Initiative for Biodiversity Impact Indicators for Commodity Production

Convention on Biological Diversity Secretariat (SCBD)

Mainstreaming, Partnerships and Outreach (MPO) Division

Consultant: Jonathan Loh

October 2015

Assignment

The Initiative for Biodiversity Impact Indicators for Commodity Production was launched at CBD CoP XII in Rep. of Korea in October 2014. The purpose of the initiative is firstly to identify common types of impact on biodiversity caused by global agricultural commodity production. Secondly, a set of commodity impact indicators for agricultural commodity production will be drawn from this and, ultimately, corresponding guidance practices to help reduce the major impacts of key agricultural commodities on biodiversity will be developed.

The output of this work assignment - a set of biodiversity impact indicators for agricultural commodity production - will be the basis for the next phase of the initiative, the development of guidance for better practice for reducing biodiversity impacts from agricultural commodity production.

The work assignment comprises the following pieces.

1. Research assignment:

a. Identification, analysis, and summary of international standards (voluntary and mandated), programs, and impact indicators already in existence for agricultural commodity production.

b. Identification and analysis of relevant types of biodiversity-related impacts addressed in these standards and impact indicators.

c. Identification, analysis, and summary of cross-cutting impacts on biodiversity of major agricultural commodities.

2. Preparation of a presentation to present the results of the research assignment as well as assisting in preparing a technical workshop. The technical workshop will serve to discuss and agree on the common impact indicators identified in the consultant report.

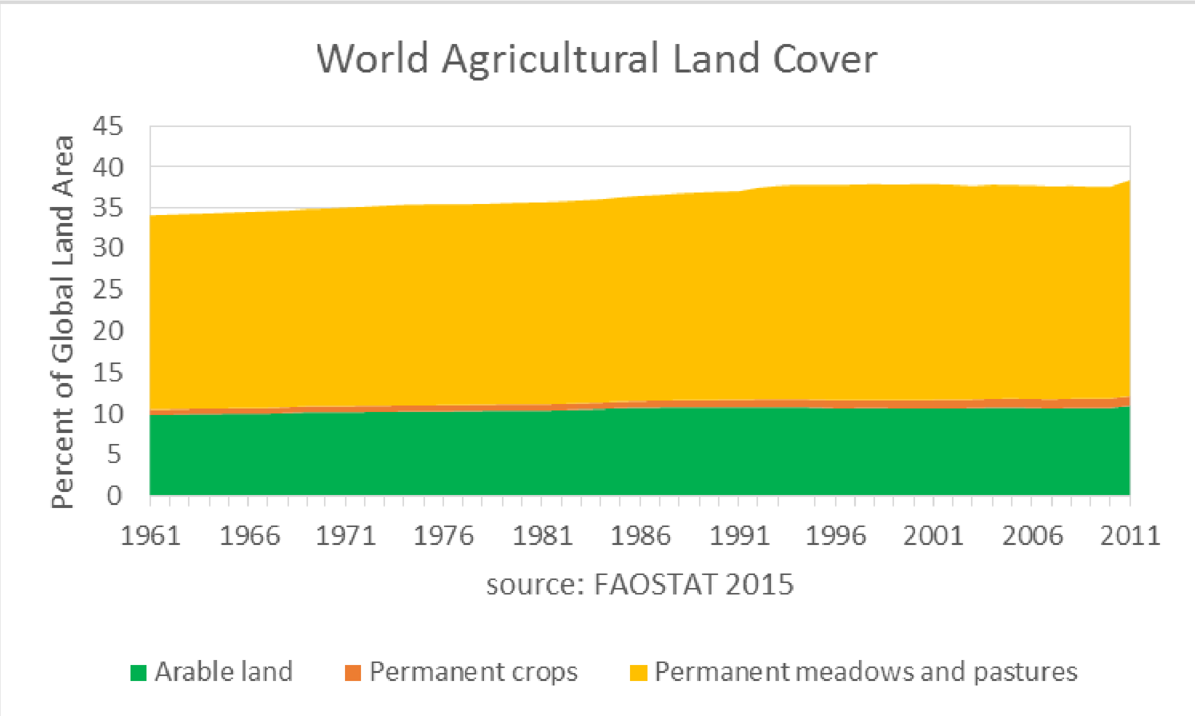
Introduction

The ultimate question faced by conservationists in the twenty-first century is this. How can the Earth sustain a reasonable quality of life for a global population of nine billion or more humans while at the same time supporting populations of the millions of other species with which we share our planet? As the world's human population and per capita consumption of resources have increased, so global agriculture has become both more extensive and more intensive to meet the exponential growth in demand for food, energy and materials. Various studies have estimated that humans now appropriate about one third of terrestrial net primary productivity (NPP) for our own use, to the exclusion of other terrestrial species (Imhoff et al. 2004).

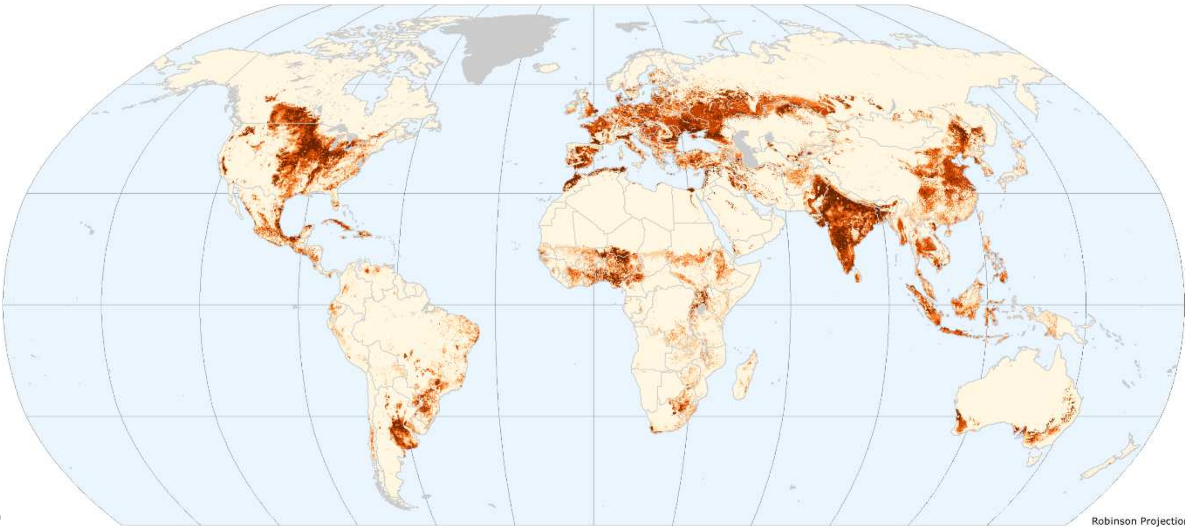
Impacts of Agriculture on Biodiversity

In terrestrial ecosystems worldwide, according to the Millennium Ecosystem Assessment (2005), the most important cause of biodiversity loss in the last 50 years has been land cover change. The major driver of land cover change has been agriculture. Agricultural land cover increased from about 34% to about 38.5% of global land area between 1961 and 2011 (FAOSTAT 2015) (Figure 1 and Map 1).

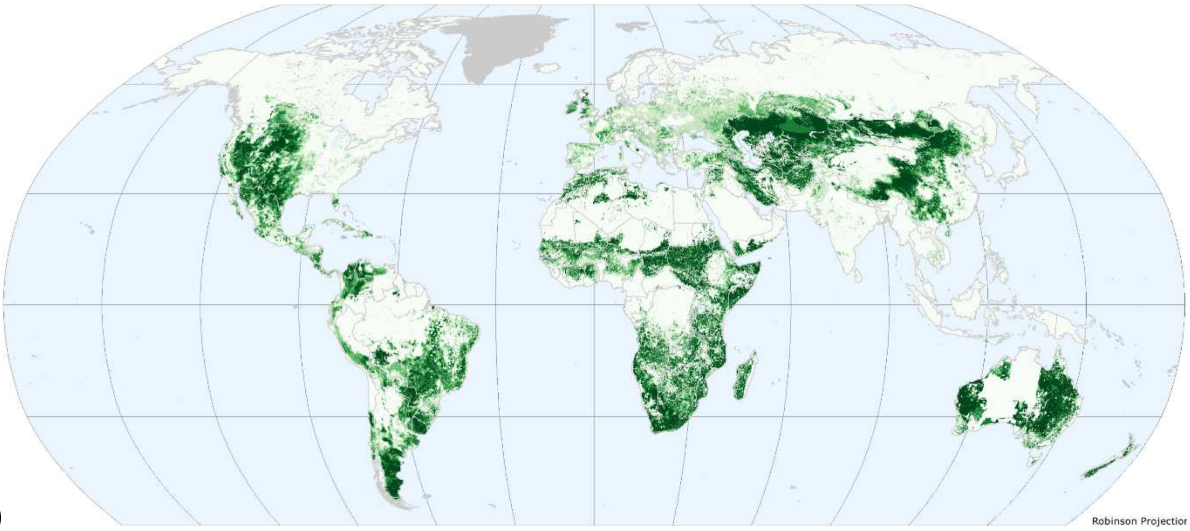
Figure 1: Global Agricultural Land Cover increased by 12.5% from 1961 to 2011



Map 1. Global land cover, 2000 a) croplands b) pastures (source: Ramankutty et al. 2000; map: CEISIN)



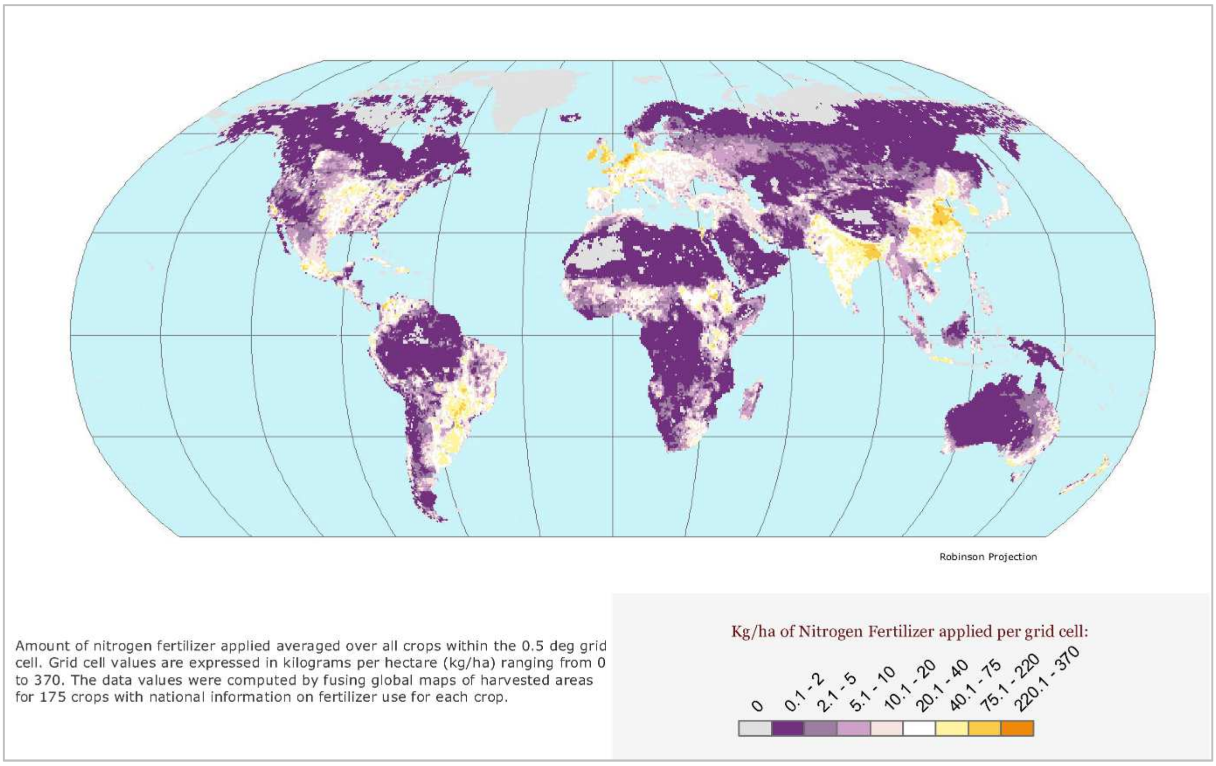
a)

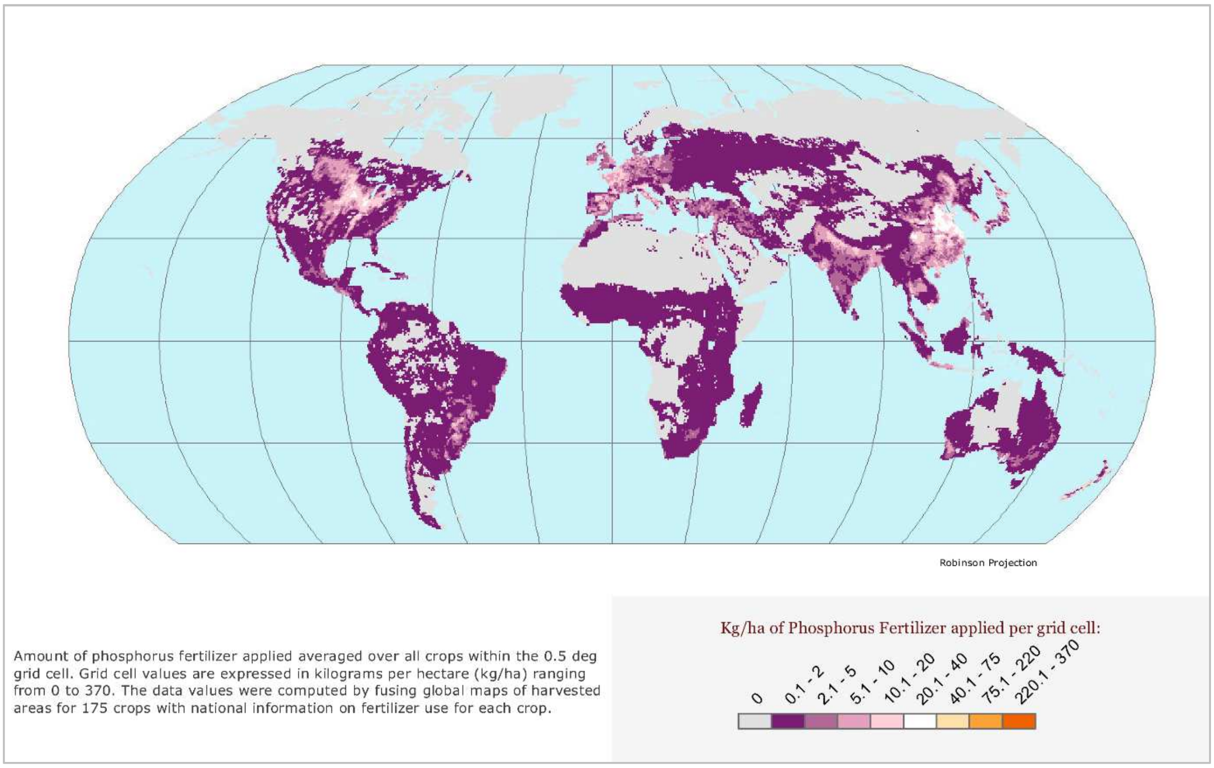


b)

Yields per hectare have increased as agricultural technology made rapid advances, particularly in the green revolution of the 1960s and 1970s, but the rate of improvement in yields is slowing while consumption is accelerating (Clay 2011), especially in the emerging market economies.

Map 2: Global nitrogen and phosphorus fertilizer use (source: Potter and Ramankutty et al. 2010; map: CEISIN)





However, the increase in agricultural land area over the last 50 years is insufficient to explain the decline in global biodiversity over the same period. The terrestrial Living Planet Index, for example, shows an almost 40% decline in the average abundance of terrestrial vertebrate species from 1970 to 2010. Even if we added the conversion of natural land cover to plantation forestry, urban land and infrastructure, the loss of biodiversity would still not be explained by the conversion of natural habitat alone.

Figure 2: Abundance of wild vertebrate species declined by about 40% from 1970 to 2010 (WWF/ZSL 2014)

An additional factor in the equation is the decline in the quality of farmland as a habitat for wild species. This factor is an important cause of global biodiversity loss, although harder to quantify than land conversion. The decline in quality of farmland as a habitat for wild species may be due to many reasons. One is the loss of micro-habitats on farms such as ponds, hedgerows, water meadows, rough pastures, copses, fallow land or woodland which can provide refuges or breeding grounds for wildlife. Losses of very small areas of habitat are not easy to detect using satellite or remote sensing and so do not show up in the data on large scale land cover change.

A second reason for the decline in farmland quality is the increased use of chemical fertilizers and pesticides which reduce the diversity of wild flora and invertebrate fauna. Chemical residues also enter surface water bodies and can have adverse effects on freshwater biodiversity too. Fertilizers contained in surface water runoff from farmland increases the nutrient level in aquatic ecosystems and can result in eutrophication which in turn leads to the loss of biodiversity.

A third cause of the deterioration of farmland biodiversity is the spread of alien species that are predators, competitors, parasites or diseases of the native species. Some alien invasive species were deliberately introduced as biological pest control agents, such as the cane toad introduced to Australia from South America which preys on local amphibian species, but most were introduced inadvertently through colonization or trade.

Approaches to Addressing Biodiversity Loss from Agriculture

In order to start addressing the trends described above, the Secretariat of the Convention on Biological Diversity (CBD) convened the Initiative for Biodiversity Impact Indicators for Commodity Production. It was launched in October 2014, during the twelfth meeting of the Conference of the Parties to the CBD. The purpose of the initiative is to compile the major cross-cutting impacts on biodiversity caused by agricultural commodity production and to develop a set of generic impact indicators as well as guidance for better practice. Defining commonalities in impacts of different commodities is a unique approach. It is hoped to allow the integration and mainstreaming of biodiversity criteria into agricultural commodity production on a wide scale.

The Strategic Plan for Biodiversity 2011–2020 includes five strategic goals, the second and third of which are to "reduce the direct pressures on biodiversity and promote sustainable use" and to "improve the status of biodiversity by safeguarding ecosystems, species and genetic diversity". Under the Strategic Plan for Biodiversity 2011-2020 are twenty targets set to be achieved by 2020, known as the Aichi targets. Two of these relate directly to sustainable agriculture:

- Aichi Target 7: *By 2020, areas under agriculture, aquaculture and forestry are managed sustainably, ensuring conservation of biodiversity*.
- Aichi Target 13: *By 2020, the genetic diversity of cultivated plants and farmed and domesticated animals and wild relatives, including other socio-economically as well as culturally valuable species, is maintained, and strategies have been developed and implemented for minimizing genetic erosion and safeguarding their genetic diversity*.

If the world's human population, income and consumption increase according to a business-as-usual scenario, food production will need to double approximately by 2050. Agriculture is projected to account for 70% of the future loss of terrestrial biodiversity (SCBD 2014). Addressing future food production is therefore crucial in determining whether the Strategic Plan for Biodiversity 2011-2020 will succeed.

Over the past 30 years, a number of initiatives have been developed to address the impacts of food and other commodity production through the implementation of voluntary, third-party certified standards. The most credible of these initiatives are science-based and involve multi-stakeholder groups, such as the various "roundtables", generally with a focus on a single commodity. These roundtables seek to build consensus among producers, buyers and sellers regarding the social and environmental impacts of a given commodity and agree how to promote and achieve more sustainable production methods. But promoting sustainable production on a commodity by commodity basis is inadequate to address the impacts of the myriad agricultural commodities produced worldwide. Additionally, approaches focusing on single commodities may miss larger holistic issues and cumulative impacts.

Furthermore, while voluntary certification processes often reach only those stakeholders who are already committed to sustainability, there remain a large number of companies and producers that are not yet engaged. Developing a basic set of generic biodiversity impact indicators and guidance for sustainable agricultural commodity production is one way of attempting to engage these producers. From the work the existing certification schemes and other studies (eg. Clay 2004), we know that most agricultural commodities share a number of impacts on biodiversity in common, which may affect biodiversity either directly or indirectly. Focusing on the main and most harmful impacts could effectively help changing agricultural commodity production towards better practices with regard to biodiversity impacts. These major agricultural impacts on biodiversity, direct and indirect, are summarized in Table 1.

Table 1: Direct and indirect impacts of agriculture on biodiversity

Direct Impacts on Biodiversity	Indirect Impacts on Biodiversity
Conversion of natural ecosystems to croplands or grazing lands	Habitat fragmentation
Degradation of (semi-natural) agro-ecosystems	Soil loss and erosion
Decline of wild species populations (directly or indirectly) through pest control	Pollution of soils and water from agrochemicals
Loss of genetic diversity in domesticated species	Water abstraction or diversion for irrigation
	Introduction or spread of alien invasive species
	Climate change

In order to halt or minimize the footprint of food production, we need to be aware of the biggest impacts on biodiversity by commodity production (those impacts that occur in most commodity production processes and that are most harmful to biodiversity). More sustainable commodity production can likely be triggered by focusing on only the most fundamental biodiversity impacts - instead of all possible impacts in all the different commodities. A generic and basic set of indicators and guidance will allow focusing on what creates the biggest impacts and to start tackling those.

The aim of the CBD initiative is to produce a set of generic biodiversity impact indicators for agriculture. Such a set of indicators, which cuts across agricultural commodities, is a new approach to addressing biodiversity impact form agriculture. The intention is that this core set of indicators can be used by public and private sector organizations as well as standards and certification bodies to integrate biodiversity impact monitoring into their work. This work will thus feed into other initiatives by providing a core set of indicators for biodiversity impacts from agricultural commodity production that is applicable across commodities and addresses the most important and harmful impacts on biodiversity. The work is intended to fill the gap of the commodity by commodity type approach used so far to address sustainability in commodity production.

Once a core set of impact indicators has been identified, the initiative will formulate guidance on sustainable practice for producers, applicable across different agricultural sectors and regions of the world. The guidance will be designed such that it can be applied easily by those producers who are not already committed to sustainability.

Standards

The development of voluntary standards for sustainable agriculture has been one response to the loss of global biodiversity, which has been led by the non-profit and private sectors. Standards have been developed largely by NGOs in collaboration with producers and buyers, and implemented on a voluntary basis without government regulation or intervention. Most standards have tended to focus on single crops or products such as coffee, palm oil or sugar, while some standards are not crop-specific. Tables 2 shows the crops and associated standards which form the basis of this report, and Figure 3 shows the proportion of world production of these crops that has been certified. Table 3 shows the relative importance of these crops in terms of global agricultural land area and change in land area from 1961 to 2013.

Table 2: International agricultural standards systems examined in this report

Product/Sector	Organization
Biofuels	Roundtable on Sustainable Biomaterials, Bonsucro
Cocoa	Rainforest Alliance/Sustainable Agriculture Network, UTZ Certified
Coffee	Rainforest Alliance/Sustainable Agriculture Network, UTZ Certified
Cotton	Better Cotton Initiative
Tea	Rainforest Alliance/Sustainable Agriculture Network, UTZ Certified
General/not crop-specific	Linking Environment And Farming (LEAF)
Palm oil	Roundtable on Sustainable Palm Oil (RSPO)
Soybeans	The Round Table on Responsible Soy (RTRS) Association
Sugarcane	Bonsucro
Umbrella body	ISEAL Alliance

Figure 3: Percentage of global crop production certified as sustainably produced in 2014 (Milder et al. 2015)

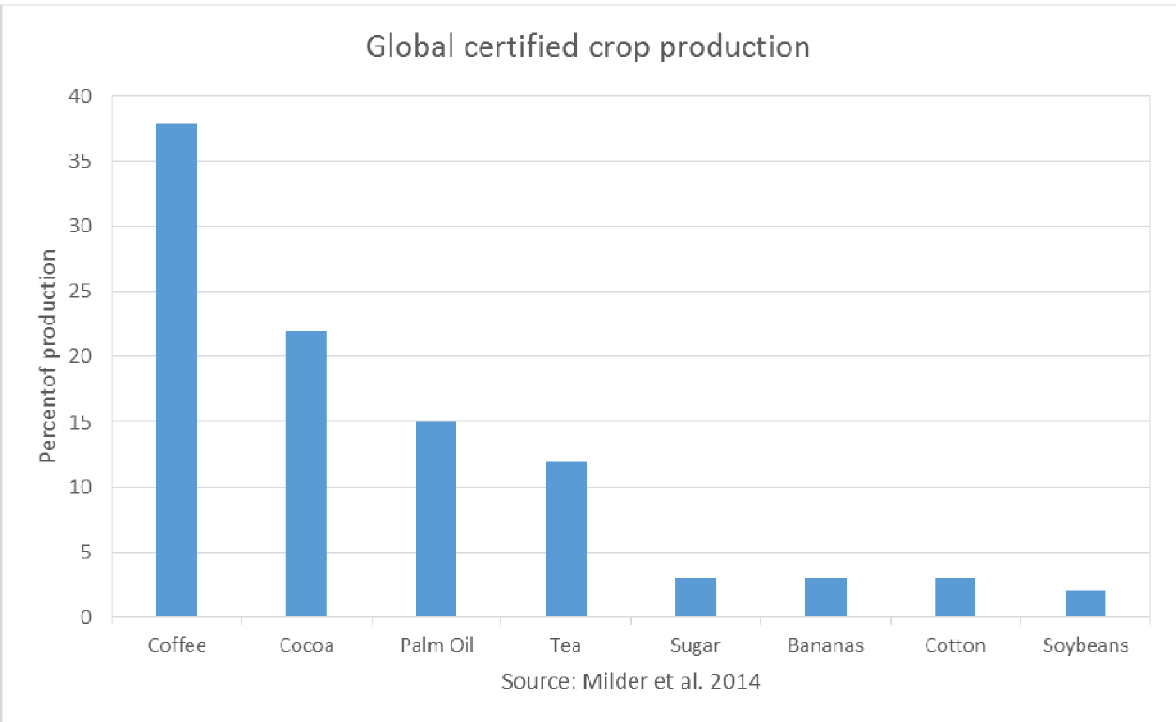


Table 3: World crop production 2013 and 1961, and percentage increase, top 30 by area harvested in 2013 (source: FAOSTAT). Bold text: crops with standards discussed in the report

Global crop production	Area harvested (ha)		Increase	
Crop	**2013**	**1961**	**Total (ha)**	**Percent**
Wheat	219,046,706	204,209,450	14,837,256	7%
Maize	185,121,343	105,559,708	79,561,635	75%
Rice, paddy	165,163,423	115,365,135	49,798,288	43%
Soybeans	**111,544,703**	**23,818,820**	**87,725,883**	**368%**
Barley	49,148,479	54,518,640	-5,370,161	-10%
Sorghum	42,227,048	46,009,146	-3,782,098	-8%
Rapeseed	36,498,656	6,277,273	30,221,383	481%
Millet	33,118,792	43,401,259	-10,282,467	-24%
Seed cotton	**32,168,292**	**31,861,183**	**307,109**	**1%**
Beans, dry	29,052,957	22,766,818	6,286,139	28%
Forage and silage, grasses nes	28,086,214	23,706,067	4,380,147	18%
Sugar cane	**26,942,686**	**8,911,879**	**18,030,807**	**202%**
Sunflower seed	25,453,575	6,667,130	18,786,445	282%
Groundnuts, with shell	25,417,816	16,641,343	8,776,473	53%
Cassava	20,392,815	9,623,856	10,768,959	112%
Vegetables, fresh nes	19,794,204	7,400,786	12,393,418	167%
Potatoes	19,337,071	22,147,976	-2,810,905	-13%
Oil, palm fruit	**18,053,325**	**3,621,037**	**14,432,288**	**399%**
Forage and silage, alfalfa	14,743,443	19,927,829	-5,184,386	-26%
Chick peas	13,570,375	11,836,682	1,733,693	15%
Forage and silage, maize	13,218,181	27,696,803	-14,478,622	-52%
Coconuts	12,073,771	5,260,283	6,813,488	130%
Cow peas, dry	11,926,786	2,410,732	9,516,054	395%
Rubber, natural	10,315,732	3,879,860	6,435,872	166%
Olives	10,309,275	2,608,804	7,700,471	295%
Coffee, green	**10,142,835**	**9,757,455**	**385,380**	**4%**
Cocoa, beans	**10,012,333**	**4,403,484**	**5,608,849**	**127%**
Oats	9,779,904	38,260,751	-28,480,847	-74%
Sesame seed	9,416,369	4,963,028	4,453,341	90%
Sweet potatoes	8,181,850	13,363,636	-5,181,786	-39%

Some of the change in area harvested between 1961 and 2013 is due to switching between crops and some is due to conversion of non-cropland to cropland. The crops with the largest total increase in harvested area (>10 million ha) since 1961 are soybeans, maize, paddy rice, rapeseed, sunflower seed, sugar cane, wheat, oil palm and cassava.

Method

Recent scientific literature and reports by standard-setting organizations were reviewed for information relating to impact monitoring and indicators. For each major crop, the main threats to biodiversity from its cultivation and processing, and the indicators for monitoring the impacts of crop certification have been summarized. The full list of indicators, organized by standard system, are listed in Annex 1.

Thematic Areas

Each indicator reviewed was classified according to the general thematic area it addresses. This was to facilitate comparison of indicators between standards. There are eight thematic areas. There is some overlap between these thematic areas, and in some cases it is arguable which of the eight a particular indicator belongs to. It could be argued that some of the eight could be merged to make a simpler classification, or that some could be split to make a more complex classification. There is no correct system of classification but the following is a reasonable compromise. It will also become apparent that some of these thematic areas are far more important than others in terms of the number of indicators they cover.

State, Pressure and Response

Each indicator was further categorized as being a measure of state, pressure or response. This was to provide a second way of structuring the entire indicator set. Sometimes it is arguable whether an indicator is a measure of state or pressure. For example, an indicator of water quality could be considered to be a measure of the *state* of the water, or a measure of *pressure* on biodiversity. As this is an analysis of biodiversity indicators, water quality should strictly-speaking appear as a pressure indicator. However, as water quality would normally be considered as a state indicator, so it has been listed here as one. This is not critically important. What is important is that any impact monitoring system should have a mixture of state, pressure and response indicators relevant to the target of the system if the theory of change explicit or implicit in the system is to be validated.

It will be apparent that some of the response indicators identified in this report are not "true" indicators, but rather they are simply actions or inactions required by a certification standard. They have been included as indicators however because the implementation or non-implementation of such actions (or inactions) is used by many standards organizations as part of (or in some cases the entirety of) their impact monitoring and evaluation system.

Table 4: Thematic areas used and number of indicators reviewed in this report, and key to the colour-coding used throughout.

Thematic Area	Number of Indicators reviewed		
	State	Pressure	Response
Ecosystems	16	1	24
Wildlife (species)			9
Water use		3	10
Water quality	4	3	11
Agrochemicals		11	23
Soil	1	1	19
Waste and pollution (other than agrochemicals)			9
Energy use and carbon/greenhouse gas emissions		2	12

Analysis

Once all indicators in the entire set of indicators were classified according to their thematic area and categorized as measures of state, pressure or response, they were summarized into a generic or minimum set which captures all the indicators. The minimum set includes generalized versions of all indicators except those which are specific to a single crop, or which fall outside of the thematic areas. These generalized indicators cut across sectors and are applicable to crops other than those for which the standards have been formulated. From this set it is possible to produce a short-list of general indicators of agricultural impacts on biodiversity. However, none of the standards reviewed here are specific to livestock farming and therefore indicators specific to the impacts of meat or dairy production are not present in the set. The indicators are listed by thematic area in Tables 7 to 15 in the results section.

Definitions

A note on terminology. The word "impacts" can have two meanings when talking about biodiversity. One meaning is the effect a human activity such as farming or hunting or tourism has on biodiversity. Another meaning, particularly in the context of conservation programmes and sustainability standards, is the effect of a response or initiative, in this case certification, on the status of biodiversity. Unfortunately, "impact" is used in both senses of the word in this report. Hopefully it will be clear from its context which it is but, as far as possible, "impact" is used to mean the effect of certification on biodiversity, and not the effect of agriculture on biodiversity. Here are some relevant definitions from the ISEAL code on assessing impacts (ISEAL 2014):

> *Impacts*: Positive and negative long-term effects resulting from the implementation of a standards system, either directly or indirectly, intended or unintended.
>
> *Impact Evaluation*: A systematic, objective and in depth, ex-post assessment of the medium or long-term effects; positive or negative, intended or unintended, of the implementation of a standards system. Impact evaluations employ methodologies that are designed to enable evaluation users to understand the extent to which an observed change can be attributed to the standard system or another intervention.
>
> *Indicator*: Quantitative or qualitative factor or variable that provides a simple and reliable means to measure achievement of outcomes, to reflect the changes connected to a standards system, or to help assess the performance of an organisation.

A number of standards refer to High Conservation Value (HCV) forests or land, eg. Bonsucro and RSPO. HCV land is categorised according to the table below (colour-coded in line with thematic areas used in this report).

Table 5: High Conservation Value (HCV) classification

HCV 1 Species Diversity	Concentrations of biological diversity including endemic species, and rare, threatened or endangered species that are significant at global, regional or national levels.
HCV 2 Landscape-Level Ecosystems and Mosaics	Large landscape-level ecosystems and ecosystem mosaics that are significant at global, regional or national levels, and that contain viable populations of the great majority of the naturally occurring species in natural patterns of distribution and abundance.
HCV 3 Ecosystems and Habitats	Rare, threatened, or endangered ecosystems, habitats or refugia.
HCV 4 Ecosystem Services	Basic ecosystem services in critical situations, including protection of water catchments and control of erosion of vulnerable soils and slopes.

HCV 5 Community Needs	Sites and resources fundamental for satisfying the basic necessities of local communities or indigenous peoples (for livelihoods, health, nutrition, water, etc.), identified through engagement with these communities or indigenous peoples.
HCV 6 Cultural Values	Sites, resources, habitat and landscapes of global or national cultural, archaeological or historical significance, and/or of critical cultural, ecological, economic or religious/sacred importance for the traditional cultures of local communities or indigenous peoples, identified through engagement with these local communities or indigenous peoples.

Results

The following indicators appeared in one or more of the reports or literature reviewed, and are generic or could apply to many crops or commodities. Where similar indicators appear in several reports, they have been generalized. For example, many impact monitoring systems consider water use to be important. Some simply state water use as an indicator, some state water footprint (but not necessarily what the water footprint should include) and some describe one or more measures of water use efficiency. The summary below includes two measures of water use efficiency and a water footprint measure which, between them, capture the range of indicators on water use.

There are more response indicators listed than pressure or state indicators. Many of the response indicators are not necessarily actually indicators *per se*, but simply actions or interventions (or inactions or non-interventions) required to meet certification standards. The indicator in such cases would be whether or not the action or intervention has been implemented or completed. The full list of indicators for each crop or commodity covered in the impact reports can found in Annex 1. Table 6 summarizes the impacts of each of the crops for which standards have been reviewed, and Tables 7 to 13 present the generalized indicators by thematic area.

Table 6: Major environmental impacts of crop production (Clay 2004)

Major impact	Cocoa	Coffee	Cotton	Palm oil	Soy beans	Sugar cane	Tea
Conversion of natural habitat	X	X	X	X	X	X	X
Threats to endangered species				X			
Water use and contamination				X			
Soil erosion and degradation	X	X	X	X	X	X	X
Agrochemical use and runoff	X	X			X	X	X
Effluents from processing		X		X		X	
Genetic modification					X		

Table 7: Ecosystems/Habitats and Species/Wildlife indicators

State	Pressure	Response
Percent of farm area in different land classes (eg. protected, HCV, restoration or habitat quality)	Area of expansion of cultivation into natural habitats	Vegetation mapping
Landuse change over time (based on above)	Evidence of human impacts	Ecological assessment
Tree species diversity		Species inventory
Tree density/cover (% or classes)		Management plan
Tree diameter		Habitat or farm area designated for protection/restoration/ conservation
Canopy height		Hunting ban
Vegetation structural diversity		Monitoring of invasive species/pests
Ground cover (%)		
Micro-habitats (% or area)		

Note: SAN/RA has done most research and development in this thematic area of all the standards organizations.

Table 8: Water Use indicators

State	Pressure	Response
Water availability in catchment for downstream users	Water use per unit product (litre/kg, m^3/tonne)	Water management/conservation plan
	Water use per area of crop (m^3/ha/year)	Type of irrigation system
	Water footprint (irrigation and processing)	Irrigation water monitoring
		Type of processing system
		Maintenance of vegetation and wetlands for aquifer recharge
		Rainwater storage

Table 9: Water Quality indicators

State	Pressure	Response
Water quality for downstream users	Discharge water quality	Wastewater management plan
Safe drinking water for domestic use	Biological oxygen demand (BOD) of effluent	Type of wastewater treatment system
Water quality in water bodies		Mapping and management/ restoration of riparian zones
		Pollution prevention from run-off or processing effluents
		Water quality monitoring

Table 10: Agrochemicals indicators

State	Pressure	Response
	Pesticide use and toxicity (kg active ingredient/ha/yr)	Agrochemical inventory
		Type of application system
	Inorganic NPK fertilizer use (kg/ha/yr)	Record of agrochemical use and spraying conditions
	Organic fertilizer use	Ban on illegal and WHO pesticides
		Ban on Stockholm and Rotterdam Convention chemicals
		Minimization of drift
		Safe storage and disposal
		Health and safety precautions
		Integrated pest management plan
		Monitoring of pests
		Prevention of pest resistance
		No application near populated areas or water bodies
		Aerial application does not impact populated areas

Table 11: Soil indicators

State	Pressure	Response
Soil health	Erosion	Soil conservation/erosion prevention plan
[Soil carbon content*]	[percent bare ground*]	Vegetative ground cover/mulching
	[sediment in runoff*]	Contour planting
		Terracing
		Avoiding planting on steep slopes
		Drainage channels
		Check dams
		Live fences
		Soil ridges around plants
		Intercropping
		Fallow areas
		Crop cover during land preparation
		Planting only in suitable soils
		Composting/biomass recycling
		Monitoring of soil carbon/organic matter content

*Note: * not included in reports but mentioned in the discussion*

Table 12: Waste and Pollution (other than agrochemicals) indicators

State	Pressure	Response
		Waste management plan
		Pollution risk assessment
		Recycling
		Composting
		No burning of crop residue, vegetation or wastes
		Proper storage and disposal of solid and toxic waste
		Spillage prevention

Table 13: Energy Use and Carbon/Greenhouse Gas Emissions indicators

State	Pressure	Response
	Energy use and source	Energy/carbon management plan
	Conversion of natural habitat to farmland	Landuse management plan
	Fossil fuel use per area of crop (kgC/ha/yr)	Carbon sequestration by restoration or plantation
	Fossil fuel use per unit of product (kgC/tonne) – carbon intensity	Greenhouse gas footprint calculator
	Carbon footprint (landuse and energy)	Monitor and report energy use/greenhouse gas emissions
		Energy audit
		Minimize greenhouse gas emissions

Discussion

It is possible to further reduce the indicators listed in the results to a core set of no more than a dozen indicators which could be broadly applicable to any crop anywhere in the world. The core set should focus only or mainly on state and pressure indicators which, because they require greater monitoring costs and change relatively slowly compared with response indicators, need not be measured every year or on every farm. This is in line with the sampled and focused research approach of impact monitoring that is used by many of the standards organizations. Response indicators are necessary for standards organizations to monitor compliance and progress, but they are not useful for monitoring their impact on biodiversity.

It emerges from the results that there are some indicators common to many standards and these would form the basis of a core set. Such a core set of course would not be comprehensive, but it could measure and monitor most of the major impacts on biodiversity.

State indicators

State indicators first and foremost should aim to measure the status of biodiversity in and around the farm. Because ecosystems extend beyond farm boundaries, what is really needed are indicators at a landscape scale that can monitor the impact on biodiversity both within a farm and within the wider landscape.

The percentage of farm area in land classes of different habitat quality is perhaps the most useful and readily measurable indicator of biodiversity at the ecosystem level. Habitat quality could be defined in c according to tree species diversity and/or density or canopy cover. Such as system is used by COSA (2013) and SAN/RA (2014) (see Annex 1). This measure of the quality of habitat could also be applied to an entire landscape. Remote sensing tools could be developed that would allow monitoring on a wider scale.

Populations or abundance of wild species on and around the farm is an indicator that is not included in any of the impact monitoring systems, largely because this indicator requires intensive monitoring effort and specialist knowledge of species. However, it means that biodiversity at the species level is not being measured or monitored, and therefore it is possible that the decline or local extinction of a species, particularly a smaller or less well-known one, would go unnoticed.

None of the standards reviewed includes genetic diversity of crop varieties as an indicator, yet the loss of diversity within domesticated species is one important type of biodiversity loss with known economic and ecological consequences. Furthermore, maintaining the genetic diversity of cultivated and domesticated species is one of the twenty Aichi targets for 2020. Because farms usually grow just one or a few varieties of a crop, and varieties originated though the selection of different traits in different localities, this indicator would be better measured at a landscape or regional scale.

Water quality is important for biodiversity, particularly freshwater species, as well as for people. Water quality was included as a state indicator in some the impact reports, but the particular measure of water quality was not specified. There are a number of measures of water quality, one or more of which could be used to monitor its suitability both for domestic use and for wildlife.

There was only one indicator on the state of soil which was “soil health”. Because of the fundamental importance of soil condition in farming, and as a measure of the overall sustainability of farming, it might be useful to identify one indicator on the state of soil as a general proxy for agricultural sustainability. Soil health is, of course, a multi-dimensional concept, but if we were to single out a single indicator, soil carbon content could be good candidate: firstly because of the importance of organic matter to soil health, secondly because of the importance of soil carbon in the global carbon cycle, and thirdly because it is easy to measure.

Pressure and footprint-type indicators

Many of the standards incorporate footprint-type indicators for land use, agrochemical use, water use efficiency or carbon emissions intensity. These form a natural suite of pressure indicators, although it is not obvious how much of a threat on-farm carbon emissions would represent to local biodiversity.

The first and most obvious pressure or footprint indicator to mention is the expansion of cultivated land into natural habitat. This is a critical indicator that can be measured at the level of both the farm and the wider landscape. As long as this indicator remains greater than zero, then we would expect also to measure deterioration in the ecosystem state or habitat quality indicator at the landscape scale.

There are other indicators that measure footprints which have a less direct but perhaps equally important impact on biodiversity. These are the footprints of water use, agrochemical use, and energy use or carbon emissions:

- Water use per unit area (m^3/ha/yr) or per unit product, including water used in both irrigation and processing (m^3/tonne)
- Pesticide use per unit area (kg active ingredient/ha/yr)
- Inorganic fertilizer use per unit area (kg NPK/ha/yr)
- Carbon emissions (from landuse and processing) per unit product (kg C/tonne)

Although not included as pressure indicators, some of the important response indicators could easily be developed into pressure indicators. For example, the amount of agrochemicals entering water bodies depends not only on the amount of chemical used but also on the amount of runoff reaching the water body. Several response indicators relate to actions designed to minimize pollution from runoff, such as maintaining or restoring riparian vegetation or maintaining vegetative ground cover. A pressure indicator based on these responses could be percent of bare ground cover or percent of watercourse bank length without vegetation cover.

Finally, a recent paper on coffee and cocoa certification by Tscharntke *et al*. (2015) made some points which are generally applicable to measuring the impact of standards for any crop:

> With a few exceptions, coffee and cocoa certification standards do not specify the level of biodiversity conservation that must be achieved but rather require sets of improved practices that are hypothesized to benefit biodiversity. Because it is predicated mostly on practices and not outcomes, certification itself generally cannot be taken as direct evidence of conservation effectiveness.
>
> ….there is system-specific evidence of certified farms being more biodiversity friendly than noncertified farms, and little or no evidence of negative conservation impacts. However, the overall evidence base is far from adequate in either extent or methodological robustness to draw generalized conclusions about the conservation benefits and additionality of agroforestry crop certification.
>
> Conservation evidence on a local scale is important, but there is a need to better consider the dominant role of landscape-scale processes on sustaining biodiversity. Integrating certification into landscape approaches – through modifications to existing systems as well as development of new types of certification models – could greatly help in tying improved farm management practices more strongly to landscape conservation.

Conclusion and Recommendation

In line with the goal of the CBD Initiative for Biodiversity Impact Indicators for Commodity Production, the results of this analysis suggest that it is feasible to come up with a core set of indicators. Criteria for choosing the indicators to be included in the core set could include the following:

- Indicators should cover the core thematic areas: land cover/ecosystems; wildlife/species; water use and quality; soil; agrochemicals/pollution; energy/carbon.
- Data should be easy to collect, and the cost of data collection should not be prohibitive.
- Indicators should be applicable to different kinds of crops and farms.
- Indicators should include measures of the state of biodiversity and pressures on biodiversity, not just interventions, actions or responses.
- State indicators should be measurable over the longer term and wider spatial scale.
- Pressure indicators should be measurable over the medium term and spatial scale.
- Response indicators should be measurable over the short term and local (farm) scale.

A core set which meets the selection criteria suggested might look something like the list in Table 14.

Table 14: Possible Core Set of Indicator of Impacts of Agriculture on Biodiversity

Thematic area	Indicator	Units	Spatial Scale (of monitoring)	Temporal Scale (of monitoring)
Land Cover and Ecosystems	Conversion/loss of natural habitat cover	Ha/yr or km^2/yr	Region and landscape: remote sensing	5-10 years
	Percent of land area in different habitat classes based on tree density or species diversity	Percent in each class, or weighted index score	Landscape and farm	3-5 years
Wildlife/Species	*Presence/absence or counts of selected species at randomized sampling sites*	*Index score*	*Region and landscape*	*5-10 years*
Domesticated Species/Genetic Diversity	*Diversity of breeds or cultivars on farms*	*Index score*	*Region and landscape*	*3-5 years*
Water Quality	Biological oxygen demand at sampling sites	BOD_5 (mg O_2/litre over 5 days)	River basin	1-3 years
Water Use	Water footprint (irrigation and processing) of product	m^3/tonne	Farm (can be scaled up)	Annual
Soil	*Soil organic matter*	*Carbon content (%) in top soil*	*Landscape and farm scale*	*1-3 years*
Agrochemical Use	Pesticide use and inorganic fertilizer use	Kg/ha/yr (active ingredient or P-equivalent)	Landscape and farm scale	Annual
Energy Use	Carbon footprint (landuse and processing) of product	KgC/tonne product	Farm (can be scaled up)	Annual

Note: italics denote indicators not included in the analysis of standards in this study.

This list has been made by the author as a suggestion for further discussion.

Outlook

As stated in the discussion above, it emerges from the results that there are some indicators common to many standards and these could form the basis of a core set. Such a core set of course would not be comprehensive, but it could measure and monitor most of the major impacts on biodiversity. Focusing on the main and most harmful impacts could effectively help changing agricultural commodity production towards better practices with regard to biodiversity impacts.

The results of this research will be further refined to produce a core set of indicators which will feed into guidance on how to reduce impacts on biodiversity from agricultural commodity production, to be developed by the CBD Initiative for Biodiversity Impact Indicators for Commodity Production. The guidance is hoped to be used by standard bodies and certification schemes for agriculture, as well as governments, as a starting point to incorporate biodiversity criteria into their standards and policies and thus to help address the most pressing biodiversity impacts caused by agricultural commodity production.

This report was produced with the financial assistance of the European Union.

Convention on
Biological Diversity

References

4C Association. 2014. *A Snapshot from the Field: Five countries over five years*. 4C Association, Bonn, Germany

BCI. 2014a. *Better Cotton Initiative 2014 Annual Report*. Better Cotton Initiative, Geneva, Switzerland

BCI. 2014b. *Better Cotton Initiative 2013 Harvest Report*. Better Cotton Initiative, Geneva, Switzerland

Bonsucro. 2014. *Bonsucro Outcome Report 2015*. Bonsucro, London, UK

Clay J. 2004. *World agriculture and the environment: a commodity-by-commodity guide to impacts and practices*. Island Press, Washington DC, USA

Clay J. 2011. Freeze the footprint of food. *Nature*, **475**, 287

COSA. 2013. *The COSA measuring sustainability report: coffee and cocoa in 12 countries*. The Committee on Sustainability Assessment, Philadelphia, USA.

ENS. 2015. http://ens-newswire.com/2015/06/23/corporations-demand-higher-palm-oil-standards

FAOSTAT. 2015. FAO online database http://faostat3.fao.org/home/E accessed August 2015

ISEAL. 2014. *Assessing the Impacts of Social and Environmental Standards Systems: ISEAL Code of Good Practice v2.0*. ISEAL Alliance, London, UK.

LEAF. 2013. *Driving Sustainability: A review of our impact, achievements and challenges 2013*. LEAF (Linking Environment and Farming), Warwickshire, UK.

LEAF. 2014. *LEAF - inspiring and enabling sustainable farming: A review of our global impacts 2014*. LEAF (Linking Environment and Farming), Warwickshire, UK.

Milder JC, Hughell D, Newsom D, Crosse W, Wilson C, Kennedy ET. 2013. *Charting Transitions to Conservation-Friendly Agriculture: the Rainforest Alliance's approach to monitoring and assessing results for biodiversity, ecosystems and the environment*. Rainforest Alliance, New York, USA

Milder JC et al. 2015. An agenda for assessing and improving conservation impacts of sustainability standards in tropical agriculture. *Conservation Biology*, 29 (2), 309-320.

Newsom D, Milder JC & Bartemucci P. 2014. Improving Practices, Changing Lives: an analysis of tea certification audit reports from Malawi, Rwanda and Tanzania. Rainforest Alliance, New York, USA

Potts J, Lynch M, Wilkings A, Huppé G, Cunningham M, Voora V. *The State of Sustainability Initiatives Review 2014: Standards and the Green Economy*. IISD, Winnipeg, Canada and IIED, London, UK

RSB. 2015. *RSB Outcome Evaluation Report*. Roundtable on Sustainable Biomaterials, Geneva, Switzerland

RSPO. 2014. *Impact Report 2014*. Roundtable of Sustainable Palm Oil, Kuala Lumpur, Malaysia.

RTRS. 2013. *RTRS Standard for Responsible Soy Production Version 2.0 Eng*. Round Table on Responsible Soy Association, Buenos Aires, Argentina

RTRS. 2014. *RTRS Accreditation and Certification Standard for Responsible Soy Production, Version 4.0 Eng*. Round Table on Responsible Soy Association, Buenos Aires, Argentina

SAN/RA 2014. *Monitoring & Evaluation System Public Report. Report prepared and submitted to the ISEAL Secretariat*. Sustainable Agriculture Network/Rainforest Alliance, New York, USA.

SCBD 2014. *Global Biodiversity Outlook 4*. Secretariat of the Convention on Biological Diversity, Montréal, Canada.

Tscharntke T, Milder JC, Schroth G, Clough Y, DeClerk F, Waldron A, Rice R, Ghazoul J. 2015. Conserving Biodiversity through Certification of Tropical Agroforestry Crops at Local and Landscape Scales. *Conservation Letters*, 8(1), 14-23.

UNEP-WCMC. 2011. *Review of the Biodiversity Requirements of Standards and Certification Schemes: A snapshot of current practices*. Secretariat of the Convention on Biological Diversity, Montréal, Canada. Technical Series No. 63.

UTZ. 2014a. *UTZ Certified Impact Report: January 2014*. UTZ Certified, Amsterdam, the Netherlands

UTZ. 2014b. *UTZ Certified Program indicators 2014*. UTZ Certified, Amsterdam, the Netherlands

Annex 1: Crop-specific Impact Monitoring Systems and Indicators

Coffee and Cocoa

Coffee and cocoa are treated together in this report as they are certified by the same certification organizations and share many of the same impact indicators. The main impacts of coffee and cocoa production are conversion of forest habitat, soil erosion and degradation, agrochemical use and runoff, and effluents from coffee processing.

The Committee on Sustainability Assessment (COSA)

COSA conducted independent research on the sustainability of coffee and cocoa production in twelve countries.

Table A1: Global Themes, Elements and Indicators for Coffee and Cocoa (COSA 2013)

Global Theme	Core Elements	Indicators
Water	Water quality Water quantity	Safe water for domestic use *See soil conservation indicators*
Resource use	Resource/input management	Biocides used Biocide use efficiency Toxicity class of biocides NPK use efficiency Integrated pest management
		Energy quality and use (gas, wood and other sources)
Waste	Waste management	Recycling
		Water contamination prevention measures
Soil	Soil conservation	Erosion Number of soil conservation practices to improve water utilization: • Mulch or planted soil cover • Contour planting • Terracing • Drainage channels • Check dams • Live fences (trees or shrubs) • Soil ridges around plants
	Soil health	Intercropping Local nutrient cycle
Biodiversity	Plant and tree diversity	Percent of farm area in six levels of plant biodiversity: • Cleared land, pasture or grassland • Commercial monoculture • 2-3 species cultivated with sparse trees • 4-10 species cultivated with some trees • Crop production with multi-strata forest • Fully functional natural forest
	Tree density	Trees per hectare Forestation
Climate Change	Sequestration & Mitigation	Carbon sequestration Conversion of natural areas to farmland

Sustainable Agriculture Network/Rainforest Alliance (SAN/RA)

SAN/RA's monitoring and evaluation aims to measure a farm's sustainability both before and after certification in order to assess impact. Biodiversity conservation is broadly defined to include:

- The maintenance or restoration of biodiversity composition, structure, and function.
- Protecting native species, including rare or declining species, migratory and endemic species.
- Maintaining ecosystem services, linking conservation and livelihoods.
- Landscape, ecosystem, and watershed conservation.

Sustainable Agriculture Network uses a system of ten guiding principles to assess whether a farm has met its sustainability standard. A number of criteria are used to determine whether the farm is in compliance with each principle. Five of these principles relate directly in indirectly to biodiversity.

Table A2: SAN/RA Principles and Criteria

Principle	Criteria
Ecosystem conservation	Protect/restore natural ecosystems
	No destruction of natural ecosystems
	No harm to nearby natural areas
	No extraction of endangered plants
	Buffer between agrochemical use and natural areas
	Buffer between crops and aquatic areas
	Buffer between crops and human activity
	Restoration of typical ecosystems
	Maintain connectivity of natural ecosystems
Wildlife protection	Wildlife inventory
	Protection of wildlife habitat
	Ban on hunting and capturing of wildlife
	Inventory of wildlife in captivity
	Permits for wildlife breeding
	Permits for wildlife reintroduction
Water conservation	Water conservation program
	Permits for water use
	Irrigation use monitoring
	Wastewater treatment
	Legal wastewater discharge
	Water quality monitoring for discharge
	Ban on solid deposition into water bodies
	Ban on septic tank use for industrial wastewater
	Surface water quality monitoring if natural water bodies may be impacted
Integrated crop management	Integrated pest management
	Inventory & reduction of agrochemical use
	Equipment and procedures to prevent excessive application
	Ban on illegal substances & agrochemicals
	Eliminating use of WHO pesticides
	No transgenic crops
	Fumigation only as post-harvest treatment
	Restricted use of fire as pest-management tool
Soil management and conservation	Soil erosion prevention and control program
	Soil or crop fertilization program
	Vegetative ground cover
	Promote use of fallow areas
	New production on appropriate soils & landforms

In line with the ISEAL impacts code, SAN/RA conducts monitoring and impact assessment at three levels – programme-wide monitoring (global, short-term, cheap), sampled monitoring and focused research (localised, long-term, expensive) – providing progressively more detail but requiring increasing monitoring effort. Accordingly, there are three levels of indicators for biodiversity.

Table A3: Rainforest Alliance global and sampled monitoring indicators (source: SAN/RA 2014)

Monitoring level	Theme	Indicators
Programme-wide monitoring	Biodiversity	Land area designated for conservation management, disaggregated by certification status, location, type of land area (restoration, HCV, strict preservation)
Sampled monitoring	Habitat condition	Percent tree cover
	Habitat condition	Vegetation structural diversity
	Habitat condition	Plant functional diversity type
	Habitat condition	Abundance of small-scale habitat elements
	Ecosystem services	Water quality in water bodies on or near production or business unit
Focused research		Not available

Table A4: Surveys and analysis in Natural Ecosystem Assessment (Source: Milder *et al*. 2013)

Scale (s) at which monitoring is conducted	Natural Ecosystem Assessment Modules		
	Landscape change assessment	Monitoring on-farm conservation value	Assessing changes at the forest frontier
Landscape scale	Land cover is classified based on analysis of remote sensing imagery with ground verification	Changes in on-farm values are analyzed relative to surrounding land use and landscape structure	Changes in condition at the forest frontier are analyzed relative to surrounding land use and landscape structure
Farm scale	No sampling conducted	For a representative sample of farms, farm boundaries and land uses are mapped; species and diameter of emergent trees (very large or tall trees) is recorded	No sampling conducted
Plot scale (vegetation sampling plots of 10x10m)	If more detailed information is required, then for each land cover type, a sample of plots is surveyed for: • Tree canopy height • Tree canopy % cover • % ground cover • Evidence of erosion or other human impacts • Species and diameter of non-crop trees	For each major land use on the farm, up to three plots are surveyed for: • Vegetation structure (% cover at each of six vertical layers) • Species and diameter of non-crop trees • Characteristics such as density, age, and health of the focal crop (e.g., cocoa)	Ten or more plots are arrayed at regular intervals along a transect spanning the agriculture-forest boundary. Each plot is surveyed for: • Tree canopy height • Tree canopy % cover • % ground cover • Evidence of erosion or other human impacts • Species and diameter of non-crop trees

UTZ Certified

UTZ Certified impact areas relate to soil health, water use, energy efficiency and biodiversity protection.

Table A5: UTZ Certified Impacts, Outcomes and Indicators (Source: UTZ 2014a & 2014b)

Impact Area	Outcomes	Indicators	Moni tor-ing	Focus areas for further research
Natural resources	Optimal soil quality/ healthy soil	Number and type of soil erosion prevention practices being used: • maintaining or planting shade trees/crop cover during land preparation • use of terracing • live fences • mulching or planted soil cover • soil ridges around the plants • avoid planting on steep slopes • only planting trees in soil that is healthy and fertile	Y	Soil health
		Use of inorganic fertilizer y/n	Y	Amount of fertilizer applied; type of fertilizer applied. Number of applications
		use of organic fertilizer y/n	Y	
		use of composting techniques y/n	Y	
	Optimal water quality	Type of waste water treatment system (coffee)	Y	Water quality
				Type of water quality protection measures
	Reduced waste & pollution	Reuse/recycling of organic/biodegradable waste (e.g. coffee pulp) for fertilizer	Y	
	Efficient use of water	Type of irrigation system	new	water used per unit produce (litre/kg)
		Type of wet processing system (coffee)	new	Water footprint (TBD)
GHG emissions	Efficient use of energy			Carbon footprint (TBD)
Biodiversity protection	Protection of natural habitats	Mapping of certificate holders (based on GPS coordinates)	new	Tree cover density and diversity (dominant production system) (TBD)

Cotton

Better Cotton Initiative (BCI)

The major impacts of cotton production are habitat conversion, soil erosion and degradation, agrochemical use and water use and pollution. The Better Cotton Initiative sets standards for sustainable cotton production, it assesses progress towards environmental sustainability by monitoring the efficiency of pesticide, fertiliser and water use of irrigation.

Table A6: Results and Indicators for Cotton Impacts (source: BCI 2014a & 2014b)

Result	Note	Indicator
Pesticide use	Pesticides include insecticides, herbicides, acaricides, fungicides, as well as all substances used as defoliant, desiccant, or growth regulators. Type and concentration of active ingredient applied is recorded to calculate the amount of chemicals contained within pesticides.	Percent difference between BCI farmers and comparison farmers in kilograms (kg) of active ingredient applied per hectare (ha).
Fertiliser use	Farmers report on category and exact composition of each fertiliser used. The long-term objective is to ensure optimal application of nutrients to match the needs of the crop, maintain long-term soil health and structure, and minimise off-farm pollution (notably eutrophication from nutrient run-off or leaching) and GHG emission (nitrous oxide emissions and industrial nitrogen fixation).	Percent difference between BCI farmers and comparison farmers in kilograms (kg) of synthetic and organic fertiliser applied per hectare (ha).
Water use for irrigation	Water use is only measured on farms that irrigate. Rain-fed farms are excluded from the analysis.	Percent difference between BCI farmers and comparison farmers on cubic metres (m^3) water per hectare (ha).

BCI does not measure impacts but monitors as far as the level of outcomes or results:

> "We are working to design and use indicators and evaluation methods in the near future that move toward the measurement of impact ….[in] collaboration with other institutions interested in impact measurement. Thus, we do not (yet) speak of 'impact', but rather of 'results'. We can say with confidence, for example, that X farmers in Country A used, on average, 30% less pesticide than a comparison group of farmers in the same region who were not using our methodology." (BCI 2014b)

Oil Palm

Roundtable on Sustainable Palm Oil (RSPO)

Oil palm accounted for about 40% of the 169 million tonnes of global vegetable oil production in 2013. The major impacts from palm oil production are conversion of natural tropical forest ecosystems, soil erosion and degradation, threats to species, and pollution from processing effluent (Clay 2004). Although the oil palm (*Elaeis guineensis*) is native to Africa, Malaysia and Indonesia account for about nearly 90% of global palm oil production. Growing conditions are optimal up to 10 degrees either side of the equator, a band within which most of the world's tropical rainforests occur. Hence oil palm is grown in the places with the highest terrestrial biodiversity and high conservation value (HCV) forest ecosystems (RSPO 2014).

Oil palm grown on peatlands pose a threat to both biodiversity and climate. "Peatlands store an estimated 550 gigatonnes of carbon globally, twice as much as is stored in the world's forests….It is estimated that oil palm plantations on peat increased from 418,000 hectares in 1990 to 2.43 million hectares in 2010. Today, peatland plantations account for approximately 18% of total oil palm area. The largest absolute extent of plantations on peat is in Sumatra, estimated at 1.4 million hectares."

Certified palm oil accounted for about 18% of world production in 2014 (RSPO 2014). The RSPO standards have been criticised recently by a number of companies and investors in the food industry as being too lax and lacking credibility (ENS 2015).

Table A7: RSPO Principles, Criteria and Indicators on Conservation of Natural Resources and Biodiversity (RSPO 2014)

RSPO Principles and Criteria		Indicators
High conservation value (HCV) assessment	Use the HCV toolkit to assess and develop an operations management plan for maintaining and enhancing HCV areas and rare, endangered and threatened species, as well as sites that have social and cultural values to local communities. The HCV assessment, including stakeholder consultation, is conducted prior to any conversion or new planting.	Land use change analysis to determine changes to the vegetation since November 2005. This analysis is used, with proxies, to indicate changes to HCV status.
Environmental impact	Minimise and mitigate the negative impacts of plantations on the environment, while enhancing the positive impacts: • conserve biodiversity • preserve essential ecosystem services • respect cultural landmarks and community access to natural resources	Area set aside for conservation

RSPO Principles and Criteria (cont'd)		Indicators (cont'd)
New plantings procedures	1. A comprehensive independent social and environmental impact assessment must be undertaken 2. Free, prior informed consent from affected communities must be obtained and be fairly compensated 3. Protection and management plans must be developed for primary forest and any HCV in the concession areas 4. Surveyed soil and topography maps should be available to show soil suitability for planting 5. Significant peat land areas are to be avoided 6. Net GHG emissions must be minimised 7. A third party independent audit and verification must be conducted	Area of new plantings
Reduce GHG emissions in existing plantations	Plans to reduce emissions of greenhouse gases are developed, implemented and monitored	
	Management of peatland is guided by best management practice on existing peatland and restoration of peatland using local species	
Minimising net GHG emissions from new plantings	Planting on peat is to be avoided in new plantings	
Public reporting	Growers commit to report their GHG emissions from 1 January 2017, from sources such as: • land use change • palm oil mill effluent (POME) • emissions from peatland • nitrogenous oxide from fertiliser	PalmGHG footprint calculator: • Carbon per tonne of CPO [certified palm oil] • Carbon per tonne of CPK [certified palm kernel]
Best management practice on soil	Improve soil fertility at a level that ensures optimal and sustained yield	
	Implement best practices: • minimisation of soil degradation • the control of soil erosion • biomass recycling • planting on terrace • regeneration of vegetation	
Best management practice on water resources	Water management plans must take into account the efficiency of use and renewability of sources	Water footprint (m^3/tonne fresh fruit bunch processed)
	Operations should provide a riparian zone, and avoid contamination of surface and ground water through run-off of soil, nutrients and chemicals, and palm oil mill effluent	BOD (biological oxygen demand) discharge level
Access to water by local communities	Ensure that the use of water does not adversely impact on other users within the catchment area, including local communities and customary water users	
	Aim to ensure that local communities, workers and their families have access to adequate, clean water for drinking, cooking, bathing and cleaning purposes	

Soybeans

Round Table on Responsible Soy (RTRS) Association

Table A8: RTRS Principles, Criteria and Indicators (RTRS 2014)

Criteria	Indicator
	Principle 4: Environmental Responsibility
Large or high-risk infrastructure	Social and environmental impact assessment conducted prior to development
	Mitigation measures implemented and documented
Pollution and waste management	No burning of crop residues, waste or vegetation for clearance
	Adequate storage and disposal of fuel, batteries, tyres, lubricants, sewage and other waste
	Facilities to prevent spillages
	Reuse and recycling
	Residue management plan
GHG emissions reduction and sequestration	Fossil fuel use is monitored per hectare and per unit production
	Increases in intensity are justified or there is a reduction plan
	Soil carbon is monitored and steps taken to mitigate losses
	Opportunities for sequestration by native vegetation restoration, forest plantation or other means are identified
Expansion of soy cultivation	No expansion of soy cultivation on land cleared of native habitat after May 2009 other than under specified conditions
	No conversion of land subject to unresolved claim by traditional users
Biodiversity	Map of on-farm native vegetation
	Implementation of plan to maintain native vegetation
	No hunting of rare or threatened species
	Principle 5: Good Agricultural Practice
Surface and ground water	Good practices implemented to minimize impacts from chemical residues, fertilizers, erosion and promote aquifer recharge
	Any contamination is reported to authorities and monitored
	Best practice implemented for use of irrigation water
Vegetation around springs and watercourses	Map of watercourses and riparian vegetation
	Implementation of plan to restore riparian vegetation where removed
	Wetlands not drained and native vegetation maintained
Soil	Implementation of techniques to maintain soil quality
	Implementation of techniques to control erosion
	Monitoring of soil organic matter
Integrated crop management (ICM)	ICM plan documented and implemented
	Plan with targets for reduction of harmful products
	Rotation of active ingredients to prevent resistance
	Monitoring of pests, diseases, weeds and natural predators
Agrochemicals	Records of agrochemical use
	Proper storage and disposal
	Health and safety precautions
	No use of chemicals listed in the Stockholm and Rotterdam Conventions
	Implementation of procedures to minimize drift
	Records of weather conditions during spraying
	Aerial application do not impact populated areas
	No application of WHO class Ia, Ib or II within 500mof populated areas or water bodies
	No application of pesticides within 30m of populated areas or water bodies
Biological control	Information on requirements and records kept
Invasive species and pests	Follow systems to identify and monitor invasive introduced species or pest outbreaks
	Report new species or pest outbreaks to authorities if no such systems exist

Criteria (cont'd)	Indicator (cont'd)
Origin of seeds	Purchased from known legal sources
	Self-propagated seeds must comply with seed production norms and IP rights

Sugarcane

Bonsucro

The major impacts on biodiversity from sugarcane cultivation and milling are the conversion of natural forests, soil erosion and degradation, agrochemical use and water pollution from mill effluents. Bonsucro is an organization that develops and set standards for the production and milling sugarcane

Table A9: Bonsucro objectives and indicators for monitoring biodiversity and natural resources (Bonsucro 2014)

Biodiversity & Natural Resources	Indicator	Metric Requirement
Objective: Areas of High Conservation Value are preserved and mills mitigate their impacts on the environment	Net water consumed per unit mass of product (kg/kg of product)	Mill: <20 kg/kg sugar; or <30 kg/kg of ethanol. Agriculture: <130 kg/kg cane
	Herbicides and pesticides applied per hectare per year	<5 kg active ingredient/ha/yr
	Nitrogen and phosphorous fertilizer (calculated as phosphate equivalent) applied per hectare per year	<120 kg/ha/yr
	High Conservation Value areas used as a % of total land affected by a new project or an expansion	Zero conversion of HCV land classified at any time since 2008

Biomaterials

Roundtable for Sustainable Biomaterials (RSB)

RSB develops and maintains standards for the sustainable production and processing of biomass, biofuels and biomaterials. RSB certification began in 2011 and its monitoring and evaluation indicators are still undergoing testing and development.

Table A10: RSB Impact indicators (RSB 2015)

Impact Sub-category	Indicator
Biodiversity	Protected or conservation area (ha)
Soil	Soil erosion reduction and conservation practices (ha)
	Soil quality improvement practices (ha)
Water	Water conservation or water use reduction practices (no. farms)
Carbon/greenhouse gas emissions	Carbon dioxide emissions (MT)
	Carbon emissions reduction through displacement of fossil fuels by biofuels (%)

General/Not Crop-specific

Linking Environment and Farming (LEAF)

LEAF certified a total of 274,000 ha of farmland in 2013 which included grazing as well as cropland.

Table A10: Integrated farm management themes and sustainability indicators (LEAF 2014)

Integrated Farm Management theme	Sustainability Indicators
Organisation and Planning	Hectares of crop with Farm Environmental Policy
	Number of staff participating in regular training on Integrated Farm Management
Soil Management and Fertility	Hectares of crop under Soil Management Plan
	Hectares of crop where nitrogen efficiency per tonne product is measured
Crop Health and Protection	Hectares of crop under Crop Protection Policy
	Hectares of crop where beneficial wildlife is protected and supported
Pollution Control and By-Product Management	Hectares of crop carbon-footprinted
	Hectares of crop with Pollution Risk Assessment action plan
Animal Husbandry	Number of head of livestock under a livestock health plan
	Number of producers complying with organic & animal waste storage best practice
Energy Efficiency	Hectares of crop managed by producer who is monitoring farm energy use
	Number of producers who have had had energy efficiency audit carried out
Water Management	Hectares of irrigated crop where water efficiency is measured
	Hectares of crop benefiting from increasing stored water from periods of rainfall abundance
Landscape and Nature Conservation	Hectares of crop under Whole Farm Conservation Plan
	Number of producers with minimum 5% of land for non-crop wildlife habitats
Community Engagement	Number of visitors on farms participating in Open Farm Sunday
	Number of school children visiting Open Farm School Days