Principle 8) and water (Principle 9). Principle 1 (legality) includes the criterion "Biofuel operations shall comply with all applicable laws and regulations of the country in which the operations occur and with relevant international laws and agreements". At least in theory this would include "compliance", as appropriate, with the provisions of the CBD. No relevant international agreements are specified under this criterion, although specific reference to other conventions is made in several other criteria.

94. A separate consolidated RSB EU Renewable Energy Directive (RED) set of standards was developed for the European Union market (http://rsb.epfl.ch/page-64909-en.html) and is recognized by

the European Union under the RED, the European Commission and the German Federal Agency for Agriculture and Food (BLE).

95. The primary use of the RSB global standards is RSB certification, which uses a risk management approach and independent third party certification bodies. RSB certification has been available to biofuels operators since March of 2011. Membership is not required for RSB certification which involves the same process irrespective of membership. The evaluation procedure for certification is adaptive to an organization's size, practices and local context. The certification system is at once flexible enough to adapt to the situation of each operator, while avoiding risks of breaching the standards. Group certification of producers is also permitted under certain conditions to facilitate access by small operators.

96. An operator must apply for certification through RSB services (http://www.rsbservices.org/). The certification system incorporates the RSB Tool (http://buiprojekte.f2.htw-berlin.de:1339/), which guides an operator through the steps of the certification process. This process includes the greenhouse-gas calculation, which calculates life-cycle emissions using different methodologies (such as RSB, EU, RED); a self-risk assessment, which determines risk class; and a self-evaluation against the RSB standards. The operator must submit this information to apply for certification.

97. Third party certification bodies (auditors) evaluate whether an operator is compliant with the RSB Principles and Criteria and the RSB standards by conducting a desk audit. The auditor then schedules an onsite visit and a field audit. If the audit is successful, the certification body then issues a certificate of compliance. If the audits are unsuccessful, the operator will need to implement corrective measures and re-apply for certification.

98. The CBD Secretariat officially joined Chamber 7 (international organizations etc.) in September 2011. Direct contributions to the work of the RSB have so far been limited pending further familiarization with its work. Hence a critique of the RSB, regarding biodiversity, is avoided in this note. However, it can be observed that currently a major constraint is the inability to address iLUC. As noted previously, without adequately dealing with iLUC, certification schemes and sustainability standards etc. cannot achieve sustainability – although all of these processes continue to evolve and improve.

99. As for the GBEP indicators, the RSB Principles and Criteria represent a reasonably comprehensive set of criteria ("indicators") when matched against the Aichi Biodiversity Targets and their indicators (Table 2).

Table 2: Roundtable on Sustainable Biofuels (RSB) principles and criteria, and potential linkages with Aichi Biodiversity Targets (http://www.cbd.int/sp/targets/) of the Strategic Plan for Biodiversity (2011-2020). Minimum requirements for each of the RSB criteria can be found in the RSB Principles and Criteria (RSB-STD-01-001, Version 2.0):

http://rsb.epfl.ch/files/content/sites/rsb2/files/Biofuels/Version%202/PCs%20V2/11-03-08%20RSB%20PCs%20Version%202.pdf

RSB Criteria	**Corresponding Aichi Biodiversity Targets**
Principle 1. Biofuel operations shall follow all applicable laws and regulations.	
Criterion 1. Biofuel operations shall comply with all applicable laws and regulations of the country in which the operation occurs and with relevant international laws and agreements.	Not directly relevant but related to targets 4 and 17
Principle 2: Sustainable biofuel operations shall be planned, implemented, and continuously improved through an open, transparent, and consultative impact assessment and management process and an economic viability analysis.	
Criterion 2a. Biofuel operations shall undertake an impact assessment process to assess impacts and risks and ensure sustainability through the development of effective and efficient implementation, mitigation, monitoring and evaluation plans.	Targets 2, 4.

RSB Criteria	Corresponding Aichi Biodiversity Targets
Criterion 2b. Free, Prior & Informed Consent (FPIC) shall form the basis for the process to be followed during all stakeholder consultation, which shall be gender sensitive and result in consensus-driven negotiated agreements.	Targets 17, 18
Criterion 2c. Biofuel operators shall implement a business plan that reflects a commitment to long-term economic viability.	Targets 2, 4
Principle 3. Biofuels shall contribute to climate change mitigation by significantly reducing lifecycle GHG emissions as compared to fossil fuels.	
Criterion 3a. In geographic areas with legislative biofuel policy or regulations in force, in which biofuel must meet GHG reduction requirements across its lifecycle to comply with such policy or regulations and/or to qualify for certain incentives, biofuel operations subject to such policy or regulations shall comply with such policy and regulations and/or qualify for the applicable incentives.	Targets 3, 20
Criterion 3b. Lifecycle GHG emissions of biofuel shall be calculated using the RSB lifecycle GHG emission calculation methodology, which incorporates methodological elements and input data from authoritative sources; is based on sound and accepted science; is updated periodically as new data become available; has system boundaries from Well to Wheel; includes GHG emissions from land use change, including, but not limited to above- and below-ground carbon stock changes; and incentivizes the use of co-products, residues and waste in such a way that the lifecycle GHG emissions of the biofuel are reduced.	Targets 5, 7, 8, 10, 15
Criterion 3c. Biofuel blends shall have on average 50% lower lifecycle greenhouse-gas emissions relative to the fossil fuel baseline. Each biofuel in the blend shall have lower lifecycle GHG emissions than the fossil fuel baseline.	Targets 8, 10
Principle 4. Biofuel operations shall not violate human rights or labor rights, and shall promote decent work and the well-being of workers.	
Criterion 4.a Workers shall enjoy freedom of association, the right to organize, and the right to collectively bargain.	Targets 17, 18, 19
Criterion 4.b No slave labor or forced labor shall occur.	Targets 2, 14
Criterion 4.c No child labor shall occur, except on family farms and then only when work does not interfere with the child's schooling and does not put his or her health at risk.	Targets 2, 14
Criterion 4.d Workers shall be free of discrimination of any kind, whether in employment or opportunity, with respect to gender, wages, working conditions, and social benefits.	Targets 2, 14
Criterion 4e. Workers' wages and working conditions shall respect all applicable laws and international conventions, as well as all relevant collective agreements. Where a government regulated minimum wage is in place in a given country and applies to the specific industry sector, this shall be observed. Where a minimum wage is absent, the wage paid for a particular activity shall be negotiated and agreed on an annual	Targets 2, 14
Criterion 4.f Conditions of occupational safety and health for workers shall follow internationally-recognized standards.	Targets 2, 14
Criterion 4 g. Operators shall implement a mechanism to ensure the human rights and labor rights outlined in this principle apply equally when labor is contracted through third parties.	Targets 2, 14
Principle 5. In regions of poverty, biofuel operations shall contribute to the social and economic development of local, rural and indigenous people and communities.	
Criterion 5.a In regions of poverty, the socioeconomic status of local stakeholders impacted by biofuel operations shall be improved.	Targets 2, 14
Criterion 5.b In regions of poverty, special measures that benefit and encourage the participation of women, youth, indigenous communities and the vulnerable in biofuel operations shall be designed and implemented.	Targets 1, 2, 14, 17, 18, 19
Principle 6. Biofuel operations shall ensure the human right to adequate food and improve food security in food insecure regions.	
Criterion 6a. Biofuel operations shall assess risks to food security in the region and locality and shall mitigate any negative impacts that result from biofuel operations.	Targets 2, 14, 15

RSB Criteria	Corresponding Aichi Biodiversity Targets
Criterion 6b. In food insecure regions, biofuel operations shall enhance the local food security of the directly affected stakeholders.	Targets 2, 14, 15
Principle 7. Biofuel operations shall avoid negative impacts on biodiversity, ecosystems, and conservation values.	
Criterion 7.a Conservation values of local, regional or global importance within the potential or existing area of operation shall be maintained or enhanced.	Targets 2, 4
Criterion 7.b Ecosystem functions and services that are directly affected by biofuel operations shall be maintained or enhanced.	Target 2, 4, 5, 7, 8, 14, 15
Criterion 7.c Biofuel operations shall protect, restore or create buffer zones.	Targets 4, 5, 7, 10, 11, 12, 13, 14, 15, 19
Criterion 7.d Ecological corridors shall be protected, restored or created to minimize fragmentation of habitats.	Targets 4, 5, 7, 10, 11, 12, 13, 14, 15, 19
Criterion 7.e Biofuel operations shall prevent invasive species from invading areas outside the operation site.	Targets 2, 9, 12
Principle 8: Biofuel operations shall implement practices that seek to reverse soil degradation and/or maintain soil health.	
Criterion 8.a Operators shall implement practices to maintain or enhance soil physical, chemical, and biological conditions**.**	Targets 2, 4, 5, 7, 8, 14, 15
Principle 9. Biofuel operations shall maintain or enhance the quality and quantity of surface and ground water resources, and respect prior formal or customary water rights.	
Criterion 9.a Biofuel operations shall respect the existing water rights of local and indigenous communities.	Targets 4, 7, 8, 14
Criterion 9.b Biofuel operations shall include a water management plan which aims to use water efficiently and to maintain or enhance the quality of the water resources that are used for biofuel operations.	Targets 4, 5, 7, 8, 10, 14
Criterion 9.c Biofuel operations shall not contribute to the depletion of surface or groundwater resources beyond replenishment capacities.	Targets 4, 14
Criterion 9.d Biofuel operations shall contribute to the enhancement or maintaining of the quality of the surface and groundwater resources.	Targets 4, 5, 8, 10
Principle 10. Air pollution from biofuel operations shall be minimized along the supply chain.	
Criterion 10.a Air pollution emission sources from biofuel operations shall be identified, and air pollutant emissions minimized through an air management plan.	Targets 8, 10, 12
Criterion 10.b Biofuel operations shall avoid and, where possible, eliminate open-air burning of residues, wastes or by-products, or open air burning to clear the land.	Targets 8, 10, 12
Principle 11. The use of technologies in biofuel operations shall seek to maximize production efficiency and social and environmental performance, and minimize the risk of damages to the environment and people.	
Criterion 11.a Information on the use of technologies in biofuel operations shall be fully available, unless limited by national law or international agreements on intellectual property.	Targets 16, 19
Criterion 11.b The technologies used in biofuel operations including genetically modified: plants, micro-organisms, and algae, shall minimize the risk of damages to environment and people, and improve environmental and/or social performance over the long term.	Targets 7, 9, 13, 14, 16, 17
Criterion 11.c Micro-organisms used in biofuel operations which may represent a risk to the environment or people shall be adequately contained to prevent release into the environment.	Targets 7, 9
Criterion 11.d Good practices shall be implemented for the storage, handling, use, and disposal of biofuels and chemicals.	Targets 7, 8, 9, 14
Criterion 11.e Residues, wastes and byproducts from feedstock processing and biofuel production units shall be managed such that soil, water and air physical, chemical, and biological conditions are not damaged.	Targets 2, 4, 5, 7, 9, 14

RSB Criteria	**Corresponding Aichi Biodiversity Targets**
Criterion 12.a Existing land rights and land use rights, both formal and informal, shall be assessed, documented, and established. The right to use land for biofuel operations shall be established only when these rights are determined.	Target 18
Criterion 12.b Free, Prior, and Informed Consent shall form the basis for all negotiated agreements for any compensation, acquisition, or voluntary relinquishment of rights by land users or owners for biofuel operations.	Targets 17, 18

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