Additional file 4. Qualitative assessment of standards related to oil palm, jatropha, and soybean

The most recent versions of eight standards were considered (Table 1). Two of them are crop specific (RSPO, RTRS), further two address biofuels only (EU-RES-D, RSB), and the rest are more general agricultural or environment management standards. All except EU-RES-D are voluntary and it should be noted that the EU-RED-D can be implemented through these voluntary certification schemes. The only mandatory aspects of the EU-RES-D relate to accounting rules for greenhouse gas emissions and certain other requirements, such as areas where production of biofuels is not allowed to take place.

To assess the standards several keywords that either matched directly or were linked to the search terms of the review were chosen. Those keywords were then searched within the standards based on following categories:

- not mentioned,
- mentioned,
- mentioned and judged sufficient to prevent and mitigate negative effects on biodiversity,
- mentioned and included if identified as a “High Conservation Value” (HCV) area,
- multiple provisions for avoidance, but no strict prohibition included,
- not applicable.

If the keyword was mentioned in the criteria, a qualitative evaluation was conducted of the potential of these criteria to mitigate the impacts of crop cultivation on biodiversity.

Information was taken from principles and criteria stated in each standard, with reference to primary guidance documents as needed.

Table 1. Different standards related to biofuel crop production.

Abbreviation	Standard	Year published
ISO	Environmental management systems — Requirements with guidance for use (14001:2004) by International Organization for Standardization	2004
RSPO	Roundtable on Sustainable Palm Oil (RSPO) Principles and Criteria for Sustainable Palm Oil Production	2007, updated 2013
IFC AC & P	International Finance Corporation (IFC) Environmental, Health, and Safety Guidelines for Annual Crop Production; Environmental, Health, and Safety Guidelines for Plantation Crop Production	2007
EU-RES-D	Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC	2009
RSB	Roundtable on Sustainable Biofuels (RSB) Principles and Criteria, version 2.0	2010
SAN	Sustainable Agriculture Standard of Sustainable Agriculture Network	2010
RCA	ECOFYS: Responsible Cultivation Areas: Identification and certification of feedstock production with a low risk of indirect effects	2010
RTRS	Roundtable on Responsible Soy Association (RTRS) Standard for Responsible Soy Production Version 1.0	2010

The main approach of the standards towards biodiversity conservation is to conserve habitats that are considered biodiversity rich or have otherwise significant biodiversity value. Five of the

standards define the land type considered to have rich biodiversity (Table 2) and RTRS has plans to develop national level biodiversity maps. High conservation value (HCV) areas are recognized by all except two of the standards (SAN, ISO) and their conversion is prohibited or conditionally prohibited; the RTRS and the RSB allow a limited exploitation of HCV areas on a condition that the HCVs they include are maintained (e.g. viable populations of endangered species). The EU-RES-D also prohibits conversion of areas that provide high carbon stock, wetlands, peatlands, and continuously forested areas that can also harbor significant biodiversity. Although the SAN standard does not refer to HCV areas, in practice it provides protection of those areas as it prohibits the destruction of any natural ecosystem from certification onwards. Protected areas are also explicitly mentioned as 'no go' areas by almost all of the standards.

At the landscape level the RSB and SAN standards specifically guide to maintain connectivity and the IFC guides to maintain the field borders as natural corridors among cultivated areas. Although conversion of certain areas is prohibited under the standards, only the RCA addresses indirect effects of land-use change and provides guidance how to mitigate those effects. Similarly, habitat fragmentation is only addressed by the RSB.

At the species level, endangered and threatened species are protected by all of the standards. Species level is also addressed via the HCV concept where "forest areas containing globally, regionally or nationally significant large landscape level forests, contained within, or containing the management unit, where viable populations of most if not all naturally occurring species exist in natural patterns of distribution and abundance" are important to maintain, but

Table 2. Comparison of principles and criteria included in biofuel related standards.*

	EU-RES-D	RSB	RSPO	SAN	RCA	RTRS	IFC AC & P	ISO 14001:2004
Crop	All	All	Oil Palm	All	All	Soy	All	All
Land types considered as biodiversity rich	Primary forest, grasslands	Locally, regionally, globally important areas	Primary forest	Natural ecosystems	Global importance	-	Based on surveys	NA
Protected areas	++	++	++	++	++	-	-	++
HCV protected	++	++	++	Natural ecosystems protected	++	++	++	NA
Peatlands protected	++	-	** (extensive areas (>25 ha) avoided)	-	++	-	-	NA
Wetlands protected	++	++	*	-	++	-	-	NA
Continuously forested areas are protected	++	-	*	-	++	++	-	NA
Species abundance (viable populations)	-	-	-	Inventory within farm	-	-	-	NA
Endangered or threatened species	++	++	++	++	++	++	++	++

Hunting controlled or prohibited	-	-	++	++	-	++	-	-
Habitat loss of non-forest lands (e.g. grasslands)	-	++	*	++	-	++	+	NA
Deforestation	-	++	*	++	++	++	-	NA
Fragmentation	-	++	*	-	-	-	-	NA
Connectivity / Corridors	-	++	++	++	-	-	++	NA
Indirect effects (e.g. land use change)	+	-	+	-	++	-	-	NA
Protection of vital ecosystem services and ecosystem function	+	++	-	++	+	++	+	NA

Mitigation of negative impacts	+	-	++	++	++	++	-	+
Monitoring required	Yes	Yes	Yes	Yes	NA	Yes	Yes	Yes
Public audit reporting	Every 2 years	Yes	Yes	Records must be available	NA	Yes	-	Yes
Environmental impact assessment or similar	No	Required	Required	Evaluation required	No	Required	Required	Inherent
Smallholders responsibilities	-	Differentiated	Differentiated	-	NA	Certain criteria differentiated for groups	NA	NA

* The table has a qualitative evaluation of potential of these criteria to mitigate the impacts of crop cultivation on biodiversity. Information taken from principles and criteria stated in each standard, with reference to primary guidance documents as needed.

Key to the table:
- = not mentioned,
+ = mentioned,
++ = mentioned and judged sufficient to prevent and mitigate negative effects on biodiversity,
* = mentioned and included if identified as a “High Conservation Value” (HCV) area,
** = multiple provisions for avoidance, but no strict prohibition included,
NA = not applicable

otherwise maintaining viable species' populations is hardly mentioned. Furthermore, preventing or controlling hunting is mentioned only by three of the standards, the RSPO, the RTRS, and the SAN.

Ecosystem services and functions are often addressed through the HCV concept. The RTRS, the RSB and the SAN address them through explicit criteria and guidance on good management practices whereas the IFC requires specifically monitoring of soil health. The ecosystem functions most often addressed are related to water quality and soil erosion.

Environmental impact assessment (EIA) is required by all standards except the EU-RES-D, which does not require it in the context of biodiversity, but refers to it in the context of greenhouse gas emissions, and the RCA. The RCA is focused on identifying suitable areas for environmentally and socially responsible production and thus, EIA falls outside of the scope of the concept. Among those standards that require EIA there are differences in the approach. For example, the RSB and the RSPO provide guidance on how and when to conduct an EIA whereas the RTRS and the SAN are more general in their requirements. Monitoring is included in all the standards but approaches towards it differ. For example, the RTRS and the RSPO give guidance on indicators whereas the SAN just notes that monitoring should be conducted to prove compliance or to show corrective action taken in non-compliance situations. Some standards have also different requirements for smallholders or groups, for example regarding the EIA.