Biofuels Baseline 2008

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Executive Summary

The biofuels market place (Chapter 2)

- In 2008, 9.5 Mtoe biofuels have been consumed in road transport, leading to a share of renewable energy sources of 3.5% of all petroleum products consumed in road transport;
- About 72% of these biofuels concerned biodiesel, 19% concerned bioethanol and about 9% resided in other biofuels (for example pure plant oil).The percentage of biodiesel has been going up (in 2007 64%, in 2009 77%), with the percentage of bioethanol keeping relative stable (18% in 2007, 19% in 2009). The contribution of other biofuels has been decreasing (18% in 2007, only 4% in 2009);
- Five Member States (Germany, France, UK, Italy and Spain) represent more than 70% of the European biofuels market, both in production and consumption. Their majority is only slowly decreasing over time;
- About 78 % of all EU consumed biodiesel in 2008 is produced in the EU, about -22% is imported from third countries, primarily from the US. Indirectly, significant fractions come from Argentina and Indonesia. In 2009, the direct imports from the US decline and shift to direct import from Argentina. With the import of biodiesel, especially the fraction of soybean in EU consumed biodiesel increases. Also the fraction of palm oil slightly increases, while the fraction of rapeseed decreases;
- Rapeseed is by far the most important feedstock for biodiesel produced in Europe, followed by soy oil, palm oil and waste oils. 58% of the feedstock for biodiesel is produced within the EU, and 42% imported from third countries.
- Wheat, maize and sugar beet are the most important feedstock for bioethanol produced in Europe (65% of total bioethanol consumed in EU is also produced in the EU).
- The share of imports in EU consumed bioethanol in 2008 is 35%, most of which comes from Brazil. With this import, a large share of sugar cane is introduced as feedstock for EU bioethanol. 76% of the feedstock for bioethanol originates from the EU, only 24% is imported;
- There is a trend of decreasing capacity use, between 2005 and 2009 more than half of the biofuels production capacity in Europe was not used. This unused capacity does indicate that there is sufficient conversion capacity available for several years to come;
- Initiatives for advanced biofuels production in Europe are located in a limited number of Member States and focus on a broad range of conversion technologies. The amount of advanced biofuels produced in 2008 was negligible (Section 2.6);

Biofuels policy framework (Chapter 3)

- The legal basis for biofuel policies in the EU Member States in 2008 was the previous Biofuels Directive [2003/30/EC], which aimed at 5.75% biofuels in 2010. Germany, Austria, Sweden and Slovakia had already met this target in 2008. Most other Member States were far from achieving the target;
- In 2009 the new Renewable Energy Directive came into force laying down the mandatory 10% target for renewable energy share in transport for all Member States by 2020 and including the biofuels sustainability scheme. Member States had to implement the Renewable Energy Directive and its sustainability scheme in their national legislation by December 5th of 2010. Evaluation of the transposition of the Directive in all the Member States is ongoing;
- The Renewable Energy Directive requires that all biofuels supplied to the EU market comply with the sustainability criteria. This compliance has to be ensured by the economic operators selling fuel on the market.
- Third countries that play a significant role in providing feedstock for EU consumed biofuels are not required to implement the requirements of the Renewable Energy Directive, however compliance with the biofuel sustainability requirements must be guaranteed by the EU Member States who count imported biofuels towards their national renewable energy targets, where such fuels are counted towards renewable energy obligations and where they receive financial support;
- Third country analysis reveals areas requiring further attention in the assessment of compliance with EU sustainability criteria: the national legislation in third countries does not always provide sufficient sustainability guarantees for conservation of land with high carbon stock value (wetlands, grasslands, peatlands);
- Several of third countries providing biofuels or feedstocks for the EU market seem to have insufficient requirements for Environmental Impact Assessments, which means that new biofuel projects may not always address sustainability concerns sufficiently;
- For biofuels originating in third countries voluntary schemes may be used as a proof of compliance with the EU sustainability criteria. European Commission has so far (July 2011) recognised 7 voluntary schemes: International Sustainability and Carbon Certification (ISCC), Bonsucro EU, Round Table on Responsible Soy (RTRS EU RED), Roundtable of Sustainable Biofuels (RSB EU RED), Biomass Biofuels voluntary scheme (2BSvs), Abengoa RED Bioenergy Sustainability Assurance (RSBA), Greenergy Brazilian Bioethanol verification programme [1].

Environmental and social aspects (Chapter 4)

- The total gross land use associated with EU biofuel consumption in 2008 is estimated to be 7 Mha, of which 3.6 Mha in the EU and 3.3Mha in third

[1] EC decision 19 July 2011.
http://ec.europa.eu/energy/renewables/biofuels/sustainability_schemes_en.htm

countries[2]. It is estimated that 590 kha is required per Mtoe of biofuels[3]. If accounting for co-products that reduce land needs elsewhere, the total net land use for EU biofuels is estimated at 3.6 Mha. The macro economic modelling done in Chapter 5 shows an increased global agricultural land use of 1.3 Mha related to biofuel production between 2000 and 2008, indicating that not all land used for biofuels is expansion of agricultural land;

- The countries that appear to have been mostly influenced in their land use by biofuel export to the EU market are Argentina (soybean), Brazil (soybean and sugarcane), USA (soybean) and Ukraine (rapeseed), as well as Malaysia and Indonesia (both oil palm) - although to a smaller extent;
- The expansion of cropland is likely to have different effects in different countries. Some countries may be able to expand their cropland for specific crops by changing the crop rotation patterns, including reducing the amount of land in fallow, while others may have to expand on to pastures or natural vegetation. The effects of the latter are also likely to vary between different countries, depending on the types of land that become converted to cropland;
- Land use analysis in key biofuel producing regions indicate that land use for biofuel crops does not automatically imply expansion of cropland in the country where the biofuels are being cultivated. In the period 2001-2008, the EU, Argentina and Brazil experienced a net gain of cropland. Indonesia, Malaysia and USA have seen a net decrease of cropland;
- Total supply chain green house gas (GHG) savings related to the EU biofuel consumption in 2008 are estimated to amount 15.3 Mtonnes CO_{2eq}. This is a saving of 53% compared to the situation where only fossil fuel would be used, this figure does not include direct or indirect land use change;
- According to water analysis of key producing regions Argentina, Brazil and the USA typically have low water stress risks and high availability of water for agriculture, including biofuel crops. Countries within the EU can range from low to high water stress risks;
- According to soil risk analysis Indonesia and Malaysia are estimated to have higher risks for soil erosion, fertility and vulnerability to pests. The EU, Argentina and USA have lower risks, while Brazil is classified as medium category on soil risks;
- The EU biofuel demand is estimated to account for a rather small share of local environmental impacts from biofuel crop cultivation in most exporting countries;
- For the countries providing the EU with biofuels or their feedstocks in 2008, it can be stated that biodiversity monitoring is in place to a certain degree, but several countries could improve on specific aspects;
- Estimates for employment resulting from biofuels production vary widely. In the EU, over 100,000 people may have a job relating to biofuels. The global employment related to biofuels may be over 1.5 million, half of which in Brazilian cane and related ethanol production.

[2] The land use is based on the ultimate feedstock origin as analysed in section 2.4, combined with yield data. More information is provided in Appendix I.

[3] Total land used for the production of EU biofuels divided by the total consumption of EU biofuels

Macro economic impacts (Chapter 5)

- Increased EU biofuel consumption is estimated to have contributed only little to the historical cereal price increases in 2007 and 2008. The impact of EU biofuel consumption is estimated as more substantial for price increases of non-cereal food commodities, notably through its demand for vegetable oil in the production of biodiesel;
- Global biofuel production expansion and weather related crop production distortions in 2006/07 and 2007/08, have contributed to widening the demand-supply gap in 2008 and can explain a significant part of the observed historical price increases;
- The combination of the two factors caused a combined impact that was larger than the sum of the two individual impacts, i.e. there was a non-linear and mutually reinforcing interaction of the two stress factors;
- The increase in biofuel production in the EU between 2000 and 2008 has led to an increased global agricultural land use of 1.3 Mha (0.02% of global agricultural land). This estimate obtained in modelling[4] is substantially smaller than the estimated 3.6 Mha total net land use for biofuels production as mentioned in Chapter 4. A part of the land used for biofuels feedstock production became available through yield improvements of other crops, or at the cost of decreasing production of other crops.

[4] Within the analysis an ecological-economic modelling framework is applied. It includes two major components, the FAO/IIASA Agro-ecological Zone (AEZ) model and the IIASA world food system (WFS) model

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1 Introduction

1.1 Purpose

The European Union is promoting the use of biofuels and other renewable energy in transport. In April 2009, the Renewable Energy Directive [2009/28/EC] was adopted that set a 10% target for renewable energy in transport in 2020. The directive sets several requirements to the sustainability of biofuels marketed in the frame of the Directive.

The Commission is required to report to the European Parliament on a regular basis on a range of sustainability impacts resulting from the use of biofuels in the EU.

This report serves as a baseline of information for regular monitoring on the impacts of the Directive.

1.2 Reporting on biofuels in the Renewable Energy Directive

The reporting and monitoring obligations for the European Commission are set out in Articles 17.7, 23.1, 23.3, 23.4, 23.5 and 23.6 of the Renewable Energy Directive. An overview of the topics that have to be reported is given in Table 1 (next page).

1.3 Reading guide

- Chapter 2 discusses the EU biofuels market, the production and consumption of biofuels and international trade. It is derived where the feedstock for EU consumed biofuels originally come from;
- Chapter 3 discusses the biofuel policy framework in the EU and major third countries of supply. It looks at various policy aspects that are relevant to comply with the EU sustainability requirements;
- Chapter 4 discusses the environmental and social sustainability aspects associated with EU biofuels and their feedstock;
- Chapter 5 discusses the macro economic effects that indirectly result from increased EU biofuels consumption, on commodity prices and land use;
- Chapter 6 presents country factsheets for main third countries that supplied biofuels to the EU market in 2008.

Table 1. Reporting and monitoring obligations, Article in the Renewable Energy Directive and reference to where the topic is discussed in this report.

Article	Topic / obligation	Geographical Scope	Section
17.7	Impact on social sustainability of increased demand for biofuel	EU MS and third countries	4.8
17.7	Impact of Community biofuel policy on the availability of foodstuffs at affordable prices	in particular for people living in developing countries	5.4
17.7	Wider development issues		4.8
	The respect of land-use rights		4.8
17.7	Ratification and implementation of Conventions of the International Labour Organisation	EU MS and countries that are a significant source of raw material for EU consumed biofuels	4.8
17.7	Ratification and implementation of the Cartagena Protocol on Biosafety		n/a
17.7	Ratification and implementation of the Convention on International Trade in Endangered Species of Wild Fauna and Flora		n/a
23.1	Monitor the origin of biofuels and bioliquids consumed in the EU	World	2.5
23.1	Impact on land use	EU and main third countries of supply	4.2 and 5.5
23.1	Commodity price changes and effects on food security	World	5.4
23.4	Greenhouse gas emission saving	World	4.3
23.5a	Relative environmental benefits and costs of different biofuels		4
23.5a	Effect of Community's import policies thereon		2.5
23.5a	Security of supply implications and balance between domestic production and imports		2.7
23.5b	Economic and environmental impacts	EU MS and third countries	
	Impacts on biodiversity		4.7
23.5d	Impact on biomass using sectors		n/a
23.5e	Availability of biofuels made from waste, residues, non-food cellulosic material and lignocellulosic material		2.6
23.5f	Indirect land use changes in relation to all production pathways		5.5

1.4 Geographical scope

Since this report evaluates the development of the EU market for biofuels, as well as the supply chain impacts of EU biofuels consumption, the geographical scope should cover the EU as well as the main countries of feedstock origin. Early in the project the country scope was fixed to streamline the data collection in third countries (first 2 columns in Table 2. On basis of the market and trade information in Chapter 2, it becomes apparent that this scope is partially too wide and partially too narrow. Analyses related to the data collection in this report follow the pre-decided scope. Analyses that were performed on basis of the trade analysis (greenhouse gas performance, global water analysis) follow the latter scope. The country factsheets (Chapter 6) are only presented for the most significant feedstock producing countries.

Table 2. Geographical scope of the report.

Pre-decided scope	Significant for EU biofuels
	Norway
USA	USA
	Canada
Brazil	Brazil
Argentina	Argentina
Bolivia	Bolivia
Guatemala	Guatemala
Peru	Peru
	El Salvador
	Costa Rica
Indonesia	Indonesia
Malaysia	Malaysia
India	
Pakistan	Pakistan
Ukraine	Ukraine
Russia	
Ethiopia	
Malawi	
Nigeria	
Mozambique	
Sudan	
Tanzania	
Uganda	
	Egypt
	South Africa

2 The Biofuel market place

2.1 Major findings

In this chapter, the consumption and production of biofuels and other renewable energy sources for transport and the international trade related to biofuels are discussed. Focus year is 2008, sometimes using 2007-2009 as indication for trends. The major findings are:

- In 2008, 9.5 Mtoe biofuels have been consumed in road transport, this is 3.1% – 3.5% of all petroleum products consumed in road transport (295 Mtoe). In 2007, this was 2.2% - 2.6% (Section 2.2);
- About 72% of these biofuels concerned biodiesel, 19% concerned bioethanol and about 9% resided in other biofuels (for example pure plant oil).The percentage of biodiesel has been going up (in 2007 64%, in 2009 77%), with the percentage of bioethanol keeping relative stable (18% in 2007, 19% in 2009). The contribution of other biofuels has been decreasing (18% in 2007, only 4% in 2009);
- Five Member States (Germany, France, UK, Italy and Spain) represent more than 70% of the European biofuels market, both in production and consumption. Their majority is only slowly decreasing over time;
- About 78 % of all EU consumed biodiesel in 2008 is produced in the EU, about - 22% is imported from third countries, primarily from the US. Indirectly, significant fractions come from Argentina and Indonesia. In 2009, the direct imports from the US decline and shift to direct import from Argentina. With the import of biodiesel, especially the fraction of soybean in EU consumed biodiesel increases. Also the fraction of palm oil slightly increases, while the fraction of rapeseed decreases;
- Rapeseed is by far the most important feedstock for biodiesel produced in Europe, followed by soy oil, palm oil and waste oils. 58% of the feedstock for biodiesel is produced within the EU, and 42% imported from third countries.
- Wheat, maize and sugar beet are the most important feedstock for bioethanol produced in Europe (65% of total bioethanol consumed in EU is also produced in the EU).
- The share of imports in EU consumed bioethanol in 2008 is 35%, most of which comes from Brazil. With this import, a large share of sugar cane is introduced as feedstock for EU bioethanol. 76% of the feedstock for bioethanol originates from the EU, only 24% is imported;
- There is a trend of decreasing capacity use, between 2005 and 2009 more than half of the biofuels production capacity in Europe was not used. This unused capacity does indicate that there is sufficient conversion capacity available for several years to come;
- Initiatives for advanced biofuels production in Europe are located in a limited number of Member States and focus on a broad range of conversion technologies. The amount of advanced biofuels produced in 2008 was negligible (Section 2.6);

2.2 Consumption of biofuels in the EU

In this section the consumption of biofuels in the EU in the period 2007-2009 is discussed. First some general data regarding biofuels are presented, after which a short analysis of the remaining shortfall relative to the 2010 indicative target is given. Finally, consumption is regarded by type of fuel. Bioethanol and biodiesel are discussed separately, as they represent large segments of the market. Besides these, other biofuels, such as biogas, are briefly addressed.

Biofuels in general

In Figure 1 the consumption of biofuels in road transport in the EU27 is depicted. In total, 9.5 Mtoe biofuels were consumed in 2008. This covers 3.1% of all fuels consumed in road transport, which is below the 4.25% interpolated trend target of the Biofuels Directive [2003/30/EC] 2005 and 2010 indicative targets of 2% and 5.75% respectively.

Table 3. Total biofuel and all fuel consumption in road transport in the EU from 2005 – 2009 [Eurostat nrg_1073a; nrg_102a; tsdcc340][1).]

	2005	2006	2007	2008	2009
Biodiesel (Mtoe)	1.4	2.3	4.2	6.8	9.1
Biogasoline (Mtoe)	0.6	0.8	1.2	1.8	2.3
Other liquid biofuels (Mtoe)	1.2	2.3	1.2	0.9	0.5
Total biofuels in road transport (Mtoe)	**3.1**	**5.5**	**6.6**	**9.5**	**11.9**
Total fuels consumed in road transport (Mtoe)	295.5	298.7	301.6	295.1	287.7
Share calculated	1.04%	1.81%	2.16%	3.12%	3.96%
Share Eurostat		2.00%	2.60%	3.50%	

1) Note that the Eurostat methodology for the accounting of Renewable Energy Sources has recently changed in accordance with the new statistical methodology of RES directive. The biofuels share as reported by Eurostat cannot be reconstructed because background data is not public.

Biogas consumption in road transport was minimal in 2008, as is further discussed under the heading 'Other biofuels' later on in this section. We assumed that the Eurostat category biodiesel includes the consumption of pure plant oil.

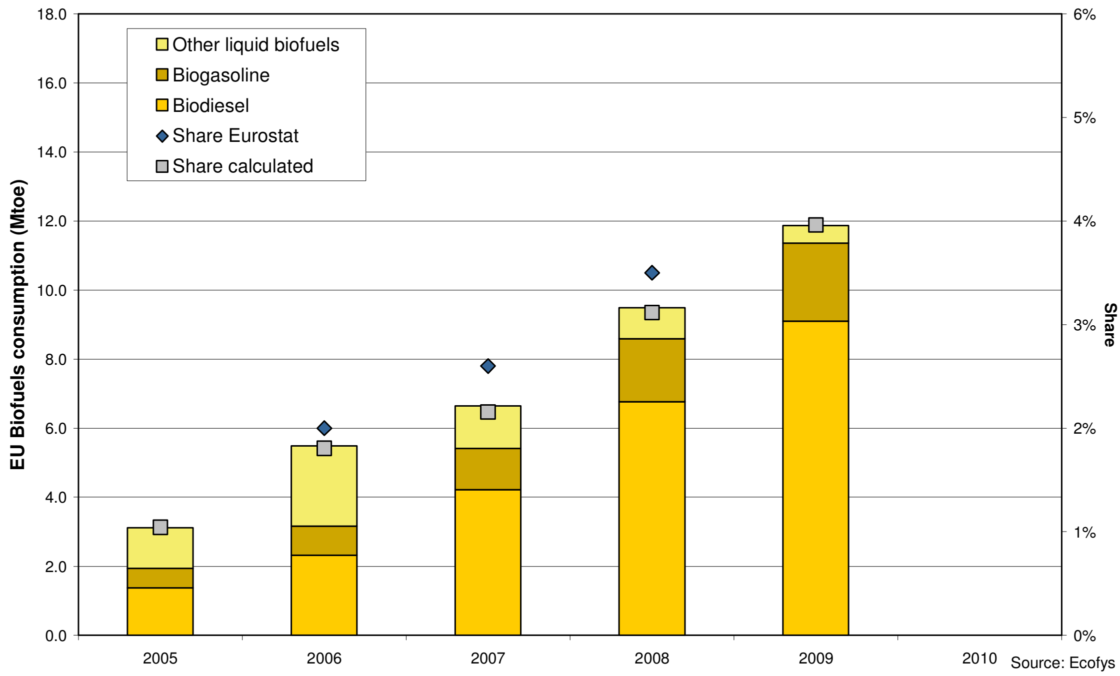

Figure 1. Consumption of biofuels in road transport in the EU. The bars represent the absolute volume in Mtoe (left hand scale); the squares represent the calculated share and the diamonds the share as officially reported by Eurostat.

Table 4 and Figure 2 give a detailed overview of the biofuel market[5] in 2007 - 2009. Furthermore, Table 5 presents the shares of biofuel consumed in the EU in 2007 and 2008.

Germany is the largest consumer market for biofuels, even though the consumption of biofuel decreased in 2008, it recovered in 2009. Finland's market experienced the strongest percentage growth, though its total market is still 40 times smaller than the German market. Germany, Romania and Austria have a relevant other liquid fuels category consisting of for example vegetable oils, different blends or biogas. Over the period 2007-2009, Belgium is the strongest grower, while the Hungarian biofuels consumption has significantly decreased.

[5] The term 'biofuel market' refers to biofuel consumption in a specific country.

Table 4. EU Biofuel consumption in road transport in 2007 - 2009 expressed as absolute volume (ktoe). Growth of this consumption from 2007 to 2009. Ranked according to 2008 market size [Eurostat nrg_1073a].

Country	2007 Volume	2008 Volume	Growth	2009 Volume	Growth
Germany	2722	2506	-8%	2781	9%
France	1447	2272	57%	2454	8%
United Kingdom	346	790	128%	968	27%
Italy	141	754	435%	1180	62%
Spain	385	619	61%	1073	83%
Poland	106	441	316%	663	46%
Austria	308	385	25%	483	26%
Sweden	285	344	21%	361	7%
Netherlands	277	287	4%	373	36%
Hungary	29	165	469%	123	-25%
Portugal	133	128	-4%	201	58%
Slovakia	91	126	38%	168	48%
Czech Republic	30	110	267%	195	74%
Romania	40	107	168%	163	48%
Belgium	87	101	16%	286	184%
Finland	1	85	8400%	90	9%
Greece	85	69	-19%	78	3%
Lithuania	53	61	15%	52	3%
Ireland	22	54	145%	75	52%
Luxembourg	35	37	6%	41	21%
Slovenia	14	25	79%	30	40%
Cyprus	1	14	1300%	15	7%
Denmark	6	5	-17%	9	91%
Bulgaria	2	4	100%	4	1%
Latvia	2	2	0%	4	161%
Malta	0	0	0%	0	0%
Estonia	0	0	0%	0	0%
Total EU	6648	9491		11870	

Table 5. EU Biofuel consumption in road transport in 2007 and 2008 expressed in share in national road transport fuel use[6].

Country	2007	2008
	Share	Share
Germany	7,5%	6,5%
France	3,6%	5,6%
United Kingdom	0,9%	2,0%
Italy	0,9%	2,3%
Spain	1,2%	1,9%
Poland	0,8%	3,3%
Austria	2,2%	7,1%
Sweden	5,9%	6,3%
Netherlands	2,7%	2,5%
Hungary	0,8%	3,9%
Portugal	2,4%	2,4%
Slovakia	0,4%	6,3%
Czech Republic	0,1%	0,2%
Romania	1,7%	2,8%
Belgium	1,1%	1,2%
Finland	0,4%	2,2%
Greece	1,2%	1,0%
Lithuania	3,6%	4,0%
Ireland	0,5%	1,2%
Luxembourg	2,0%	2,0%
Slovenia	1,1%	1,5%
Cyprus	0,0%	2,1%
Denmark	0,3%	0,3%
Bulgaria	0,2%	0,2%
Latvia	0,9%	0,9%
Malta	0,0%	0,0%
Estonia	0,0%	0,0%
Total EU	**2,6%**	**3,5%**

Five of the twenty seven countries, Germany, France, United Kingdom, Italy and Spain constitute by far the largest proportion the EU27 market in throughout 2007 – 2009, although this share has been slowly decreasing from 75% in 2007 to 71% in 2009.

[6] The shares as presented in this table are deducted from Eurostat. If a calculation of the share would be done based on the data in Table 4 this would result in slightly different share, since the Eurostat calculation of shares also includes other RES.

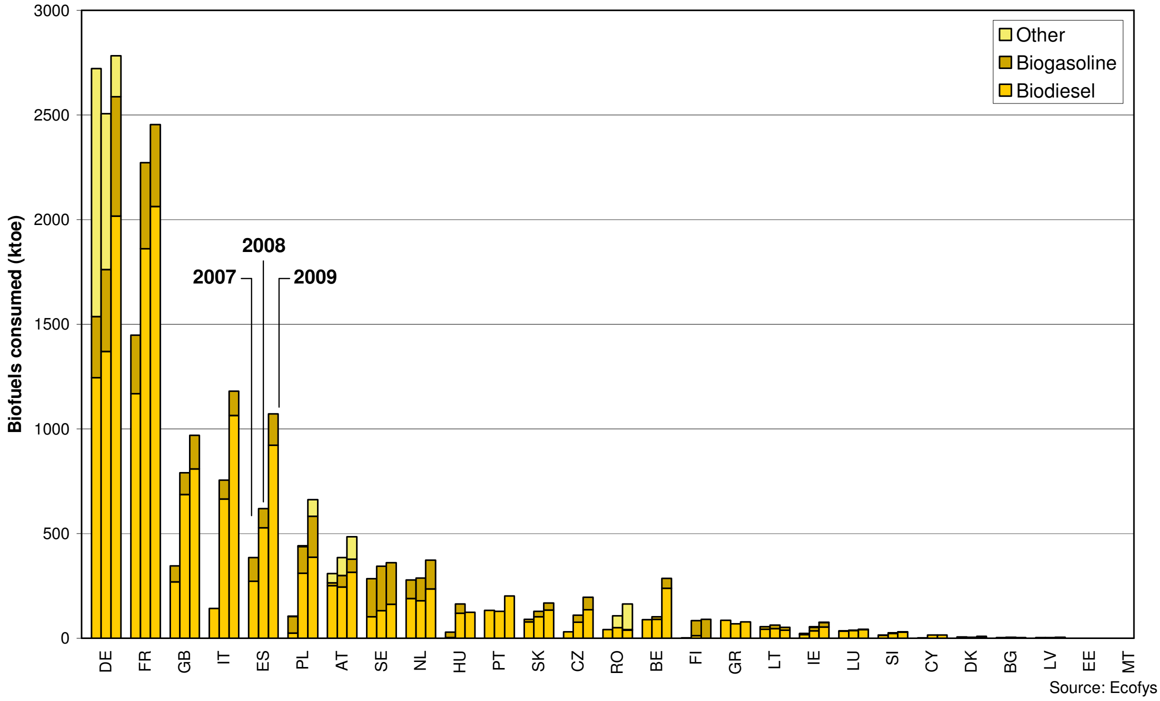

Figure 2. Amounts of liquid biofuels[7] consumed in EU Member States, ranked according to 2008 market size [Eurostat nrg_1073a].

Figure 3 shows the share of biofuels in final energy consumption in the transport sector in the Member States. We see that Germany, France, Austria and Slovakia had already more or less achieved the original target of the 2003 Biofuels Directive in 2008.

The share of biofuels consumption by country in 2008 and 2007 can vary a lot as can be seen from Figure 3. Since the price of biofuels depends on volatile agricultural feedstock costs and since surrounding and global markets directly influence the market in each Member State, consumption of biofuels can rise or drop relatively rapidly. In Germany the consumption of biofuels dropped after the target was overshoot and the legislation was adapted (see next chapter). In small markets such as Cyprus and Bulgaria, a relatively small absolute change in consumption, leads to a higher change in biofuels share. In France, the production increased by almost 1 Mtoe from 2007 to 2008 (see Figure 2 above), motivated by an attractive tax exemption and increasing openness of the French market.

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[7] Eurostat categories have been used. It is not clear what is included/excluded in the categories mentioned. We assume that the biodiesel category contains FAME biodiesel, hydrotreated bio-oil and pure bio-oil, that the biogasoline category contains bioethanol, biomethanol, bio-ETBE and bio-MTBE and that the other liquid biofuels category contains biogas and bio-DME.

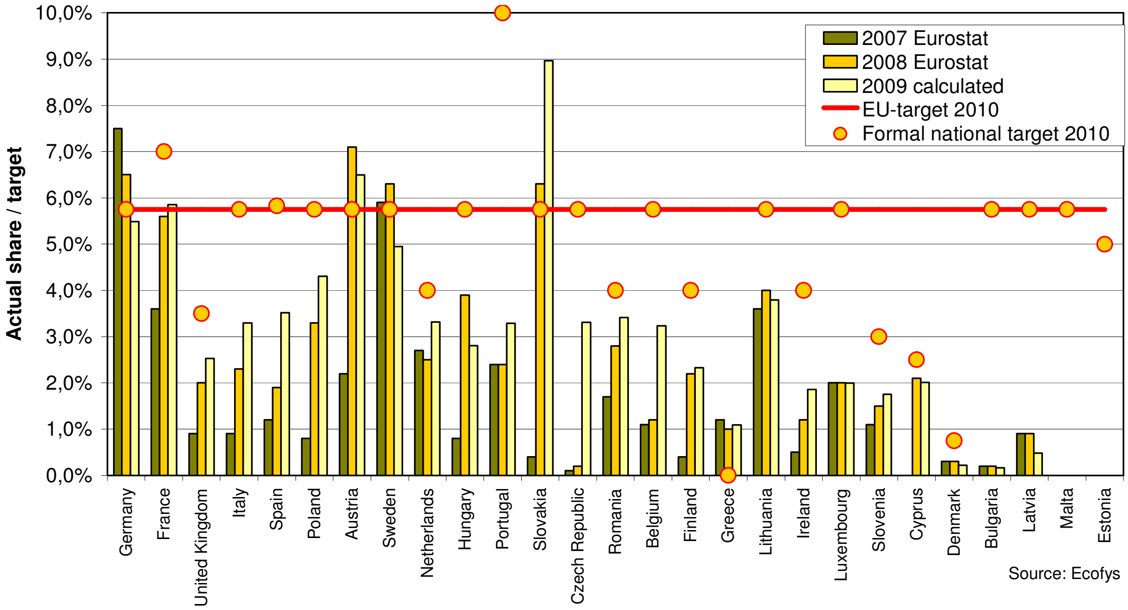

Figure 3. Share of biofuels[8,9] in total final energy consumption in transport in EU Member States [Eurostat tsdcc340]. The red line indicates the indicative EU target and the circles the national targets for 2010.

Biodiesel and bio-oil

As can be seen in Figure 1 the majority of biofuels consumed in the European market concern biodiesel. Figure 4 breaks down the development of increasing consumption of biodiesel in 2005-2009 for the most important Member States.

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[8] The share of biofuels was calculated by dividing by the total amount of petroleum products consumed in road transport. However, the Biofuels Directive states (§ 3.1.b) that the share should be calculated on basis of petrol and diesel only. Note that the Renewable Energy Directive (§3.4) uses yet another definition to calculate the share, where the denominator is the sum of petrol, diesel and biofuels in road and rail transport, and electricity and the numerator is the sum of all types of energy from renewable sources consumed in all forms of transport shall be taken into account. Both numerator and denominator are broader categories in the Renewable Energy Directive than in the Biofuels Directive.

[9] Another complexity to establish the share of biofuels resides in the fraction of bioETBE and bioMTBE that can be counted as biofuel is defined differently in both directives. The Biofuels Directive uses a different definition (47% and 36%) than the RED (37% and 22%). It is unclear how Eurostat deals with bio-ETBE.

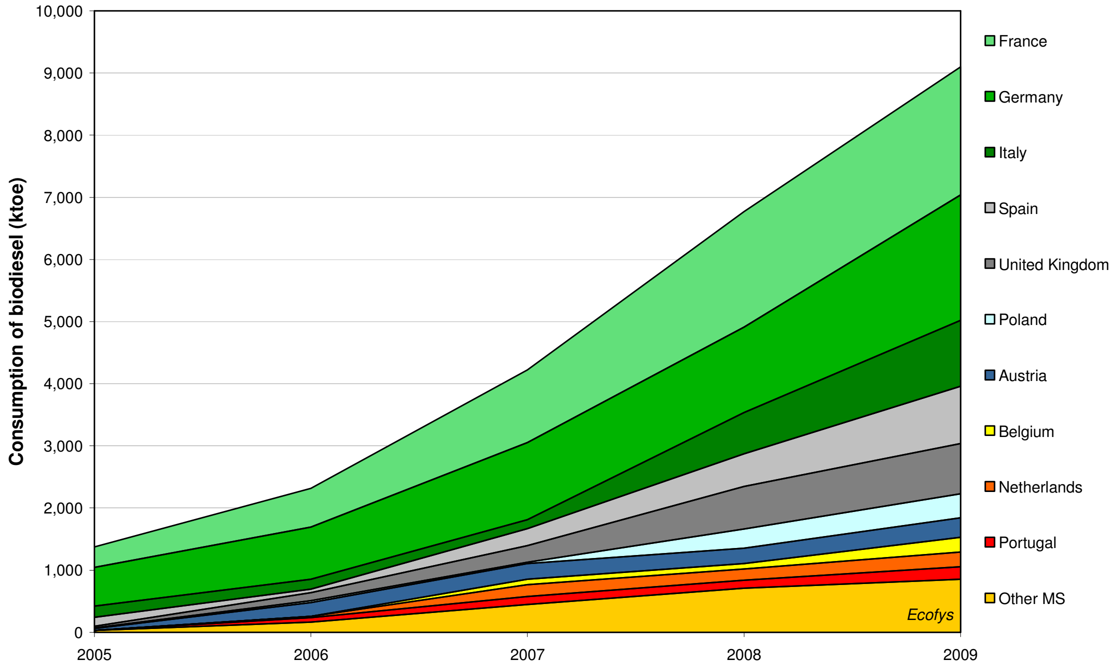

Figure 4. Consumption of biodiesel in the EU in 2005 - 2009. The consumption is shown for the 10 Member States with the largest production volume in 2009. The other 17 Member States are aggregated [Eurostat nrg_1073a].

Germany and France remain the main consumers of biodiesel, followed by Italy, Spain and the UK. The general trend is an increase in consumption of biodiesel per Member State, however consumption of biodiesel in Germany shows a reduction from 2006 onwards[10]. The UK biodiesel market did not grow from 2008 to 2009, so that it lost its 2008 third place in the EU ranking to Italy.

Bioethanol and bio-ETBE

Bioethanol is the second most important biofuel in consumtion terms in Europe (Figure 1). Figure 5 shows the consumption of ethanol in Europe in 2008 for the main consuming countries.

[10] Partly due to reductions in tax exemptions

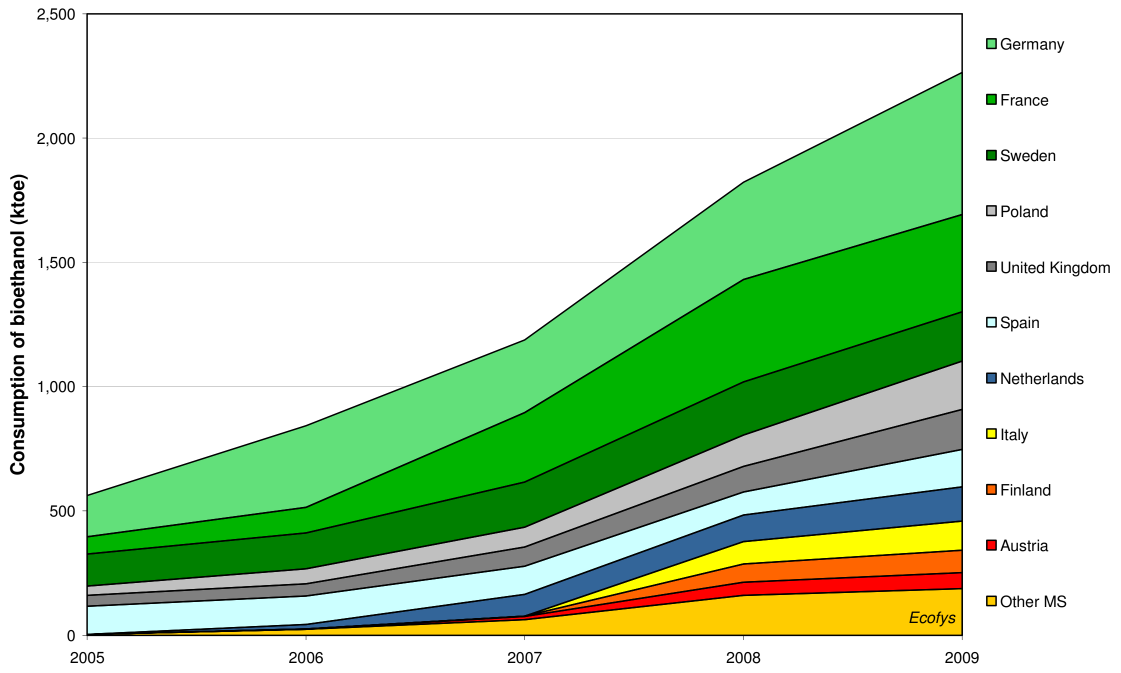

Figure 5. Consumption of bioethanol[11] in the EU in 2005 - 2009. The consumption is shown for the 10 Member States with the largest production volume in 2009. The other 17 Member States are aggregated [Eurostat nrg_1073a].

The figure shows that France, Germany and Sweden are the main consumers of bioethanol in Europe.

Form of consumed biofuels

Most biodiesel and bioethanol is used in low volume blends in diesel and gasoline respectively. High volume blends of biodiesel, varying from 20% to 100%, are mainly consumed in Germany where pure biodiesel sales in 2008 amount to 980 ktoe, compared to 1.4 Mtoe of blended biodiesel (mostly B5).

Germany has a high consumption of pure vegetable oil in road transport. In 2008, 353 ktoe of vegetable oil fuel were used, but this share is rapidly decreasing (from 737 ktoe in 2007 to 88 ktoe in 2009 according to the German national reports on the implementation of Directive 2003/30/EC) as the excise exemption system is being phased out[12].

[11] Eurostat presents its data in three categories: biodiesel, biogasoline and other liquid biofuels. The category 'biogasonline' according to Eurostat definition will mostly contain ethanol.

[12] Recently, due to coalition changes in Germany, tax exemptions for use of pure vegetable oil in Germany have not been completely phased out. They will probably be present until 2012.

E85, which consists of 85% ethanol with 15% gasoline by volume, is sold for use in flex-fuel vehicles. Table 6 shows that Sweden has by far the most retail selling points for E85. The total sales of E85 in Europe are estimated to be about 100 ktoe in 2008, on basis of extrapolation of the known sales in Germany (8450 tonne E85, which is about 5.5 ktoe and representing 5 % of the amount of gas stations).

Table 6. Number of gas stations selling E85 in the EU in 2008 [BEST, Procura, Member State reports].

	Number of gas stations
Sweden	1300
France	320
Germany	100
UK	18
Ireland	16
Hungary	15
Norway	10
Spain	8
Netherlands	3
Total	1790

Sweden, France, Ireland and Cyprus offer support for the provision of flex-fuel vehicles to the market. Most notably in Sweden, incentives include reduced registration charges and road taxes, with in some cities free parking and waived congestion charges [IIASA 2009].

Other biofuels

Although biogas is produced in all Member States and several Member States[13] have installed some support for the use of biogas in transport, only Sweden has a significant use of biogas in the road transport sector. By the end of 2007 there were 57 biogas filling stations. The amount of biogas consumed is unknown[14].

2.3 Production of biofuels in the EU

Table 7 shows the EU biofuel production in 2007, 2008 and 2009. Note that the data refers to all EU biofuel production even if not all is used in transport but for other purposes (see note under table).

[13] Amongst which Sweden, Austria (3 filling stations), Finland and UK.
[14] Member state report of Sweden only indicates amount of filling stations and total amount of biofuels consumed (grouping ethanol, FAME and biogas).

Table 7. EU Biofuel[1)] production in ktoe in 2007- 2009 and average annual growth of this production between 2007 and 2009. Ranked according to market size 2008 [Eurostat nrg_1073a].

Country	2007	2008	2009	Growth '07-'09
Germany	3987	3878	3843	-2%
France	1127	1952	2213	40%
United Kingdom	384	283	211	-26%
Italy	180	703	1119	149%
Spain	380	372	887	53%
Poland	110	296	429	97%
Austria	260	278	305	8%
Sweden	430	456	557	14%
Netherlands	120	121	290	55%
Hungary	17	162	154	201%
Portugal	162	153	230	19%
Slovakia	59	139	150	59%
Czech Republic	90	105	195	47%
Romania	20	82	75	94%
Belgium	161	288	353	48%
Finland	0	12	69	0%
Greece	83	63	71	-8%
Lithuania	32	68	108	84%
Ireland	15	22	57	95%
Luxembourg	0	0	0	0%
Slovenia	4	7	6	22%
Cyprus	0	6	6	0%
Denmark	63	89	78	11%
Bulgaria	2	11	11	135%
Latvia	15	32	49	81%
Malta	:	:	:	0%
Estonia	0	0	0	0%
Total EU	**7701**	**9578**	**11466**	**22%**

1) Biofuels are defined as biodiesels, biogasolines and other liquid biofuels, they are suitable for and mainly used in transport, but since the end-use is not documented, it is possible that the biofuels have been used in sectors other than transport, such as for the production of heat and electricity. This may occur, for example, with pure plant oil (other liquid biofuels category), but is less likely with biodiesels and biogasolines.

The production of biofuels in France increased by almost 1,100 ktoe (mainly biodiesel), in absolute sense the largest increase between 2007 and 2009 in the EU27. Italy also saw a large increase of almost 1,000 ktoe (for the larger part in biodiesel production but also in ethanol). Although the total production of biofuels in Germany slightly declined, there was a significant increase of biodiesel production, from 1263 ktoe in 2007 to 2017 ktoe in 2009. At the same time, the production of other liquid biofuels in Germany decreased from 2435 to 1257 ktoe in the same period (from 2748 to 2153 in the entire EU). This especially concerns pure plant oil, for which the demand almost disappeared as previously explained.

Germany, France, Italy, Sweden and Spain produced over 75% percent of the biofuels in the EU in 2008. Their dominance is declining slowly.

Figure 6 and Figure 9 present the development of bioethanol and biodiesel production over the years 2005-2009 for the Member States with the largest production.

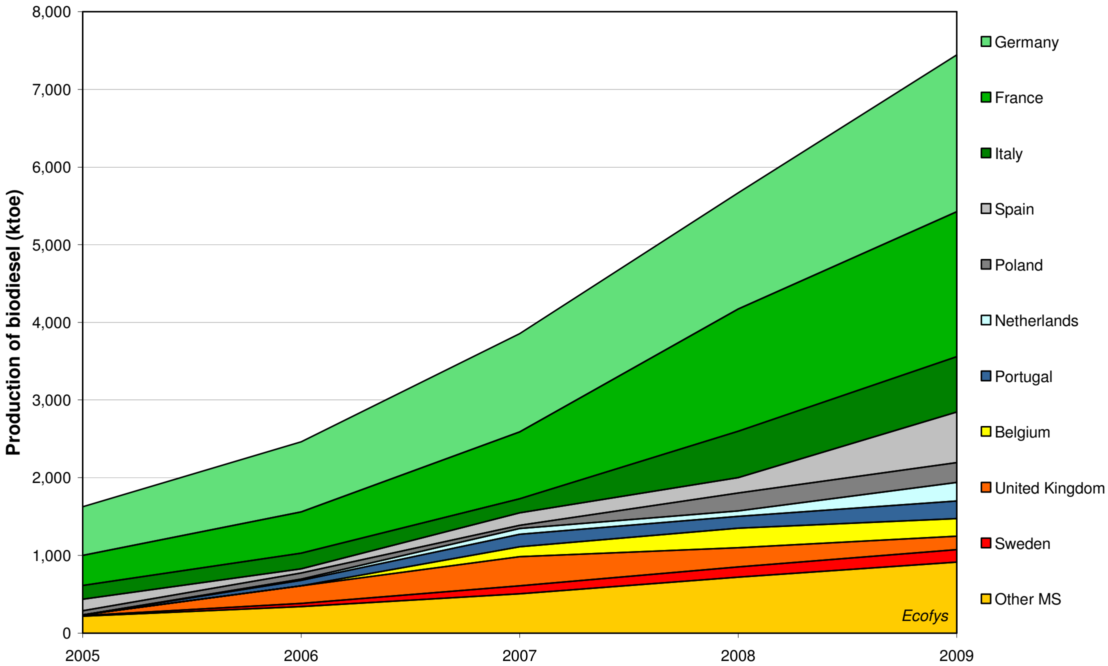

Figure 6. Production of biodiesel in the EU in 2005 - 2009. The production is shown for the 10 Member States with the largest production volume in 2009. The other 17 Member States are aggregated [Eurostat nrg_1073a].

Main biodiesel producers in the EU in 2008 are Germany and France (also the main consumers of biodiesel) followed by Italy.

There is some discrepancy between Eurostat data (2011 dataset) and industry data as displayed in Figure 7. Especially in Germany the 2007 and 2008 data show much less biodiesel production than estimated by EBB or F.O. Licht / AgraCEAS. A possible reason is that industry and earlier Eurostat data were based on usage of vegetable oils in the biofuel industry and therefore contain pure plant oil as well, whereas more recent Eurostat data is able to distinguish better between biodiesel and pure plant oil. However, this assumption could not be verified. Note that throughout this report, analyses are based on the Eurostat nrg_1073a 2011 dataset.

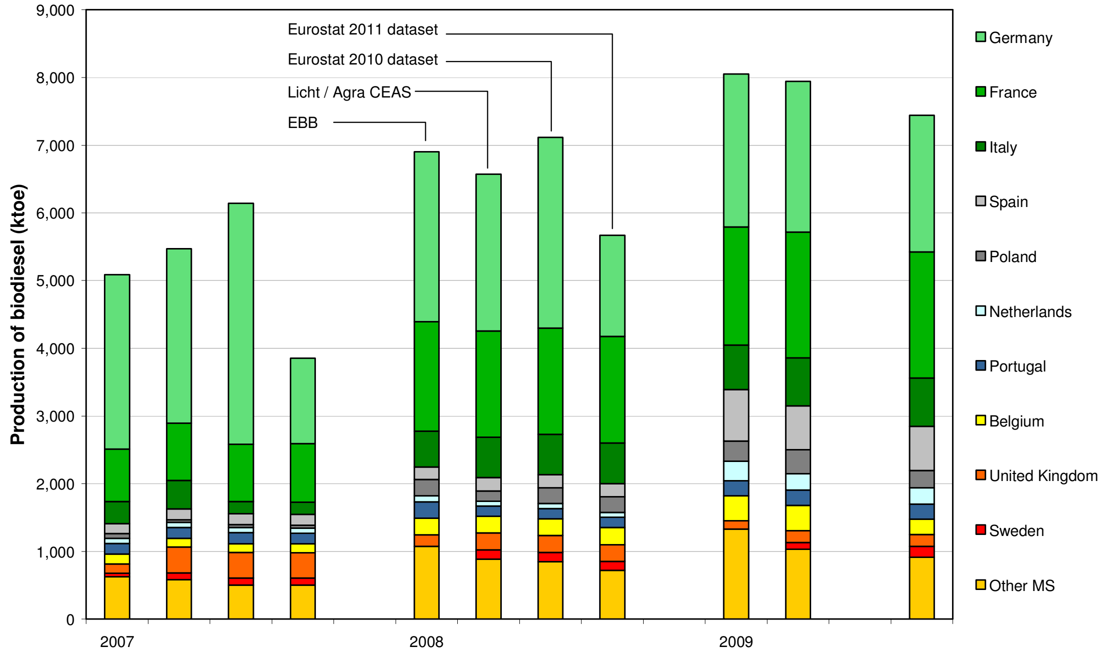

Figure 7. Comparison of biodiesel production in the EU in 2007 - 2009 according to different sources. Analysis by Agra CEAS.

From Figure 8 it can be seen that the biodiesel plants are not equally distributed over Europe. Conversion capacity around the North Sea is increasing, related to the access of overseas feedstock (palm and soy oil), capacity in France is concentrated in the north of the country, along the major waterways. On the other hand, there is still limited capacity in the Balkan area (both east and west)[15] and in Poland. The main biodiesel producers in 2008 are Diester Industrie from France (total production capacity of 2 million tonne), ADM Biodiesel from Germany (1 million tonne), Biopetrol Industries from Switzerland (750 ktonne), Verbio from Germany (450 ktonne) and Cargill from Germany (370 ktonne) [Eurobserv'er 2009].

The production of ethanol in Europe mainly place takes in Germany and France followed by Sweden and Spain (Figure 9). These are also the countries where the consumption is concentrated (Figure 5). The main bioethanol producers in 2009 are Abengoa Bioenergía from Spain (614 ktonne), Tereos from France (610 ktonne), CropEnergies from Germany (600 ktonne), Cristanol from France (388 ktonne) and Agrana from Austria (308 ktonne).

[15] For example in countries like Albania, Bosnia and Herzegovina, Bulgaria, Croatia, Greece, Macedonia, Serbia and Romania

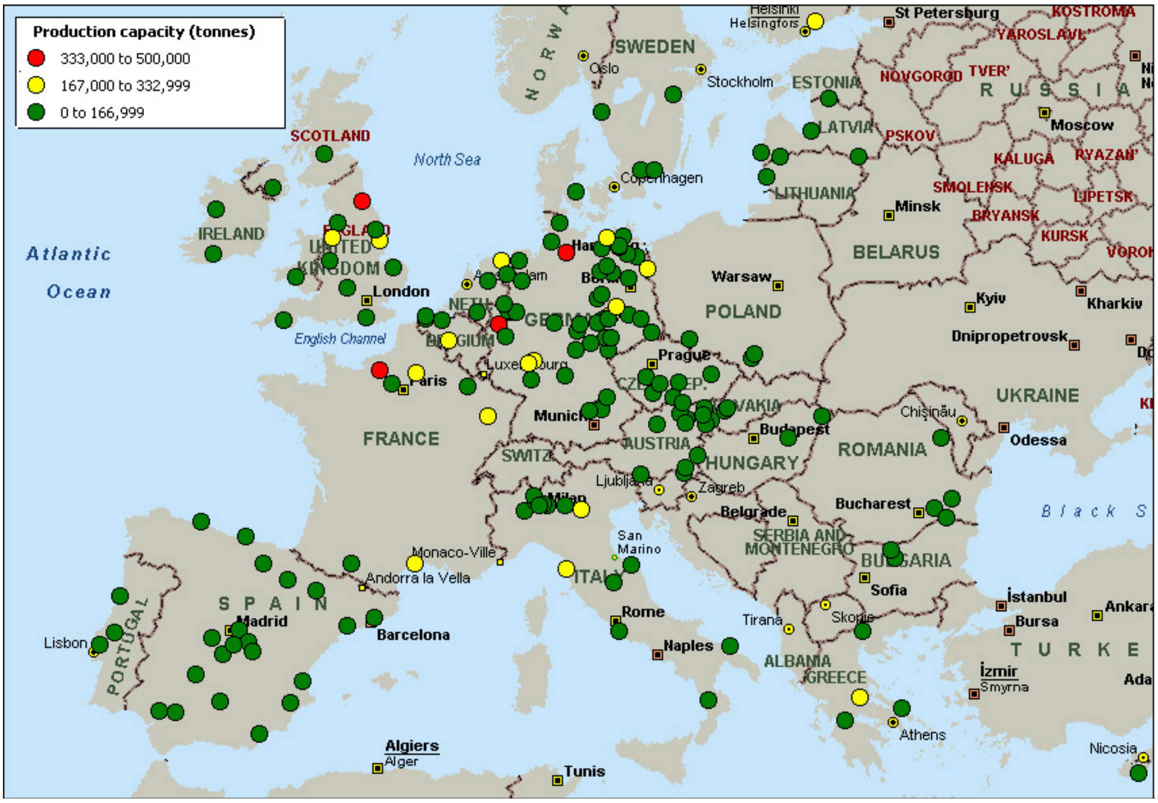

Figure 8. Map of biodiesel plants in the EU in 2009 [Agra CEAS based on F.O. Licht].

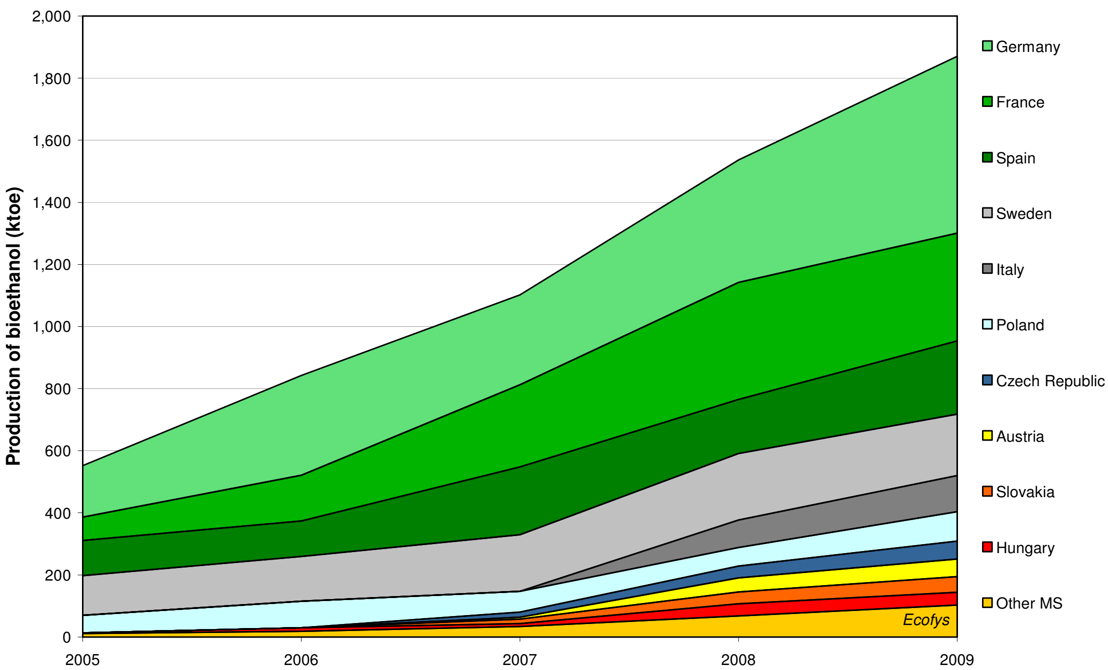

Figure 9. Production of bioethanol in the EU in 2005 - 2009. The production is shown for the 10 Member States with the largest production volume in 2009. The other 17 Member States are aggregated [Eurostat nrg_1073a].

Also for ethanol, there are large discrepancies in terms of the production estimates in some countries, as can be seen in Figure 10. Most notably in Sweden, more than 80% of the bioethanol produced according to Eurostat, is not supported by industry data; it is possible that some of the volume reported a production is actually imported ethanol blended with gasoline and then refined up to EU fuel specifications. In Italy and Germany, respectively 70% and 30% of the official production according to Eurostat is not supported by industry data. On the other hand, industry data shows significantly higher production of bioethanol in France (30% higher), Hungary (85%), Poland (30%) and several other countries compared to Eurostat data.

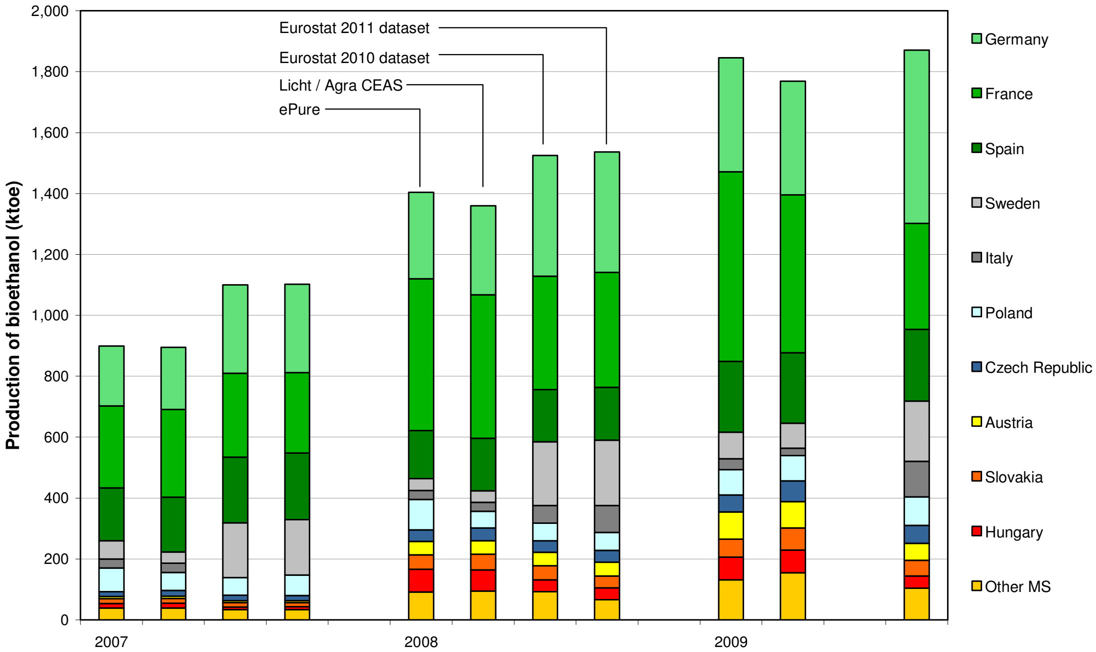

Figure 10. Comparison of bioethanol or fuel ethanol production in the EU in 2007 - 2009 according to different sources. Analysis by Agra CEAS.

Figure 11. Map of bioethanol plants in the EU in 2008 [Agra CEAS based on F.O. Licht].

The currently installed production capacity is not fully utilized. Table 8 compares installed capacity and actual production to derive an apparent level op capacity utilisation. This data suggests that bioethanol capacity utilisation amounted to around 55-65% during the years 2005-2009. As installed capacity has grown at the same pace as production and consumption, capacity utilisation has remained relatively stable. This may be considered surprising, as ethanol plants are capital intensive to construct and therefore very costly to operate at levels significantly below their stated capacity.

Table 8. Production of biofuels in the EU [Eurostat nrg_1073a] compared to the production capacity [EBB 2011, ePURE 2010] (both in Mtoe).

	Capacity	Actual production1)	Capacity utilisation
Biodiesel			
2005	3.76	1.63	43%
2006	5.40	2.46	46%
2007	9.16	3.85	42%
2008	14.24	5.67	40%
2009	18.61	7.44	40%
Bioethanol			
2005	0.92	0.55	60%
2006	1.43	0.84	59%
2007	1.98	1.10	56%
2008	2.75	1.54	56%
2009	2.92	1.87	64%

1) Note that the production of biodiesel and bioethanol does not add up to the totals found in Table 7. The difference is in Eurostat category "other liquid biofuels".

In general the apparent overcapacity indicates that while sufficient conversion capacity is available for the coming years, instead, use and consumption are lagging behind. Similarly, the biodiesel production capacity has grown faster then the actual production and only 40-46% of production capacity was apparently utilised in the same period.

There are several reasons for the apparent underutilisation of production capacity:

- The market seemed very attractive when decisions for construction were taken and construction started at many places concurrently. Once the plants came into production there was an overcapacity;
- Changing legislation especially in Germany, meant an immediate decrease in demand, especially for biodiesel;
- Increasing imports to the European Union, led to lower use of domestically produced European biofuels. Amongst others, imports of biodiesel from the USA increased in 2007 and 2008 because of a US subsidy on biodiesel blending, after which it could still be sold on EU market, further see section 2.5;
- Increasing oil and feedstock prices increased the biofuel production cost but did not raise the competing pump prices for diesel and gasoline at the same pace. The gap between biofuel production cost and value at the pump became too big to be bridged by the incentive schemes in place.

2.4 Feedstock of biofuels produced in the EU

The feedstock composition of EU biofuels in selected Member States is not officially reported. Therefore, this has been estimated based on industry estimates for the EU as a whole an dan analysis of individual Member State supply balances (total disappearance). In the EU in 2008 rapeseed oil was the most prominent feedstock used for biodiesel. Soybean and palm oil each provide around 12% of the EU biofuels feedstock. The EU biodiesel feedstock composition is quite steady over the 2007-2009 period.

Table 9. Feedstock[1)] for biodiesel produced in EU Member States in 2008. For reference, 2007 and 2009 composition for the EU as a whole is presented at the bottom of the table.

	Rapeseed/oil	Soybean/oil	Palm oil	Sunflower/oil	Tallow	RVO
Austria	54%	4%	4%	1%	20%	17%
Belgium	87%	6%	6%	1%		
Bulgaria	81%	9%	8%	2%		
Cyprus						100%
Czech Republic	87%	6%	6%	1%		
Denmark	30%	2%	2%	0%	31%	34%
Estonia						
Finland	87%	6%	6%	1%		
France	71%	14%	13%	2%		
Germany	83%	6%	6%	1%	2%	2%
Greece	42%	27%	26%	5%		
Hungary	34%	31%	30%	6%		
Ireland	87%	6%	6%	1%		
Italy	33%	31%	30%	6%		
Latvia	87%	6%	6%	1%		
Lithuania	87%	6%	6%	1%		
Luxembourg						
Malta						
Netherlands	20%	1%	1%	0%	37%	40%
Poland	87%	6%	6%	1%		
Portugal	18%	38%	37%	7%		
Romania	87%	6%	6%	1%		
Slovakia	87%	6%	6%	1%		
Slovenia	87%	6%	6%	1%		
Spain	16%	19%	18%	3%	21%	23%
Sweden	87%	6%	6%	1%		
United Kingdom	60%	4%	4%	1%	15%	16%
EU 2008	**66%**	**13%**	**12%**	**2%**	**3%**	**4%**
EU 2007	**70%**	**11%**	**13%**	**1%**	**2%**	**3%**
EU 2009	**67%**	**10%**	**13%**	**3%**	**3%**	**4%**

1) Agra CEAS calculations. Expressed as fraction of the biodiesel produced per country (e.g.: 71.5% of the biodiesel produced in Austria stems from rapeseed or rapeseed oil. The feedstock composition of EU produced biofuels is not known from previous studies or official data. EU biodiesel feedstock composition estimates are based on Agra CEAS analysis of plant capacity data from F.O. Licht; and feedstock supply balance (total disappearance) estimates for oils and fats from ISTA-Mielke. It is assumed that the primary feedstock of choice in the EU is rapeseed oil (in line with fuel specification legislation). RVO usage for biodiesel is based on indicated plant capacity data. Usage of other feedstock assumed linear with the relative total disappearance of each feedstock per Member State.

In the EU in 2008, bioethanol was especially produced from sugar feedstocks (e.g. molasses and sugar juice), wheat and maize. However, none of these feedstocks or even the combination is as prominent as rapeseed oil is for EU biodiesel. In 2007 and 2008 there is significant production of bioethanol from a mix of wine (crisis distillation) and other less obvious feedstocks.

Table 10. Feedstock[1)] of bioethanol produced in EU Member States in 2008. For reference, 2007 and 2009 composition for the EU as a whole is presented at the bottom of the table.

	Wheat	Maize	Barley	Rye	Triticale	Beet	Wine	Other[2)]	Unknown[3)]
Austria	53%	38%				9%			
Belgium	100%								
Bulgaria									
Cyprus									
Czech Republic	12%					88%			
Denmark									
Estonia									
Finland									
France	36%	16%				38%	10%		
Germany	21%	9%	5%	11%	2%	26%		4%	21%
Greece									
Hungary		36%				64%			
Ireland									
Italy						61%	39%		
Latvia	100%								
Lithuania	6%			47%	47%				
Luxembourg									
Malta									
Netherlands	100%								
Poland	33%	33%		33%					
Portugal									
Romania									
Slovakia		100%							
Slovenia									
Spain	20%	49%	9%				15%		8%
Sweden	15%		1%				2%	2%	80%
United Kingdom						100%			
EU 2008	**23%**	**18%**	**3%**	**5%**	**1%**	**25%**	**7%**	**1%**	**17%**
EU 2007	**30%**	**7%**	**7%**	**6%**	**1%**	**21%**	**7%**	**2%**	**19%**
EU 2009	**30%**	**23%**	**4%**	**5%**	**1%**	**32%**	**3%**	**1%**	

1) Agra CEAS calculations. The feedstock composition of EU produced biofuels is not known from previous studies or official data. The EU fuel ethanol feedstock composition estimates are based on Agra CEAS analysis of plant capacity data from F.O. Licht; feedstock supply balance (industrial use) estimates from industry sources; and wine alcohol for fuel ethanol tender results.
2) Other sources for ethanol can be e.g. whey (Ireland), paper pulp (Sweden), brewery waste (Finland, Germany), or fruit waste (Germany).
3) In Germany, Spain and Sweden, part of the ethanol produced according to Eurostat statistics cannot be confirmed by industry data. It is likely that this part of the ethanol is not really produced in these countries; it may have been imported under trade codes that do not directly link to ethanol.

For part of the ethanol in Germany, Spain and Sweden, it is not possible to estimate the feedstock. As stated previously, the apparent production volumes as reported by Eurostat are not supported by industry data. Especially for Swedish ethanol, this leads to a problem, as for 80% of its ethanol "production" in 2008 the real source is unclear. This situation disappeared in 2009, which suggests that the discrepancy is caused by the import of ethanol under the trade code for "other chemical products" in 2007 and 2008, which was no longer possible in 2009.

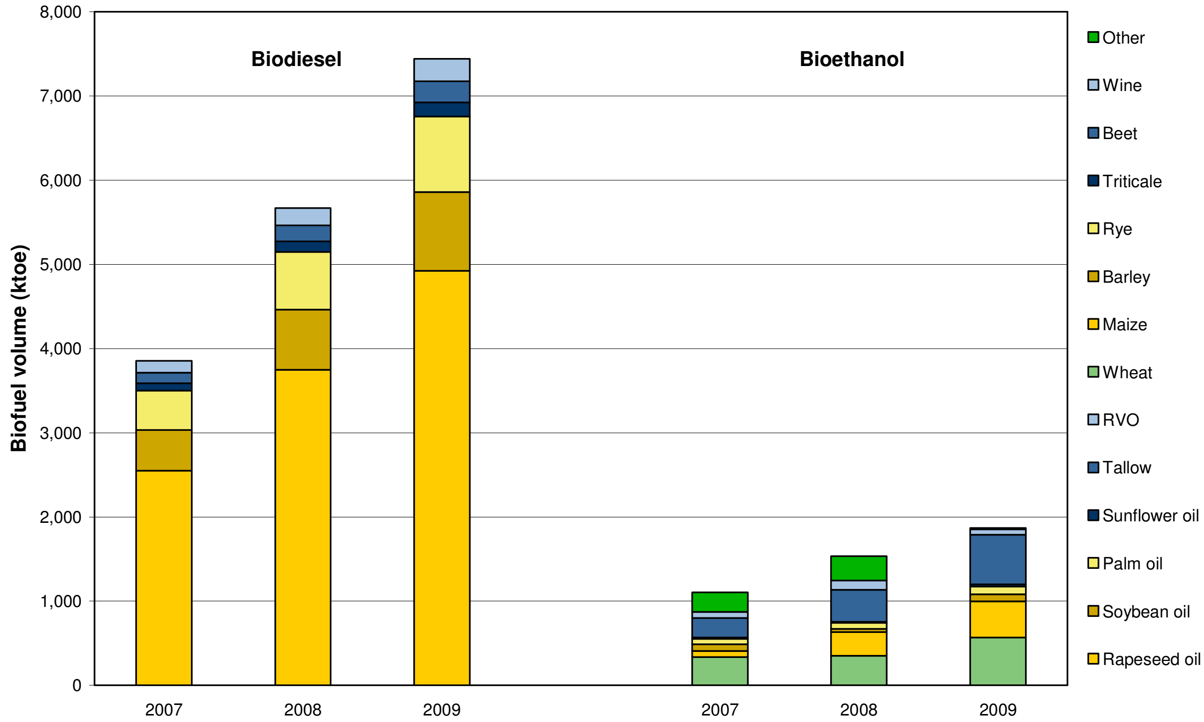

Figure 12. Feedstock composition of EU produced biodiesel and bioethanol.

2.5 Biofuels in third countries and import to the EU

Production in third countries

The production of biofuels around the world is shown in Figure 13 and Figure 14. There has been an exponential growth of global biofuel production over the last decade, although production has levelled off during the more recent years. In the EU, biofuel production has largely been focused on biodiesel. The EU is by far the largest producer of biodiesel in the world with 5.7 Mtoe in 2008 compared to global production of 11.2 Mtoe (50%). In the rest of the world, bioethanol plays a much larger role. Total global production was 40.4 Mtoe in 2008, of which only 1.5 Mtoe were produced in the EU (4%).

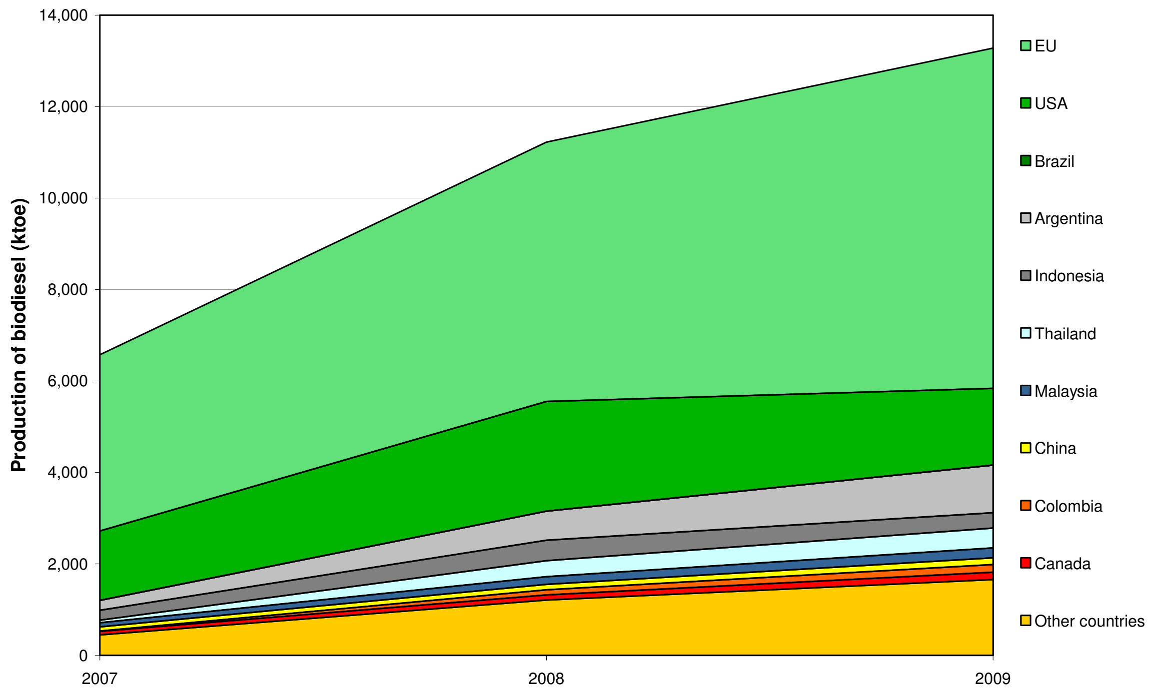

Figure 13. Production of biodiesel around the world in 2007 – 2009. The production is shown for the 10 countries with the largest production volume in 2008. The rest of the world is agregated [Agra CEAS / F.O. Licht].

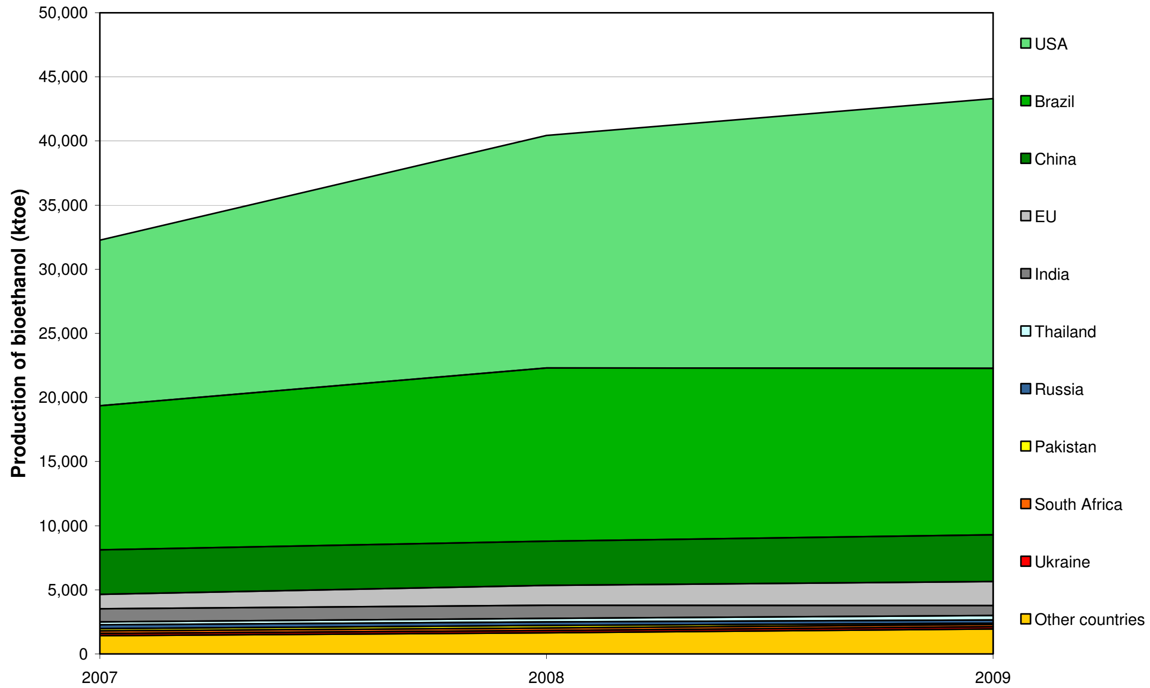

Figure 14. Production of bioethanol around the world in 2007 – 2009. The production is shown for the 10 countries with the largest production volume in 2008. The rest of the world is agregated [Agra CEAS / F.O. Licht].

Imports to the EU

In 2008, imports of biodiesel (1,619 ktoe) represented 22% of all biodiesel supplied to the EU market. Note that this does not imply that 22% of all biodiesel consumed stems from third countries, as will be explained later. The imported share is relatively constant, although slightly lower at 17% in 2007 and 2009. Exports of biodiesel from the EU to third countries are negligible. It should also be noted that Eurostat data does not reflect the whole biodiesel import into the EU due to limitations of the available HS Combined Nomenclature codes, which in particular do not capture biodiesel blends below 20% in imported petrol diesel [Lamers 2011].

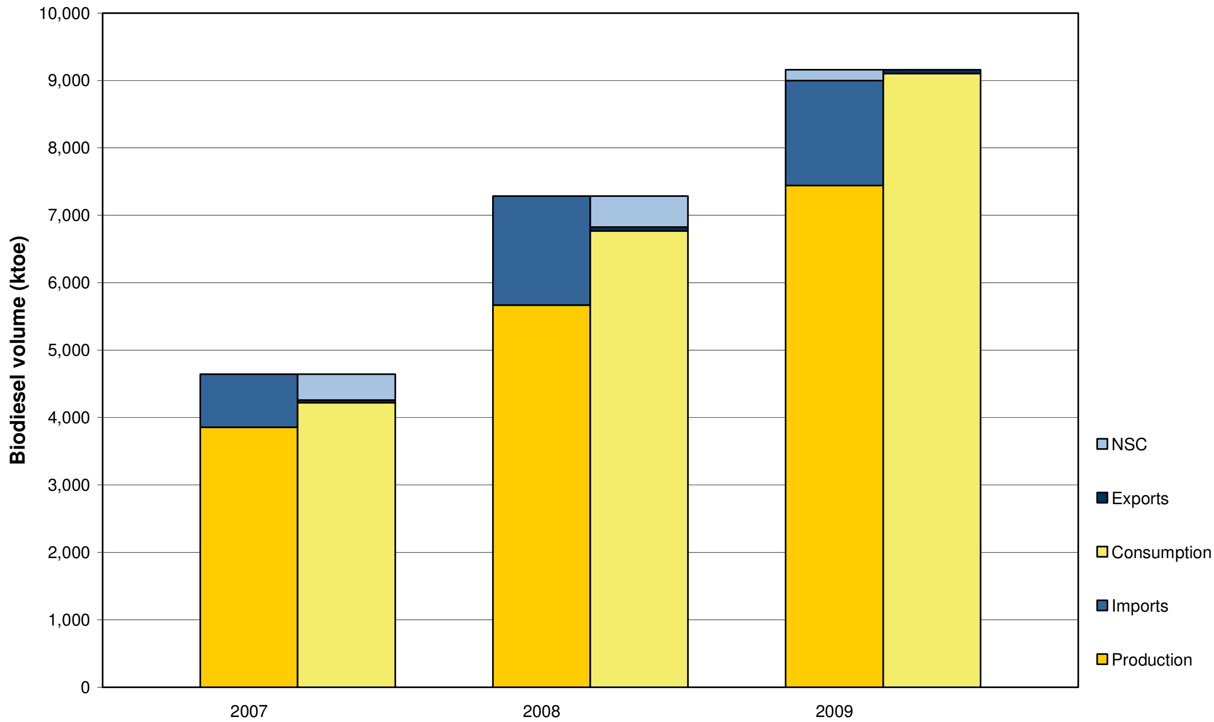

Figure 15. Supply balance of EU biodiesel. Production and consumption in the EU from Eurostat [Eurostat nrg_1073a]. Trade to and from the EU in 2008 and 2009 from Eurostat trade statistics by CN8 on biodiesel HS 3824.90.91. Trade to and from the EU in 2007 from Lamers [2011]. NSC is net stock change, defined as the difference between supply and demand.

The share of imports in the EU bioethanol supply in 2008 was 35% (822 ktoe), which is constant compared to 2007 (37%). Direct imports of ethanol decreased in 2009 in absolute and relative sense, to 28%. Note that the import statistics do not distinct between different applications of bioethanol. All the ethanol taken into consideration in this analysis is however suitable for use as biofuel, and thus available as biofuel in the EU. Eurostat data on bioethanol does not reflect the entirety of bioethanol imports into the EU, since it is also possible to import bioethanol as a low blend in gasoline, in which case the import is not captured by the available HS Combined Nomenclature codes. In particular, in 2008, 1472 million liters were exported from Brazil to the EU according to UNICA [2011], whereas only about 1065 million liters arrived according to Eurostat [EU27 Trade Since 1988 By CN8]. According to FO

Licht [personal communication], the main reason for the discrepancy is exports of E-90 blends, which enter the EU at a duty rate of 6.5%, but are not considered as ethanol by customs and therefore not captured by the HS codes. Another reason could be that some of the ethanol that left Brazil end of 2008 arrived in the EU only in 2009 practically or administratively. Exports of bioethanol from the EU to third countries are small. The calculated net stock remaining at the end of each year (light blue bar in the graph) is relatively large (29%, 21% and 11% in the respective years). This confirms that a significant share of the supply, most probably of the imports, is not applied as biofuel.

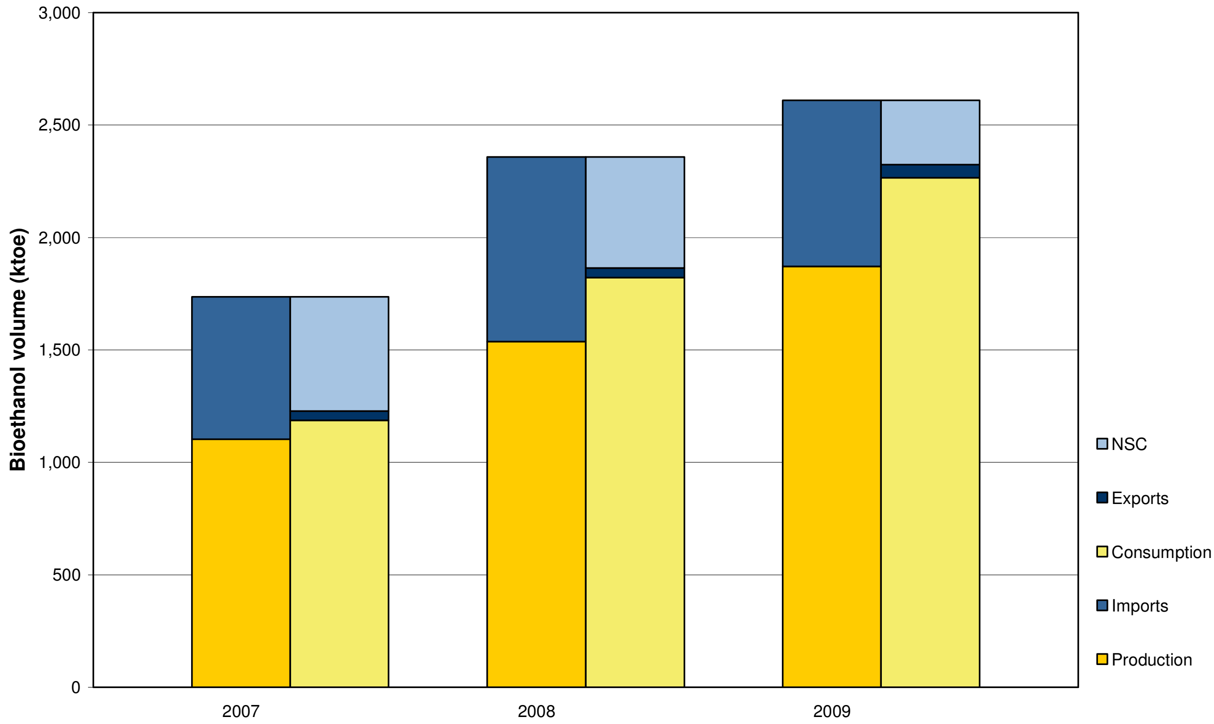

Figure 16. Supply balance of EU bioethanol. Production and consumption in the EU from Eurostat [Eurostat nrg_1073a]. Trade to and from the EU from Eurostat trade statistics by CN8 on bioethanol HS 2207.20, HS 2207.10 and HS 2909.19.10. NSC is net stock change, defined as the difference between supply and demand.

In Figure 17, the direct trade in biodiesel in 2008 is compared with the effective trade after correction for triangular trade and swap trade. The figure shows that much biodiesel is traded within the EU in multiple steps before reaching the final destination.

From the Eurostat statistics on direct import from third countries, it seems that about 1.35 Mtoe of biodiesel comes from the USA. However, further analysis of international trade, by correcting for triangular and swap trade, shows that about 200 ktoe of the biodiesel from the USA actually comes from Argentina and about 100 ktoe actually comes from Indonesia, so that the shares of these countries in the EU biodiesel supply are larger than can be seen from unprocessed trade statistics. Smaller amounts that initially seem to come from the USA actually come from

Singapore (37 ktoe) and Malaysia (23 ktoe) comes via the USA; 35 ktoe comes directly). The effective imports from the USA to the EU therefore amount to 960 ktoe.

A major reason for indirect trade of biodiesel via the USA between 2007-2009 has been the US volumetric excise tax credit (VETC) which was in effect between 2004 and 2009. The scheme was originally aimed at supporting local biodiesel production for domestic use. However, the lack of import duties and any stipultation concerning a requirement for domestic consumption made it possible to export domestic production or even to ship biodiesel into the US, collect the (full) tax credit and (re-) export the same good. This led to a common practice under which traders/producers only added a minimumal share (often less than 1.0 percent) of mineral oil to claim the credit [see Lamers et al. 2011 for a review]. The resulting B99 biodiesel was then exported to the EU where the commodity obtained a higher market price due to the domestic support schemes in the respective MS. Statistics show that the re-export of biodiesel was even practiced with originally EU-produced biodiesel. This practice, commonly referred to as 'splash-and-dash' or 'B99-effect', was counteracted by EU anti-dumping and countervailing duties in March 2009. The scope of the VETC was further limited by the US Emergency Economic Stabilization Act of 2008 to biodiesel that was US produced only.

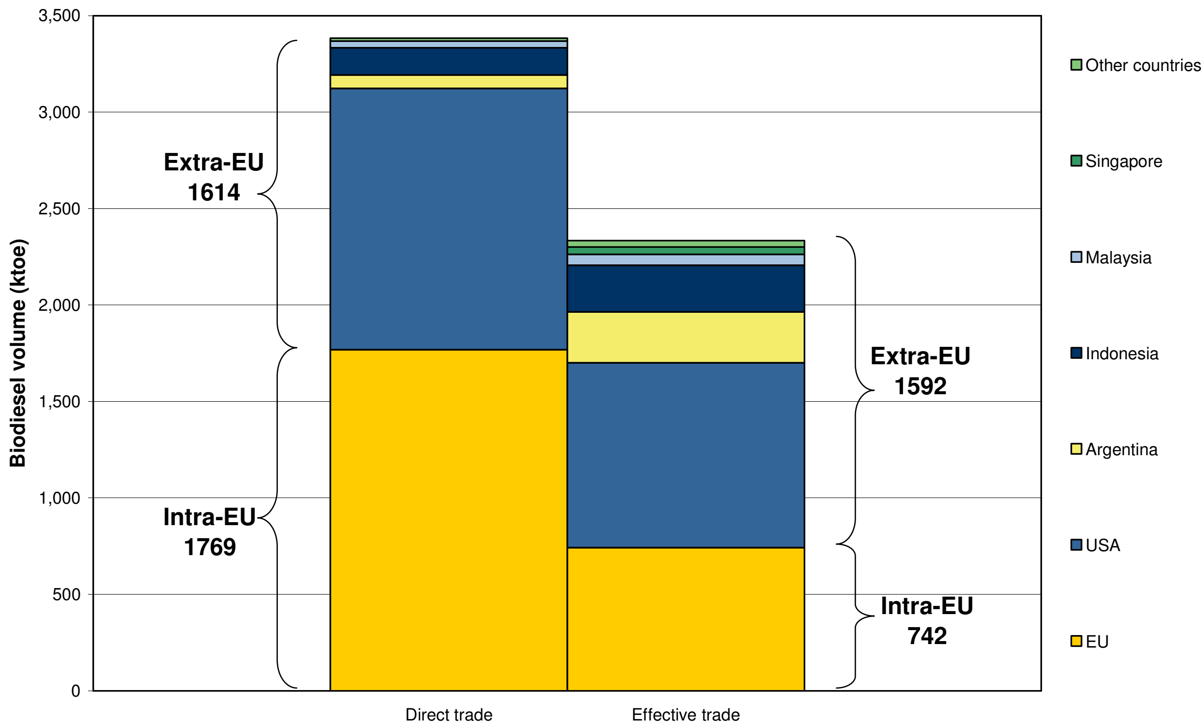

Figure 17. Analysis of the biodiesel trade to and within the EU. Direct trade from Eurostat [Eurostat DS_016890 Trade by CN8 for code HS 3824.90.91]. The effective trade is derived by correcting for triangular and swap trade. This was done by analysing the indirect origin of biodiesel supply in each of the "direct" supplying countries, assuming that indigenous production and import from again other countries are equally represented in the exports from each country.

Lamers et al. [2011] show in their further analysis of international biodiesel trade that the US imports from Argentina rose suddenly in 2008 and dropped again to low levels in 2009 and that a similar effect can be observed for Indonesia. As a result of the EU duties counteracting the US blend subsidies, it was less attractive in 2009 to export from the USA to the EU. Instead, suddenly the imports from the US to Canada increased from only 2 ktoe in 2008 to 110 ktoe in 2009, while at the same time the imports from Canada to the EU increased from only 2 ktoe to 140 ktoe. Even if we consider that the Canadian production of biodiesel also increased in the same period (from 107 to 160 ktoe), it is still clear that US biodiesel plays a significant role in the 2009 Canadian biodiesel supply from where it may have been re-exported to the EU. As noted above, the Eurostat trade data does not cover blends containing less than 20% biodiesel. It is therefore possible that US subsidised biodiesel was still imported to the EU in 2009 without facing the counteracting measures.

The international trade in bioethanol in 2008 is less distorted by triangular trade, as can be seen in Figure 18. The volumes of direct trade to the EU from major supplying countries as reported by Eurostat do not change significantly after accounting for indirect trade. This means that the third countries that supply bioethanol to the EU barely import from yet other countries (in comparison to their indigenous production).

By far the largest import volume of bioethanol in 2008 originates from Brazil (530 ktoe or 69% of all imports), followed at some distance by Pakistan (8% of all imports).

As with biodiesel above, the figure shows that much is traded around the EU in multiple steps before reaching its final destination.

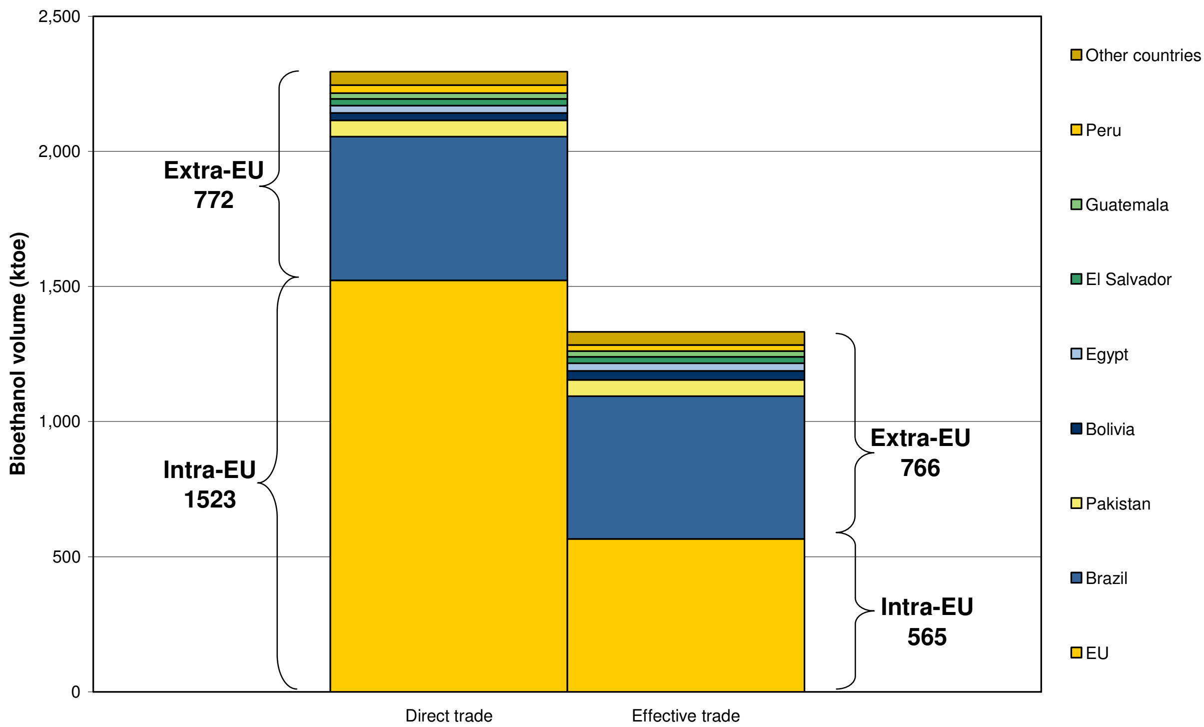

Figure 18. Analysis of the bioethanol trade to and within the EU. Direct trade from Eurostat [Eurostat DS_016890 Trade by CN8 for codes HS 2207.20, HS 2207.10 and HS 2909.19.10]. The effective trade is derived by correcting for triangular and swap trade. This was done by analysing the indirect origin of bioethanol supply in each of the "direct" supplying countries, assuming that indigenous production and import from again other countries are equally represented in export from each country.

To derive where EU consumed biofuels have been produced, we assume that the effective import of biodiesel or bioethanol to each Member State and the indigenous biofuels production are equally represented in the Member State's market and subsequently in its consumption. The resulting origin of consumed biofuels on Member State level is shown in Table 11.

From the table, some Member States seem to be completely self sufficient in biofuels. Imports of biodiesel to Cyprus, Denmark and Finland were very small or zero while there was still some limited consumption. In such cases, the origin of the biofuel was allocated largely to the country itself, although better trade data may prove different.

The results found by this analysis should be used with care, since the actual trade is not completely known from trade data as was discussed before[16] and also because Eurostat information on biofuels production per Member State differs sometimes from industry information[17]. The resulting uncertainty is estimated at about 5% for biodiesel and 15% for bioethanol for the EU total. Individual Member States' results can have larger uncertainties (especially for those with smaller markets).

Table 11. Origin of biofuels on EU Member States markets. Note: this table does not yet take into account the origin of the feedstock.

	Biodiesel			Bioethanol		
	Indigenous	Import EU	Import ROW	Indigenous	Import EU	Import ROW
Austria	79.5%	17.0%	3.5%	50.7%	34.6%	14.7%
Belgium	72.2%	0.2%	27.6%	42.7%	19.3%	38.0%
Bulgaria	64.2%	20.8%	15.0%	97.6%	1.1%	1.3%
Cyprus	100.0%	0.0%	0.0%	0.0%	35.9%	64.1%
Czech Republic	74.2%	23.2%	2.5%	83.1%	2.5%	14.4%
Denmark	100.0%	0.0%	0.0%	0.0%	61.2%	38.8%
Estonia	85.4%	0.0%	14.6%	0.0%	76.0%	24.0%
Finland	100.0%	0.0%	0.0%	98.1%	1.9%	0.0%
France	88.4%	9.2%	2.5%	81.8%	2.8%	15.5%
Germany	75.7%	2.1%	22.2%	49.3%	24.0%	26.7%
Greece	99.3%	0.4%	0.4%	0.0%	51.3%	48.7%
Hungary	99.9%	0.1%	0.0%	77.5%	19.0%	3.5%
Ireland	72.2%	1.1%	26.7%	0.0%	15.6%	84.4%
Italy	80.3%	8.6%	11.1%	47.5%	22.2%	30.3%
Latvia	80.0%	5.9%	14.1%	74.0%	13.6%	12.4%
Lithuania	75.3%	17.7%	7.0%	47.2%	44.2%	8.6%
Luxembourg	97.7%	0.1%	2.2%	0.0%	95.0%	5.0%
Malta	0.0%	34.6%	65.4%	100.0%	0.0%	0.0%
Netherlands	12.8%	13.7%	73.5%	1.9%	35.6%	62.5%
Poland	55.5%	41.0%	3.5%	57.6%	30.8%	11.6%
Portugal	94.9%	0.0%	5.1%	0.0%	39.2%	60.8%
Romania	33.2%	10.5%	56.3%	0.0%	87.0%	13.0%
Slovakia	99.9%	0.0%	0.0%	86.2%	4.0%	9.7%
Slovenia	30.3%	65.9%	3.8%	0.0%	83.7%	16.3%
Spain	39.4%	9.3%	51.3%	81.6%	9.5%	8.9%
Sweden	92.1%	6.5%	1.4%	46.0%	16.9%	37.1%
United Kingdom	50.9%	16.3%	32.8%	53.2%	30.8%	16.0%

The overall effect for Europe is shown in Table 12. Clearly, most of the biofuels consumed in the EU market have been produced in Europe. For biodiesel, the most important source of biodiesel outside the EU remains the USA, even after correcting

[16] EU bioethanol imports from third countries may be underestimated by about 20% (especially based on supposed underestimation of trade with Brazil). EU biodiesel imports may be underestimated by about 5%.

[17] EU bioethanol production may be overestimated by about 10% (Eurostat data used versus industry insights). EU biodiesel production may be underestimated by about 20%.

the trade balances for indirect trade of Argentinian and Indonesian biodiesel. Note that, even where Argentinian and Indonesian biodiesel each represent about 15% in the indirect import of biodiesel to the EU, their eventual contribution in EU biodiesel consumption is somewhat less (respectively 12% and 14%) because the imports are not equally distributed over the EU and the most important EU markets import more from the US.

For bioethanol, the single most important source of bioethanol outside the EU is Brazil.

Table 12. Origin of biofuels consumed in the EU in 2008. Note: this table does not yet take into account the origin of the feedstock, which is discussed in the next sections.

	Biodiesel			Bioethanol	
	Volume (ktoe)	Fraction		Volume	Fraction
EU	5,622	83.0%	EU	1,402	76.9%
USA	780	11.5%	Brazil	289	15.9%
Argentina	133	2.0%	Pakistan	33	1.8%
Indonesia	165	2.4%	Bolivia	19	1.1%
Malaysia	35	0.5%	Egypt	14	0.8%
Singapore	16	0.2%	El Salvador	13	0.7%
Other countries	18	0.3%	Peru	13	0.7%
			Guatemala	11	0.6%
			Other countries	27	1.5%

Feedstock use in third countries

The insights in the origin of biofuels are combined with estimations of feedstock composition. For the most prominent supplier countries outside the EU, the feedstock composition is shown in Table 13. In the US more than half of the biodiesel is produced from soybean oil, with further large contributions from palm oil and tallow. In other countries, the feedstock is mostly limited to one type. Ethanol, in the countries that contribute most to the EU supply is only produced from sugar cane.

Table 13. Feedstock composition for biodiesel and bioethanol in main supplier countries. Analysis by Agra CEAS.

Biodiesel	Rapeseed oil	Soybean oil	Palm oil	Tallow
USA	5%	57%	21%	17%
Argentina		100%		
Indonesia			100%	
Malaysia			100%	
Singapore			100%	
Bioethanol	**Sugar cane**			
Brazil	100%			
Pakistan	100%			
Bolivia	100%			
Egypt	100%			
El Salvador	100%			
Peru	100%			
Guatemala	100%			

Origin of the feedstock for biofuel production

The above analysis of feedstock usage in the EU and third countries combined with the origin of EU consumed biofuels results in understanding which feedstocks have been used in all countries to produce the biofuels that were consumed in the EU in 2008. This does not yet however give the insight into the origin of feedstock for EU biofuels.

Therefore, for several feedstocks, international trade was studied in the same way as the biofuel trade earlier in this chapter. Feedstocks considered in the trade analysis are: rapeseed / oil, soybean / oil, palm oil, maize and wheat since these are traded on a large scale internationally. Other feedstock are not internationally traded (sugar beet, sugar cane) or less relevant in the overall biofuels feedstock profile (barley, rye, triticale, wine, sunflower/oil, tallow and RVO), while for some of these, trade statistics are even not available.

The analysis of triangular trade is relevant for several of these feedstocks, especially for palm oil and soybean/oil. A large part of the EU imports of these materials goes via a limited number of countries, especially the Netherlands. To understand the origin of e.g. palm oil used in Germany, the direct origin (Netherlands) is not useful. Rather the indirect origin (mostly Indonesia and Malaysia via the Netherlands) must be known.

Figure 19 shows an analysis of feedstock used for biodiesel consumed in the EU in 2008. The international trade in rapeseed / oil is limited and most of the rapeseed used for biodiesel production in the EU (3.7 Mtoe of biodiesel equivalent) actually stems from the EU (3.2 Mtoe biodiesel equivalent), although there is still a significant amount of rapeseed that ultimately stems Ukraine (252 ktoe biodiesel equivalent) and Canada (121 ktoe biodiesel equivalent).

As expected, the palm oil used for EU biodiesel production (666 ktoe biodiesel equivalent) largely stems from Indonesia (459 ktoe biodiesel equivalent) and Malaysia (379 ktoe). This comes on top of the palm oil biodiesel that was produced in these countries and that found its way to EU consumption (respectively 165 and 35 ktoe biodiesel equivalent).

Similarly, of the 691 ktoe biodiesel produced from soybean / oil in the EU, only some 82 ktoe was produced from EU soybeans. EU soybean based biodiesel especially stems from soybeans from the USA (528 ktoe biodiesel equivalent), Brazil (342 ktoe) and Argentina (238 ktoe).

As mentioned above, the origin of RVO and tallow in EU produced biodiesel has not been analysed and is consequently the same in both set of bars.

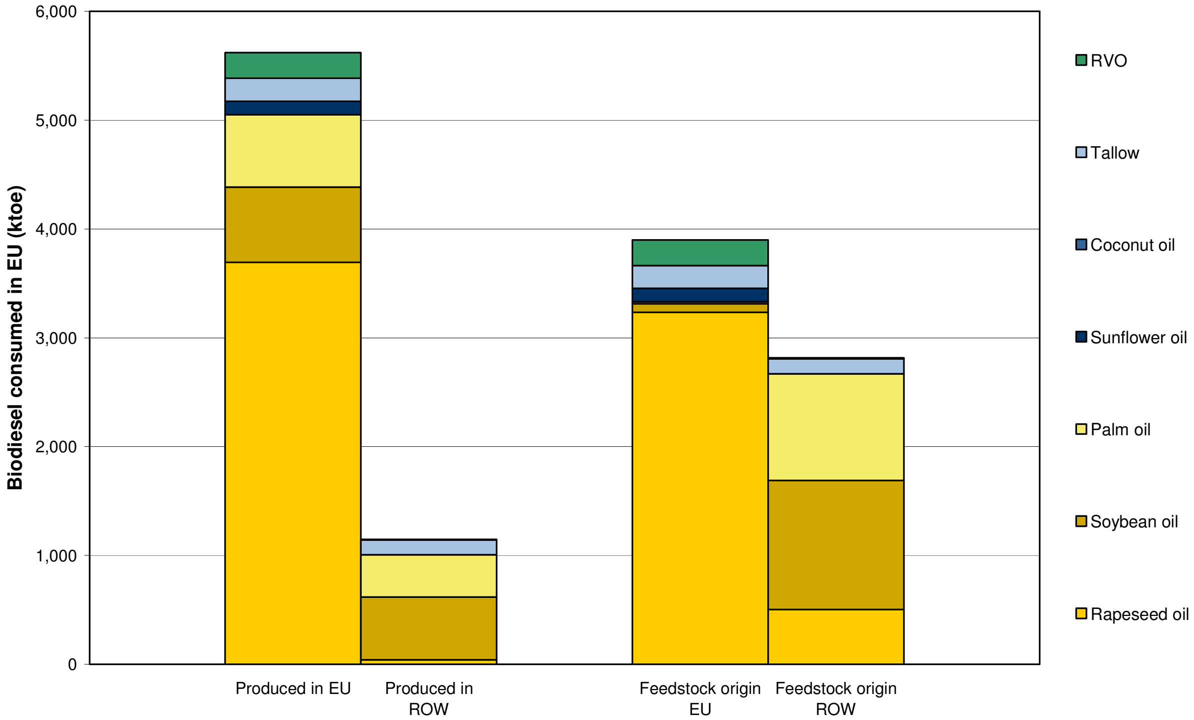

Figure 19. Analysis of feedstock used for biodiesel consumed in the EU in 2008. The left set of bars show the feedstock used for biodiesel production in the EU and in third countries, whereas the right set of bars shows the ultimate origin of these feedstock.

The ultimate origin of feedstock of EU consumed biodiesel is further split out in Table 14 for the most important supplying countries.

Table 14. Ultimate origin of feedstock for biodiesel consumed in the EU in 2008. Expressed in volume of biodiesel (ktoe).

	Rapeseed / oil	Soybean oil	Palm oil	Sunflower oil	Tallow	RVO	Total
EU	3,233	82	14	124	212	235	**3,900**
Canada	122	18			4	6	**149**
Ukraine	252	10					**261**
USA	13	528			133		**673**
Argentina	4	238					**242**
Brazil		342					**343**
Indonesia			624				**624**
Malaysia			414				**414**
Other	111	52					**164**
Total	**3,734**	**1,269**	**1,053**	**124**	**348**	**241**	**6,770**

The analysis of feedstock origin for bioethanol consumed in the EU market is less exiting, since the trade of maize and wheat to the EU is small in comparison with the EU production of these crops. In Figure 20, only a small amount of Argentinian and Brazilian maize becomes visible as ultimate feedstock for some 29 ktoe of EU consumed bioethanol. Furthermore, the location of the conversion is quite the same as the origin of the feedstock.

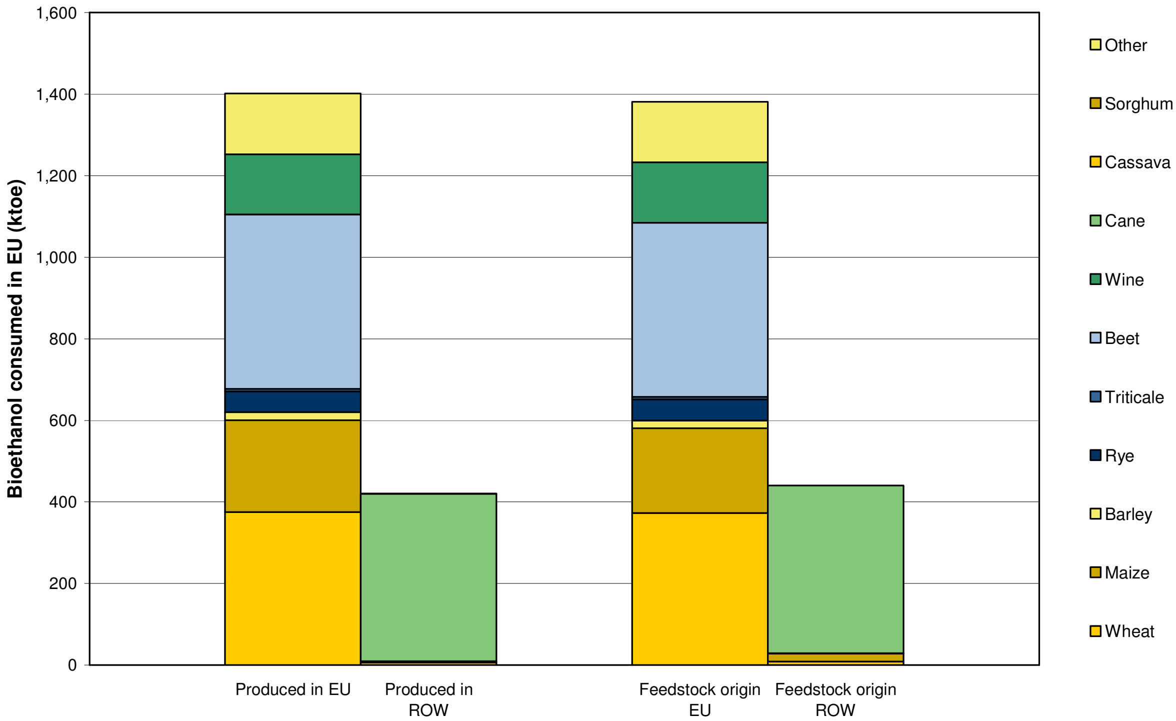

Figure 20. Analysis of feedstock used for bioethanol consumed in the EU in 2008. The left set of bars show the feedstock used for bioethanol production in the EU and in third countries, whereas the right set of bars shows the ultimate origin of these feedstock.

The original feedstock for EU consumed bioethanol in 2008 stems from a broader range of countries, compared with biodiesel feedstock.

Table 15. Ultimate origin of feedstock for bioethanol consumed in the EU in 2008. Expressed in volume of bioethanol (ktoe).

	Wheat	Maize	Barley	Rye	Triticale	Sugar beet	Wine	Sugar cane	Other	Total
EU	373	207	20	51	7	427	148		149	**1,381**
USA	2									**3**
Norway	2									**2**
Ukraine	1	1								**3**
Argentina		12						5		**17**
Brazil		6						289		**296**
Pakistan								33		**33**
Bolivia								19		**19**
El Salvador								13		**13**
Peru								13		**13**
Egypt								14		**14**
Guatemala								11		**11**
Costa Rica								10		**10**
South Africa								2		**2**
Other	2							1		**4**
Total	**381**	**228**	**20**	**51**	**7**	**428**	**148**	**411**	**149**	**1,822**

2.6 Biofuels from waste, residues and lignocellulose biomass

Biofuels which use waste, residues and lignocellulose biomass as their feedstock count double in the calculation of the share of biofuels as set as target for the purposes of the new Renewable Energy Directive.

As was shown above, 348 ktoe of the biodiesel consumed in the EU in 2008 was produced from tallow and 241 ktoe from RVO. Altogether, this represents 8.7% of the EU biodiesel.

For ethanol, part of the biofuels produced in the "other" category was also produced from waste or residue streams (e.g. from whey in Ireland, from paper pulp in Sweden, from brewery waste in Finland and Germany, or from fruit waste in Germany). Although exact amounts are currently difficult to quantify, it is plausible that most of the 149 ktoe of biodiesel in the category "other" is actually produced from a waste or residue. This means that close to 8% of the EU consumed bioethanol stems from waste or residues. The raw alcohol or wine used as feedstock for 148 ktoe of EU consumed ethanol does not count as a waste stream (it was authorised by the EU management Committee and classified as crisis distillation). Future Member State reports will give more clarity on double counting biofuels without the need for the complex top down analysis that was done in the previous sections.

The availability of advanced production technologies will enable the use of lignocellulose and residue feedstock for the production of biofuels. Although advanced biofuel production facilities are being developed for many years now, they only recently reached commercialization. The reason mainly lies in the fact that these technologies remain highly capital intensive and are at the moment not competitive with conventional biofuel production from food crops. However, during the last few years, the interest for fuels from wastes and lignocellulose feedstocks has increased as a result of concerns related to energy security and sustainability.

From the range of biofuel production technologies, bio-chemical processes mostly focus on the production of ethanol through fermentation of sugars while thermo-chemical processes produce a range of fuels including Fischer-Tropsch-diesel, bio-methanol, green diesel, bio-dimethylether and biomass derived substitute natural gas through a variety of processes including gasification, pyrolysis and transesterification. The contribution of advanced biofuels to global biofuel production depends on the technological progress in the next few years, especially the further development in the cost-effectiveness of these conversion technologies.

In 2008, the European advanced biofuel facilities were concentrated in seven Member States led by Netherlands, Norway and Denmark. The total production was however negligible. As per 2009, Germany produced some FT-diesel. Figure 21 gives an overview of operational advanced biofuels initiatives until 2008 and the planned initiatives in 2009 from residues and lignocellulose biomass in Europe. The figure includes also the biofuel type and the status and scale of the initiatives which differ widely from pilot stage to commercial demonstration. In Figure 21 only a selection of initiatives operational in 2008-2009 at a somewhat reasonable scale are presented. The production capacities of individual countries and the total European production are presented in Figure 22. It is unknown if each of the installations has indeed produced the presented amounts.

The total estimated amount of 114 ktoe of advanced biofuels produced in the EU in 2009 was only about 1% compared to the total production or consumption of all biofuels in the EU. The majority of the volume stems from the BioMCN biomethanol facility in the Netherlands, which came on stream in July 2009.

Detailed descriptions of the initiatives shown in Figure 21 are given in Appendix D.

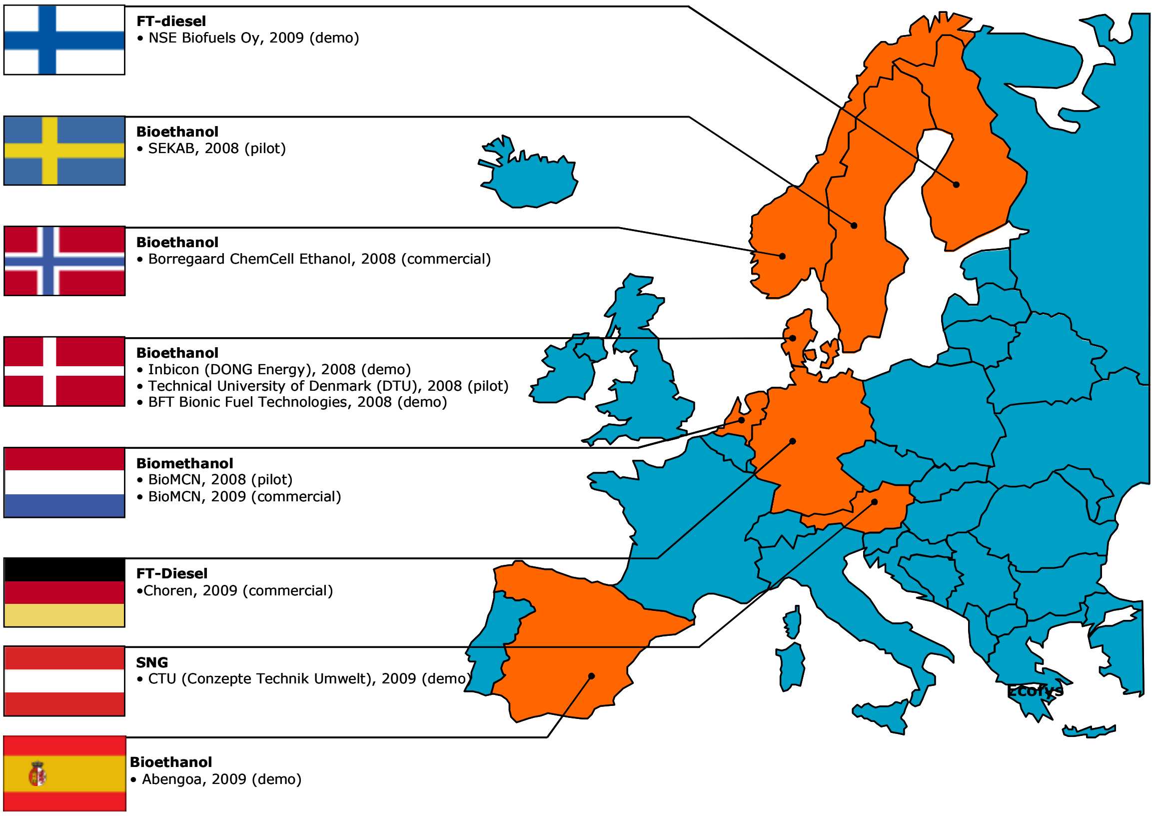

Figure 21. European initiatives until 2008 for the production of biofuels from lignocellulose or advanced biofuel production from residues.

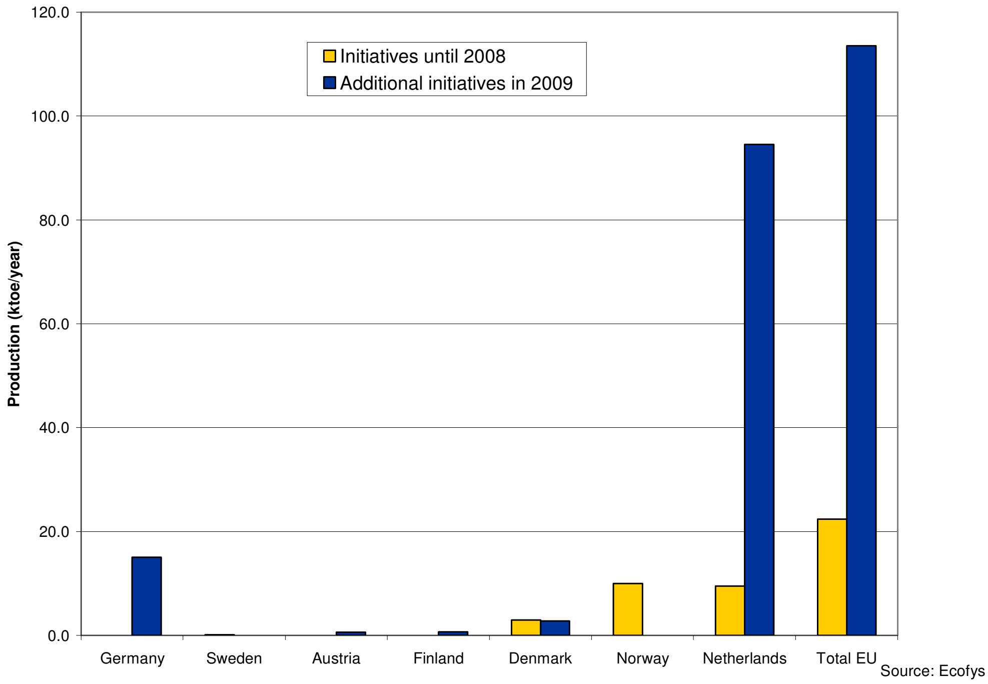

Figure 22. Production capacity of advanced biofuels in Europe until 2008 and the additional (planned) production volumes in 2009.

2.7 Self sufficiency and security of the energy supply

Self-sufficiency

Self-sufficiency is defined [EC 2009] as the ratio of indigenous production to indigenous consumption. This approach considers conversion in Europe a measure for self-sufficiency. Since part of the feedstock is imported, most notably soybeans and palm oil, the actual biofuels production is not the complete story. Moreover, a large part of the production potential is probably not currently utilised because of more attractive imports from elsewhere, but could be brought into production when needed.

The calculated self-sufficiency in the EU – as presented in Table 16 below – shows a decrease from 2005 to 2008. The decline for biodiesel is stronger than for bioethanol.

Table 16. Biofuel self-sufficiency in the EU (ratio of production to consumption) [Eurostat nrg_1073a].

	2005	2006	2007	2008	2009
Biofuel	112%	105%	92%	84%	82%
Biodiesel	118%	106%	91%	84%	82%
Bioethanol	98%	100%	93%	84%	83%

Both the production and consumption of both biodiesel and bioethanol in the EU rose during the whole period 2005-2009. However, the EU production growth was slower than that of the consumption. The most important reason for this was the increasing competition of imported biofuels. For biodiesel, even an initial overcapacity is visible.

Security of Energy Supply

It is generally assumed that the EU security of energy supply improves by introducing alternative fuels, produced from more feedstock originating from more production regions. The above discussed self-sufficiency index for biofuels is a simple index for quick comparison of domestic biofuel production to consumption on an annual basis. It is however, not a suitable index to draw conclusions on the EU security of energy supply. Moreover, in the case of biofuels specifically, imports from third countries may be desirable to balance risks associated with using EU feedstock only.

Currently, a good indicator is not available to express the impact that biofuels have on the security of the energy supply [see e.g. Londo et al. 2006 on the investigation of approaches for the transport sector]. A good indicator would have to provide an indication of "system stability" i.e. the biofuel portfolio's robustness against changes on the supply side (import as well as local markets). Specifically, it should account for diversity (of origin, or feedstock, or both) in local production or import. Furthermore, there will always be several limitations to the representation of biofuel sector characteristics in a specific biofuel indicator. Some of the main biofuel aspects which can hardly be reflected in an indicator for the security of energy supply include:

- *Differentiation between inputs*: a ranking for all MSs regarding the impact of either feedstock (e.g. soy beans), intermediate products (e.g. soy oil), or final products (e.g. blended-biodiesel) as well as differences within the individual categories on the SoES. This is directly connected to the following limitation.
- *Flexibility of production systems*: a ranking of technological requirements regarding feedstock types (e.g. specific oil types vs. HVO processing) and plant location (e.g. location in overseas port with access to various feedstock and regions vs. inland waterway location).
- *Political stability*: due to the diverse sourcing possibilities, political stability seems less important than for fossil fuel imports which are limited to specific regions/countries.
- *Crop growth and harvest risk*: weather patterns and the availability of production inputs (e.g. water) over time.
- *Trade regimes and costs*: costs are not directly taken into account but reflected in trade balances. The same applies to specific trade regimes of individual MS affecting the portfolio of imports.
- *Development of consumption*: SoES indicators mainly focus on the supply mix and its robustness.
- *Re-Export*: re-export within the EU should not be taken into account as it is a signal for sufficient supply or strong market incentives in the respective importing region. Furthermore, it only makes up a minor share in the overall trade balance (see Table 16).

In Appendix E, an attempt is made to analyse the impact of biofuels on the security of energy supply in the transport sector. It is concluded that – within the limitations of the indicator and at present consumption levels – the broad variety of feedstock and (ultimate) feedstock countries implies that biofuels have a higher security of supply than fossil fuels. The total energy supply for transport becomes therefore more secure with introducing biofuels.

3 Biofuel policy framework

3.1 Major findings

In this chapter, the biofuels policy framework in the EU and third countries has been analysed with focus on how third countries are preparing for the EU sustainability criteria. The major findings are:

- The legal basis for biofuel policies in the EU Member States in 2008 was the previous Biofuels Directive [2003/30/EC], which aimed at 5.75% biofuels in 2010. Germany, Austria, Sweden and Slovakia had already met this target in 2008. Most other Member States were far from achieving the target;
- In 2009 the new Renewable Energy Directive came into force laying down the mandatory 10% target for renewable energy share in transport for all Member States by 2020 and including the biofuels sustainability scheme. Member States had to implement the Renewable Energy Directive and its sustainability scheme in their national legislation by December 5th, 2010. Evaluation of the transposition of the Directive in all the Member States is ongoing;
- The Renewable Energy Directive requires that all biofuels supplied to the EU market comply with the sustainability criteria. This compliance has to be ensured by the economic operators selling fuel on the market.
- Third countries that play a significant role in providing feedstock for EU consumed biofuels are not required to implement the requirements of the Renewable Energy Directive, however compliance with the biofuel sustainability requirements must be guaranteed by the EU Member States who count imported biofuels towards their national renewable energy targets, where such fuels are counted towards renewable energy obligations and where they receive (financial) support;
- Third country analysis reveals areas requiring further attention in the assessment of compliance with EU sustainability criteria. Especially, the national legislation in third countries does not always provide sufficient sustainability guarantees for conservation of land with high carbon stock value (wetlands, grasslands, peatlands);
- Several third countries providing biofuels or feedstocks for the EU market seem to have insufficient requirements for Environmental Impact Assessments, which means that new biofuel projects may not sufficiently address sustainability concerns;
- For biofuels originating in third countries voluntary schemes may be used as a proof of compliance with the EU sustainability criteria. European Commission has so far (July 2011) recognised 7 voluntary schemes: International Sustainability and Carbon Certification (ISCC), Bonsucro EU, Round Table on Responsible Soy (RTRS EU RED), Roundtable of Sustainable Biofuels (RSB EU RED), Biomass Biofuels voluntary scheme (2BSvs), Abengoa RED Bioenergy Sustainability Assurance (RSBA), Greenergy Brazilian Bioethanol verification programme [18]. All

[18] EC decision 19 July 2011.
http://ec.europa.eu/energy/renewables/biofuels/sustainability_schemes_en.htm

of these schemes except Greenergy in principle have a global scope. Nevertheless, the Bonsucro scheme has a strong focus on Brazil, RTRS has a strong focus on Argentina and Brazil and 2BSvs has a strong focus on France;

- Within the EU, the UK has operated a legally required monitoring scheme for biofuels with sustainability criteria since 2008, using voluntary certification schemes as the primary approach to measure compliance. France and Germany have also started some monitoring and accepted respectively the ISCC and 2BSvs scheme to measure compliance;
- There are several national voluntary certification schemes in Central and South America, the United States, and Europe. There are few sustainability reporting and control mechanisms active in Africa, but there is also much less biofuel activity in that region compared with the other regions;
- The Americas have both voluntary and mandatory standards developed at national levels. Voluntary standards include: Aapresid in Argentina, CSBP and SBA in the United States, and a number of schemes in Brazil. Mandatory standards include: the RFS of the United States and the biofuels sustainability regulations of the Low Carbon Fuel Standard in California;
- Looking at the acceptance and presence of certification schemes in the analysed countries (column 2 and 3 in Table 17), it can be indicated that project developers in Brazil, Indonesia and Malaysia tend to be most inclined to engage in voluntary market based certification schemes. Generally, project developers in the assessed Latin American and Asian countries seem to be more inclined to engage in voluntary market based certification schemes than project developers in African countries.

Table 17. Ranking of countries based on (a) number of voluntary international certification schemes present, (b) number of projects certified under international or national certification schemes. Ranking from 1 (best) to 15 (worst)

Country	Certification schemes present 1)	Projects certified 1)
Argentina	4	5
Bolivia	7	6
Brazil	1	1
Guatemala	4	4
Peru	7	8
Ethiopia	14	14
Malawi	14	14
Mozambique	10	10
Nigeria	14	14
Sudan	14	14
Tanzania	10	11
Uganda	10	11
India	4	6
Indonesia	2	2
Malaysia	3	3
Pakistan	10	13
Ukraine	9	9

1) Assessed international schemes include: Bonsucro, FSC, ISCC, PEFC, SAN/RA, RSPO, RTRS.

- Other legislation not specifically targete at biofuels may also be able to safeguard elements of sustainability related to biofuels. The potential for legislation to deliver sustainability outcomes depends on several factors, including the scope of the legislation, specific requirements, and its enforcement.

3.2 Biofuel policy and support in EU member states

In 2008 the legal basis for biofuel policies in the EU Member States was the previous Biofuels Directive [2003/30/EC], which aimed at 5.75% biofuels in 2010. Some countries decreased their targets based on amongst others sustainability concerns.

Figure 24 shows the actual realised shares of biofuels in 2007-2009 against 2010 country targets. It shows that while Germany, Austria. Sweden and Slovakia already met their 2010 target in 2008, most other countries were still far from achieving the target.

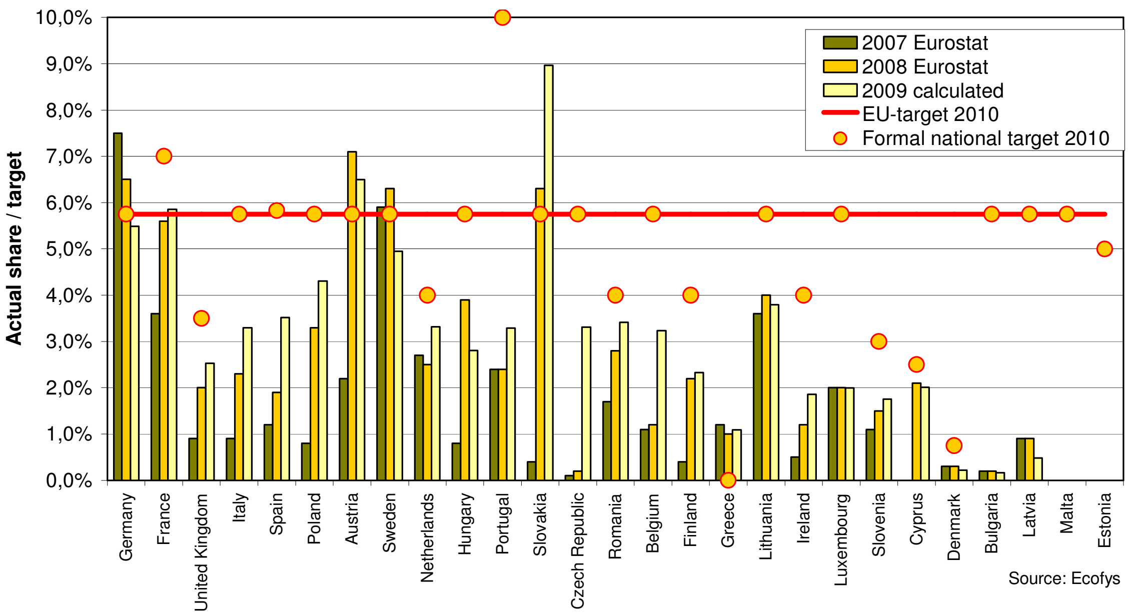

Figure 23. Share of biofuels according to Eurostat in total final energy consumption in transport in EU Member States [Eurostat tsdcc340]. The red line indicates the indicative EU target and the circles the national targets for 2010.

Different policy incentives have been installed in all EU Member States to stimulate the production and marketing of biofuels. In most countries (24 Member States), in 2008 tax breaks (full or partial exemptions of fuel excise duty) were in place to cover the gap between biofuel delivery costs and the fossil fuel price at the gas station. An increasing number of countries (20 Member States) also used macro obligations for fuel suppliers to provide a certain fraction of their fuels as biofuels[19]. Macro obligations are much less costly for governments and provide a better chance that targets are met. Countries that had installed tax incentives in combination with macro obligations appear to have achieved the highest shares of biofuels in their transport sector.

3.3 Biofuel policy framework and support in main third countries

In Section 2.5, it was shown that the following countries are a significant source of feedstock for EU consumed biofuels.

Table 18. Ultimate origin of feedstock for biodiesel and bioethanol consumed in the EU in 2008 (2% threshold) based on the country totals derived in Table 14 and Table 15.

Biodiesel		Bioethanol	
EU	58%	EU	76%
USA	10%	Brazil	16%
Indonesia	9%		
Malaysia	6%		
Brazil	5%		
Ukraine	4%		
Argentine	4%		
Canada	2%		

Third countries that provide biofuels or their feedstock for the EU market are not required to implement the requirements of the Renewable Energy Directive, however compliance with the biofuel sustainability requirements must be guaranteed by the EU Member States who count imported biofuels towards their national renewable energy targets, where such fuels are counted towards renewable energy obligations and where they receive financial support.

In the section below the policy framework in the main third countries is sketched, indicating what policy drivers are available and which incentives apply [for an overview see Lamers 2011; Ren21 2011].

Brazil

Brazil introduced a mandatory biodiesel quota of 2% in 2008, which was increased to 5% blending in 2010. There are several financial incentives present to stimulate the biodiesel market like purchase auctions, tax reductions/exemptions and shielding of producers by a 14% import tariff [Rosillo-Calle 2009].

[19] SEC 2011 (131) Review of European and national financing of renewable energy in accordance with Article 23(7) of Directive 2009/28/EC

USA

In the USA, the Renewable Fuel Standard (RFS) was established under the Energy Independence and Security Act of 2007 and requires consumption of 36 billion gallons of biofuels annually by 2022. The second version of this standard, the RFS2, came into effect in July 2010. Of the targeted 36 billion gallons of biofuels, RSF2 requires that 21 billion gallons must come from cellulosic biofuel or advanced biofuels derived from feedstocks other than cornstarch. Financial incentives for biofuels exist in the form of tax credits for both ethanol and biodiesel and through federal cash grants available for large scale production facilities for biofuels [REN21 2011].

Indonesia

Through the National Security Act in 2006, Indonesia adopted a national policy aimed at 10% biofuel consumption by 2010. Due to rising prices and a more export-focused orientation, the government has recently changed its biofuel mandate to 2.5% market share for biodiesel and a 3% market share for ethanol in the transport sector by 2010 [Dillon 2008].

Malaysia

The Government of Malaysia has a policy that restricts the amount of palm oil that can be used for biofuels. As palm oil is used for many other products, to assure that those industries (especially food) are not threatened, a maximum of six million tonnes of palm oil can be used for biodiesel annually [Schott 2009]. Although there is a high interest from the Malaysian government in the use of palm oil for biodiesel production, no blending requirements have yet been introduced. Support to biofuel producers is given in the form of low-interest loans and federal grants [Lopez 2008].

Argentina

Argentina has a biofuels mandate to stimulate the consumption of biofuels through a 5% blending target. However the production of biofuels in Argentina has an export-oriented focus, through tax exemptions and export taxex on agricultural products [Lamers, 2008].

3.4 Implementation of EU sustainability scheme in EU Member States

Member States have implemented the Renewable Energy Directive and its sustainability scheme by 5 December 2010. Currently, the EC is evaluating the transposition of the Directive in all the Member States.

Early adaptation of sustainability criteria for biofuels in the EU

The United Kingdom's Renewable Fuels Agency (RFA)'s Renewable Transport Fuel Obligation (RTFO) was the first biofuel-specific sustainability program within a country-wide policy framework scale. As part of this scheme, the volume of biofuel sold is monitored to track progress against mandated volumes. In addition, the GHG savings and sustainability characteristics of the biofuel are reported by obligated parties. The RTFO comprises seven sustainability principles; five environmental and two social. These seven principles have been used to define the RTFO sustainability meta-standard. A meta-standard approach (creating an overarching standard upon which others are benchmarked) enables the use of existing certification schemes to demonstrate compliance with the meta–standard. The following systems have been benchmarked against the RTFO standard:

- Bonsucro - Production Standard (July 2010)
- RTRS - Field Testing Version (November 2009)
- RSPO - October 2007 version (November 2009)
- Sustainable Agriculture Network/Rainforest Alliance (April 2009 and Addendum versions May 2009)
- ISCC – v1.16 (July 2010)
- RSB – Standard for EU market access (June 2010)

Despite the existing number of certification schemes, there are no certification schemes that fully cover the RFA criteria and this limits fuel suppliers' ability to source certified sustainable feedstocks [RFA 2011].

The German Biofuels Ordinance [BioNachV 2007] set the requirements for the sustainable production of biomass for use as biofuels (Biomass Sustainability Regulation). This regulation is to ensure conformity with minimum requirements for the sustainable cultivation of agricultural land and minimum requirements for natural habitat protection in producing biomass for biofuels. It also establishes that biofuels must have a *certain* potential to reduce GHG emissions during all phases of production, processing and delivery. For this purpose it is envisaged that the regulation will include a GHG accountability methodology. It also refers to environmental criteria (water, soil conservation, biodiversity, and ecosystem protection).The ordinance also provides certificates for demonstrate compliance. The German Ordinance refers to good agricultural practices and makes the Federal Ministry of Food, Agriculture and Consumer Protection responsible to enforce them. If biofuels are produced in Europe it refers to the Common Agricultural Policy Good Agricultural Practices [EC CAP 2011].

3.5 International voluntary sustainability schemes

With the growing interest in biomass and its by-products for biofuels and bioenergy, the potential sustainability costs and benefits have become more apparent and the need for sustainability reporting and control mechanisms has become increasingly evident.

For biofuels originating in third countries voluntary schemes may be used as a proof of compliance with the EU sustainability criteria. European Commission has so far recognised 7 voluntary schemes: International Sustainability and Carbon Certification (ISCC), Bonsucro EU, Round Table on Responsible Soy (RTRS EU RED), Roundtable of Sustainable Biofuels (RSB EU RED), Biomass Biofuels voluntary scheme (2BSvs), Abengoa RED Bioenergy Sustainability Assurance (RSBA), Greenergy Brazilian Bioethanol verification programme [20]. All the schemes except Greenergy in principle have a global scope. Nevertheless, the Bonsucro scheme has a strong focus on Brazil, RTRS has a strong focus on Argentina and Brazil and 2BSvs has a strong focus on France.

The standards included in this review are the key, publically available, voluntary sustainability agriculture and forestry standards relevant for biofuels that were either operational or under development during 2007-2009:

1 Bonsucro (formerly the Better Sugar Initiative)
2 The Forest Stewardship Council (FSC)
3 International Organization for Standardization (ISO)
4 International Sustainability & Carbon Certification (ISCC)
5 Programme for Endorsement of Forest Certification (PEFC)
6 Rainforest Alliance: Sustainable Agriculture Network (SAN/RA)
7 Round Table on Responsible Soy Association (RTRS)
8 Roundtable for Sustainable Palm Oil (RSPO)
9 Roundtable on Sustainable Biofuels (RSB)
10 Social Accountability International SA8000 Voluntary Standard

In the section below detailed descriptions of the abovementioned standards are provided. Table 19 summarises the scope of the reviewed standards and their stage of development.

Table 19. International standards and assessment systems discussed in this appendix.

	Operational	Early implementation	Under development
Forestry	FSC, PEFC		
Oil Palm	RSPO, ISCC	SAN/RA, RSB	
Soya	ISCC	SAN/RA, RSB, RTRS	
Sugarcane	SAN/RA, ISCC	Bonsucro, RSB	
Other	SA8000, SAN/RA, ISCC		ISO

<u>1) Bonsucro (formerly the Better Sugar Initiative)</u>
Developed as an attempt to reduce negative social and environmental impacts of sugar cane production, Bonsucro, formerly the Better Sugarcane Initiative), is a global, multi-stakeholder non-profit initiative founded in 2008. Bonsucro has developed a production standard that in line with ISO 65 and is intended to constitute an auditable document serving to measure impacts and promote sustainable practices. In July 2010, the final version of the standard was presented

[20] EC decision 19 July 2011. http://ec.europa.eu/energy/renewables/biofuels/sustainability_schemes_en.htm

after a multi-stakeholder consultative development process as outlined by the ISEAL Alliance [Bonsucro 2011].

To be Bonsucro certified, the members must adhere to the Bonsucro principles and their corresponding indicators. At least 80% of the indicators must be satisfied in addition to complying with a number of core criteria in order to become certified [Bonsucro 2011].

2) The Forest Stewardship Council (FSC)

The Forest Stewardship Council (FSC) is a stakeholder-owned system for promoting responsible forest management. The FSC Principles and Criteria (P&C) are applicable to all tropical, temperate, and boreal forests. Many of the P&C are also applicable to plantations and partially replanted forests. While the P&C are designed primarily for forests managed for the production of wood products, they may also be relevant to forests managed for non-timber products and other services.

The FSC accredits national and regional standards, but only where it can be shown that all relevant stakeholder groups have been consulted in the standard development and decision making process. FSC-accredited national and regional standards consult FSC members as well as a broad range of other stakeholders at a national or regional level. FSC addresses clearance, sustainable forestry management, and production of wood and fiber products. There are three FSC certificates: Chain of Custody, forest management, and controlled wood [FSC 2011].

3) International Organization for Standardization (ISO)

The International Organization for Standardization (ISO) was born out of the International Electro-technical Commission (IEC) in 1947. The ISO has International Standards relevant to nearly all private and public sectors that aim to make development, manufacturing, and supply of product and services more efficient, safe, and clean [ISO 2011]. ISO standards are voluntary and applied worldwide through 3000 ISO technical groups.

There are two main types of ISO standards, the ISO 9000 and ISO 14000. ISO 9000 is concerned with quality management, reviewing regulatory requirements and performance. ISO 14000 is concerned with environmental management, aiming to verify that an organization does not negatively impact the environment and to review organizations' environmental performance [Diaz-Chavez 2007].

An international effort is underway to develop an ISO standard for bioenergy. Though there currently is no ISO standard specifically for biofuels, there are some standards for agriculture and forestry that may be applicable. ISO has also launched a new standard for GHG accounting and verification, ISO 14064 [ISO 2011], to provide government and industry with an integrated set of tools for programmes aimed at reducing greenhouse gas emissions, as well as for emissions trading [Diaz-Chavez, 2007].

4) International Sustainability & Carbon Certification (ISCC)

The International Sustainability & Carbon Certification (ISCC) system is supported by the German Federal Ministry of Agriculture/Agency for Renewable Resources and Méo Corporate development. The system was developed in 2006 to respond to the German Sustainability Regulation (BionachV) and the EU directive on the promotion of Renewable Energy Sources. After pilots in 2008, the first certifications are expected in 2011 [ISCC 2010].

The objective of the system is to test an international, pragmatic certification system, with the lowest possible administrative burden, that reduces the risk of un-sustainable production and can be used as a proof of GHG emissions of biofuels on a life-cycle basis. The standard includes 10 principles, with corresponding criteria and indicators. Three of the 10 principles are social related, two are management related, and five are environment related [ISCC 2010].

5) Programme for Endorsement of Forest Certification (PEFC)

The Programme for the Endorsement of Forest Certification (PEFC) is an international non-profit, non-governmental organization dedicated to promoting Sustainable Forest Management through independent third-party certification [PEFC, 2010]. PEFC is a global umbrella organization for the assessment of, and mutual recognition of, national forest certification schemes developed in a multi-stakeholder process. These national schemes build upon the inter-governmental processes for the promotion of sustainable forest management. PEFC includes 34 national certification systems among its membership, which is also open to international stakeholders, such as civil society organizations, businesses, government entities and intergovernmental bodies [PEFC 2010].

PEFC requires that the national standards it covers are developed to meet PEFC International's Sustainability Benchmark. This "bottom-up" approach ensures that standards meet the expectations of stakeholders on the ground, address local conditions, and are consistent with national laws and regulations, while at the same time meeting international benchmarks and achieving international recognition [PEFC 2010].

6) Rainforest Alliance (RA): Sustainable Agriculture Network (SAN)

The Rainforest Alliance (RA) is an international environmental organization based in New York City. RA provides two secretariats for the Sustainable Agriculture Network (SAN): the Standards & Policy Secretariat coordinates the development of standards and related policies for SAN and the Certification Secretariat administers the certification systems for the Sustainable Agriculture Certification Network. The networks use the Rainforest Alliance certified™ seal, which has been granted since 1992.

All standards and criteria under the SAN were developed with active stakeholder involvement through a public consultation process. The Mission of SAN/RA is to improve environmental and social conditions in tropical agriculture through conservation certification. Crops certified are: soy, sugarcane, sunflower, palm oil, bananas, citrus, cocoa, coffee, flowers and ferns [SAN 2011].

The SAN standard consists of a list of general principles. Additionally, criteria for oil palm, sugar cane, soy, peanuts and sunflower farms exist. The standard has 10 principles which apply to all its certified crops [SAN 2011].

7) Round Table on Responsible Soy Association (RTRS)

The Round Table on Responsible Soy Association (RTRS) was initiated by WWF Switzerland and Coop Switzerland. ProForest developed initial criteria in 2004 known as the so-called "Basel Criteria for Responsible Soy". The RTRS is a global platform composed of the main soy value chain stakeholders with the common objective of promoting the responsible soy production through collaboration and dialogue among the involved sectors in order to foster economical, social, and environmental sustainability.

The General Assembly is the highest decision-making body of the RTRS Association. Decisions are made through the vote of Participating Members that are equally represented in the three constituencies, being: producers, civil society and industry, finance and trade. Each constituency has a voting power of one third of the total votes. The General Assembly delegates operational activities and most decision making to the Executive Board. The Executive Board is elected by the General Assembly and composed of the same three constituencies [RTRS 2011].

8) Roundtable on Sustainable Biofuels (RSB)

The Roundtable on Sustainable Biofuels (RSB) is an international, multi-stakeholder initiative that has brought together over 500 individuals from companies, NGOs, governments, and experts in nearly forty countries. The work of the different stakeholders resulted in a draft standard for sustainable biofuels production and processing. The reviewed scheme is called "Version Two" and is currently undergoing a field testing/trial phase. It is anticipated that the RSB will be ready to certify biofuels in 2011 [RSB 2010].

A new governance system consisting of 11 chambers, each representing a stakeholder group, was introduced in early 2009. These Chambers will each elect two members into a new Standards Board, which will make all of the decisions regarding the RSB strategy, any changes to the standards, and approve the various options for certification, with decisions made via consensus. The standard is based on a 'meta-standard' system, which considers existing certification and standards schemes to assure that most RSB principles are met.The standard includes 12 principles organised in criteria and indicators. From these principles, six are environmental and six are social and economic related.

9) Roundtable for Sustainable Palm Oil (RSPO)

The Roundtable for Sustainable Palm Oil (RSPO) is a global, multi-stakeholder initiative on sustainable palm oil. The principal objective of RSPO is to promote the growth and use of sustainable palm oil through cooperation within the supply chain and open dialogue between stakeholders.

RSPO unites stakeholders from seven sectors of the palm oil industry: oil palm producers, palm oil processors or traders, consumer goods manufacturers, retailers, banks and investors, environmental or nature conservation NGOs, and social or developmental NGOs. Multi-stakeholder representation is mirrored in the governance structure of RSPO such that seats in the Executive Board and project level Working Groups are fairly allocated to each sector.

The RSPO's principles were developed through multi-stakeholder consultation. The RSPO Technical Committee developed a framework for the development of criteria on sustainable palm oil. It has eight principles with respective criterion and indicators. The RSPO has already produced several pilot studies [RSPO 2010].

10) Social Accountability International (SAI) SA8000 Voluntary Standard

Social Accountability International (SAI) is a global, standard-setting, non-governmental, human rights organization [SAI 2011]. Its SA8000 voluntary standard was designed by a multi-stakeholder advisory board, including representation from companies, trade unions, NGOs, suppliers, government agencies, certification bodies, social investment firms, and human rights activists. This is a general system, specifically developed to safeguard good working conditions. SA8000 is an international voluntary standard for companies to audit and certify their labor practices. It is based on the principles of thirteen international human rights conventions, ten of which are conventions of the International Labour Organisation.

Addressing RES directive requirements

Table 20 indicates on a very general level which of the sustainability requirements of the Renewable Energy Directive [2009/28/EC] are addressed by the reviewed standards.

The sustainability issues addressed in the table reflect the issues included in the sustainability requirements of the RED; both the mandatory requirements (Article 17(2)-17(5)) and non-mandatory requirements (Article 18(4) 2nd sub-paragraph, 2nd sentence) are included. Whether the schemes are likely to meet the exact mandatory requirements or whether the schemes cover all conceivable aspects of the non-mandatory requirements mentioned in the RED is outside the scope of this report. Non-mandatory requirements in the Renewable Energy Directive are described with insufficient detail. It is not even possible to assess whether a scheme completely covers the non-mandatory requirements.

Evaluation of schemes proposed to be used for biofuel sustainability certification in relation to the Renewable Energy Directive is carried out by the EC and individual Member States.

Table 20. Overview of coverage of sustainability requirements of the Renewable Energy Directive [2009/28/EC] by key international sustainability certification standards (X = issue addressed by scheme).

Scheme	Development stage [1)]	Sustainability issues covered by scheme								
		Environmental							Social	
		GHG	Biodiversity	Carbon stock	Soil	Air	Water	Restoration degraded land	Land rights	Labour conditions
1. Bonsucro	Operational 2010	X	X	X	X	X [2)]	X	- [3)]	X	X
2. FSC	Operational	-	X	X	X	X	X	-	X	-
3. ISO	Under development [4)]									
4. ISCC	Launched 2010	X	X	X	X[5]	X[5]	X [5)]	-	X [5)]	X[5,6)]
5. PEFC			X	X	X	X	X		X	X
6. SAN / RA [6)]	Operational	-	X	-	X	X	X	-	X	X
7. RSPO	Reaching market 2008	- [7)]	X	X	X	X	X	-	X	X
8. RTRS	Version 1 published June 2010	X	X	X	X	X	X	-	X	X
9. RSB	Version 2 published 2011	X	X	X	X	X	X	-	X	X
10. SA8000	Operational	-	-	-	-	-	-	-	-	X

1) The classification of development stages in increasing order are: Launched: scheme has been launched but actual criteria to comply are not certain, Published: including more exact criteria & indicators, Operational: actual hectares are being certified (but not necessarily reaching market), and Reaching market: products are available including certification on market
2) Air quality requirements to not cover prevention of burning.
3) This standard notes a need to comply with the EU RED provision of Article 18(4) which relates to degraded land without addressing the means to do so.
4) As this standard is still under development, it is unknown what issues of the Renewable Energy Directive it may cover.
5) Exemption for EU feedstocks as assumed to be covered by Cross Compliance requirements.
6) Exemption for countries that have ratified certain ILO conventions.
7) GHG standard under development.

Coverage of international sustainability standards and initiatives in target countries

Table 21 lists the coverage of reviewed international sustainability certification standards in target countries, listing many members or certified entities in target countries. The standards certify different types of players in the biofuel chain, and some have members in addition to certified organizations or areas. The types of certified organizations/members may include:

- Producers
- Mills
- Plants
- Retailers
- Investors
- Traders
- Producers
- End-users
- NGOs
- Areas of forest or farmland
- Chains of custody for forestry or agriculture products
- First gathering points
- Refineries
- Traders
- Warehouses
- Other standards
- Crops

Table 21 contains all the certification standards included in this study that have members or certified areas in target countries. The ISO and RSB standard are not included in the table:

- The ISO standard is still under development, and as such has no coverage;
- Although, no area is certified under the RSB standard yet because it has very recently been completed, the data collection exercise indicated that biofuel producers in Bolivia are considering the RSB and it is mentioned in the Peruvian National Energy Plan 2010-2020. It is logical to expect other countries have biofuel stakeholders also preparing for its implementation. RSB's version 2.0 of the standard was released in January 2011 and pilot projects are underway.

Table 21. Coverage of international sustainability standards in target countries.

Country	Bonsucro[1)]	FSC[2)]	ISCC[3)]	PEFC[4)]
Central & South America				
Argentina		Certified forest: 229,210 hectares 18 certificates Chain of custody certificates: 50		
Bolivia	-Unión de Cañeros Guabirá	Certified forest: 883,459 hectares 12 certificates Chain of custody certificates: 28		
Brazil	-Bayer Crop Science -Cevasa -Cosan -Unica	Certified forest: 6,340,866 hectares 72 certificates Chain of custody certificates: 574	1 first gathering point certified	Brazilian Forest Certification Programme (CERFLOR)

Country	Bonsucro[1)]	FSC[2)]	ISCC[3)]	PEFC[4)]
Guatemala		Certified forest: 495,301 hectares 10 certificates Chain of custody certificates: 12	3 ethanol plants 2 first gathering points 2 sugar mills certified	
Peru		Certified forest: 503,498 hectares 7 certificates Chain of custody certificates: 24	1 ethanol plant 1 first gathering point certified	
Africa				
Ethiopia				
Malawi				
Mozambique		Certified forest: 46,240 hectares 1 certificate		
Nigeria				
Sudan				
Tanzania		Certified forest: 32,462 hectares 2 certificates Chain of custody certificates: 1		
Uganda		Certified forest: 92,107 hectares 2 certificates		
Asia				
India	-EID Parry	Certified forest: 676 hectares 1 certificate Chain of custody certificates: 119		
Indonesia		Certified forest: 850,569 hectares 9 certificates Chain of custody certificates: 155	2 farms/ plantations 6 first gathering points 6 oil mills 3 warehouses certified	
Malaysia		Certified forest: 203,840 hectares 5 certificates Chain of custody certificates: 125	2 biodiesel plants 4 first gathering points 4 oil mills 2 refineries 1 trader certified	Malaysian Timber Certification Council
Pakistan		Chain of custody certificates: 2		
United States				
United States	-Bacardi Limited -Cargill -Coca Cola Company -WWF	Certified forest: 13,689,849 hectares 113 certificates Chain of custody certificates: 3,742	3 ethanol plants 4 first gathering points 1 sugar mill 3 traders 2 warehouses certified	PEFC United States
Europe				

Country	Bonsucro[1)]	FSC[2)]	ISCC[3)]	PEFC[4)]
EU	-Belgium – AIM Progress -Denmark – Neltec Denmark -France – Ethical Sugar -Luxemburg – Ferrero -Netherlands – North Sea Group, Rabobank, Solidaridad, Suiker Unie -United Kingdom – BP, British Sugar, ED&F Man, Greenergy, Kraft Foods, Shell, Tate & Lyle	Certified forest: 22,902,571 hectares 318 certificates Chain of custody certificates: 8,727	42 biodiesel plants 1 ethanol plant 76 first gathering points 36 oil mills 3 other plants 38 refineries 6 sugar mills 44 traders 11 warehouses certified	-PEFC Belgium -PEFC Czech Republic -PEFC Denmark -Estonian Forest Certification Council -PEFC Finland -PEFC France -PEFC Germany -PEFC Italy -PEFC Luxembourg -PEFC Poland -Slovak Forest Certification Association -Institute for Forest Certification in Slovenia -PEFC Spain -PEFC Sweden -PEFC UK
Ukraine		Certified forest: 823,764 hectares 6 certificates Chain of custody certificates: 19	3 first gathering points certified	

1) Bonsucro certifies sugar producers at the sugar mill level (production standard) and buyers (chain of custody standard). The first certifications are expected in March 2011. Additionally, sugar retailers, investors, traders, producers, end-users, and NGOs can become members of Bonsucro by agreeing to the Bonsucro code of conduct. Bonsucro members in the target countries are listed here.
2) FSC certifies both areas of forest and chains of custody for forestry products. The FSC has certified almost 135 million acres of forest in 81 countries [FSC 2011b].
3) ISCC certifies the following: biodiesel plants, ethanol plants, first gathering points, oil mills, other plants, refineries, sugar mills, traders and warehouses.
4) PEFC endorses over 30 national standards benchmarked against its standard. Therefore, this table indicates what standards are endorsed in target countries.

Table 21 continued. Coverage of international sustainability standards in target countries.

Country	SAN/RA[5)]	RTRS[6)]	RSPO[7)]	SA8000[8)]
Central & South America				
Argentina	14 chain of custody certified farms	Has a National Technical Group comprised of AAPRESID (Producer Association), Los Grobo (Producer), Grupo Lucci (Producer), UBA University (Academic area), Fundación Vida Silvestre (NGO), Cargill (Industry), Asaga (Industry).		3 Facilities 5,710 employees

Country	SAN/RA[5]	RTRS[6]	RSPO[7]	SA8000[8]
Bolivia		Has a National Technical Group comprised of members from Producers, Trade, Industry and Finance and Civil Society groups, although the specific representatives of these groups are not identified on the RTRS website.		3 facilities 1,701 employees
Brazil	43 chain of custody certified farms 2 farms certified for sugar cane	Has a the National Technical Group comprised of ICV (Civil Society), APDC (Producer), Bayer CropScience (Industry), Monsanto (Industry), WWF (NGO), Business Social Development (BSD), Grupo André Maggi (Producer), IBGS (Civil Society).	5 members	93 facilities 82,068 employees
Guatemala	8 chain of custody certified farms		3 members	2 facilities 3,308 employees
Peru	3 chain of custody certified farms			4 facilities 1,231 employees
Africa				
Ethiopia				
Malawi				
Mozambique				
Nigeria				
Sudan				
Tanzania				1 facility 47 employees
Uganda				
Asia				
India		Has a National Technical Group comprised of India Soya Foundation (Industry), MPDPIP (Producer), Khajuraho Producers Company (Producer), Oxfam India (Civil Society), ASA (Civil Society), INDOCERT (Observer), Emeritus Scientist, Directorate of Soybean Research (Observer).	4 members	539 facilities 351,211 employees
Indonesia	1 chain of custody certified farm		77 members 13 certified growers, covering 24 mills	9 facilities 15,098 employees
Malaysia			89 members 10 certified growers, covering 53 mills	1 facility 474 employees
Pakistan				133 facilities 77,288 employees

Country	SAN/RA[5)]	RTRS[6)]	RSPO[7)]	SA8000[8)]
United States				
United States			26 members	
Europe				
EU-27			Members: Austria – 1 Belgium – 13 Cyprus – 2 Denmark – 3 Finland – 2 France – 29 Germany – 32 Greece – 1 Ireland – 2 Italy – 7 Latvia – 1 Luxembourg – 1 Netherlands – 37 Norway – 1 Spain – 7 Sweden – 12 Switzerland – 17 United Kingdom – 70	1034 facilities 344,177 employees
Ukraine				

5) Certifies farms for specific crops or for chain of custody. For chain of custody, whether biofuel feedstocks are produced is not indicated on the SAN/RA website, so total numbers of chain of custody certifications are shown here. For farms certified for specific crops, only those which may be used as biofuel feedstocks are shown here.

6) No area is currently certified by the RTRS because it is not yet implemented. However, the indicated countries have National Technical Groups developing national interpretations to adapt the RTRS standard to the reality of the country [RTRS 2011].

7) Certifies growers (24 growers and 89 palm oil mills) and supply chains (companies and facilities). Additionally, banks and investors, consumer goods manufacturers, environmental or nature conservation organizations, oil palm growers, palm oil processors and traders, retailers, and social or development organizations, and others can become RSPO members by agreeing to the RSPO code of conduct. Membership may signify intent to obtain certification. There are currently 566 members.

8) Certifies facilities in a number of industries as meeting its social standard, including transportation, energy, engineering and development, and agriculture, among others. How many facilities and the number of employees covered by those facilities for the target countries is shown.

Box 1. The potential of international certification standards to deliver sustainable biofuels

Three elements affecting the potential of international sustainability certification standards to deliver sustainable biofuels are introduced here.

Scope and scale of the standard
Most standards are focused on certifying a unit (e.g. a palm oil mill) and the suppliers of the unit. This site-scale or project scale approach to certifying a product as sustainable has limitations. For example, reducing water use in areas of water scarcity may be sufficient to become certified but may not be sufficient to deliver a sustainable outcome if net abstractions within the total watershed are greater than water availability. Without considering certain issues at a larger scale, potential negative impacts may be overlooked.

Practice versus Performance
The distinction between practice and performance based metrics used in standards is important to make in discussing monitoring methodologies. Practices are often identified by standards as indicators of positive outcomes because of the ease of verification. However, the outcomes of practices vary between sites. Furthermore, the cost effectiveness of the prescribed practice may vary from one location to another, or the collective impact of a suite of actions may have tradeoffs or no beneficial impact at all. Practices labelled as "sustainable" do not always result in sustainable outcomes. Hence, evaluating performance is a more meaningful monitoring technique for evaluating sustainability.

Given the relative infancy of most of the biofuel and feedstock standards, few monitoring programs have been established thus far, and most current voluntary standards that require monitoring are based on practice because practice is easier to verify than performance. Bonsucro is unusual among standards in that it defines performance metrics rather than 'Best Management Practices' (BMPs) to achieve compliance which can provide greater confidence that specific sustainability goals are being met [Bonsucro 2011b].

Producers as members
The implementation of approaches to deliver sustainable biofuels requires all parties within the supply chain to participate. Much of the development of certification standards has been demand driven and in order to implement what is believed necessary, the participation of growers / feedstock producers alone is required. Some standards however, are looking at the complete supply chain, as demonstrated by the number of chain of custody standards that are emerging.

The above presented information does not however, benchmark standards against the RED, nor evaluate the effectiveness of mechanisms.

Some of the standards are specific to forestry, oil palm, soy, or sugarcane, whereas others are more general to agriculture or industry. Some are targeted at participants in a single step of the supply chain, such as producers, mills, buyers, etc., and others certify entire supply chains. There is a noticeable lack of coverage by the selected standards in the African target countries, with the exception of the FSC which has membership in two of the seven. Central and South America and Asia were found to have the greatest coverage, primarily among companies that produce and process feedstocks. These are also the regions with the most biofuel and feedstock exports to the EU. The EU also had significant coverage, primarily among companies that process and trade biofuel. It ought to be noted that although the

United States had some coverage by the selected standards, and which has in the past exported much soy biodiesel to the EU, lacks participation in the RTRS and has no national sustainability certification scheme for soy.

The scope and scale of the certification standard, whether the standard uses practice or performance based metrics, the auditing rigor applied for certification, and which stage of the supply chain is certified all influence the potential for international sustainability certification standards to deliver sustainable biofuels.

3.6 National voluntary sustainability schemes

There is a wide range of national level voluntary certification standards: some certify a batch of feedstock or biofuel and others certify production chains or producers; Some apply broadly to biofuels or specific types of biofuels, and others apply to agriculture and forestry products in general; Some select a few criteria and others look at a more wide ranging set of criteria to describe sustainability overall. The following are the national level voluntary certification standards identified in the target countries.

Europe

The French certification 2BSvs from Bureau Veritas is a voluntary certification scheme with the main actors in the French biofuels industry, to comply with specific European regulations. Their Sustainability Certification provides global certification for the following schemes: carbon verification, social responsibility, sustainable agriculture and forestry, which are the core of sustainability requirements for biofuels and biomass [BV 2011].

Sekab, a European ethanol producer, developed a “Verified Sustainable Ethanol Initiative” with a series of criteria and indicators currently under verification [Sekab 2008] and on sale in Sweden. These criteria include:

- At least 85 % reduction in fossil carbon dioxide compared with petrol, from a well to-wheel perspective;
- At least 30 % mechanisation of the harvest now, plus a planned increase in the degree of mechanisation to 100 %;
- Zero tolerance for felling of rainforest;
- Zero tolerance to child labour;
- Rights and safety measures for all employees in accordance with UN guidelines ;
- Ecological consideration in accordance to UNICA’s environmental initiative;
- Continuous monitoring that the criteria are being met.

This is an example of a private company taking the initiative to develop its own standard.

According to the UK's Renewable Fuels Agency (RFA) [2008], Greenergy, was the first company to undertake private audits against the UK RTFO's (discussed later) standard for its Brazilian sugarcane ethanol supply. Greenergy developed a set of criteria which met the RTFO sustainability standard, addressing a wide range of social, environmental and community issues and according to the RFA [2008] it surpasses the RTFO social criteria. The environmental criteria includes: carbon, soil and biodiversity conservation, sustainable water use, and air quality. The social criteria includes: social performance (workers rights and working relationships) and communities (land rights and community relationships). In the United Kingdom, the following national standards are also in use:

- Assured Combinable Crops Scheme (ACCS): Part of the UK's broader Red Tractor assurance scheme and a wholly owned subsidiary of Assured Food Standards (AFS), the ACCS standard is part of an initiative with a wider reach than simply biofuel feedstocks. It is a standard adopted by some 78,000 British farmers and growers, only a small proportion of whom are currently involved in biofuel production and supply [ACCS, 2011]
- Genesis Quality Assurance (Genesis QA): A sister scheme to ACCS, Genesis has a number of British-based farm assurance standards covering both livestock and crops. The one of importance to the biofuels sector is its arable and sugar beet standard [Genesis QA, 2011]
- Linking Environment And Farming (LEAF): A UK-based scheme promoting environmentally-responsible farming. Standards are designed to be applicable anywhere in the world [LEAF, 2011].

Central and South America

In Argentina, the organization Aapresid developed a voluntary standard that certifies agriculture and livestock practices as sustainable in that country. Although not exclusive to biofuel feedstocks, it does certify soy production and Argentinian soy supplies a significant amount of feedstock for EU biofuels. This certification is overseen by SGS and independent audits, following the norms set by Aapresid to ensure compliance with the certification. Certified Agriculture follows six good agricultural practices:

- No soil disturbance/ presence of soil residue cover
- Crop rotation
- Integrated pest management
- Efficient and responsible agrochemical management
- Strategic crop nutrition
- Stockbreeding information management

Two entities had been certified at the time of this project's data collection activities – one of 206 hectares of agriculture and one of 18,190 hectares of agriculture and livestock production. Ninety-thousand hectares were anticipated to be certified by the end of 2010.

In Brazil, the State of São Paulo has a certification system related to fires during the crop season of the sugarcane [SMA 2007]. This program is called Green Fuel (from the Environmental Secretariat of São Paulo State) and certifies those plantations or ethanol plants that do not burn the sugar cane fields and produce sugar cane in a sustainable form. This is also done in collaboration with the National Union of Sugar Cane Producers (UNICA). In Brazil, work also began on a national standard. The National Institute for Measurement and Standards (INMETRO) established a program after the US and EU introduced their standards and is working with those governments to elaborate on a certification program that could be established in Brazil. Additionally, the Soya Plus standard is under development. INMETRO is currently following the initial work with the US to develop the biofuel standard for the International Standards Organisation (ISO).

United States

The US Council on Sustainable Biomass Production (CSBP), a multi-stakeholder organization established in 2007, is developing a comprehensive, voluntary sustainability standard for the production of biomass and its conversion to bioenergy. It aims to ensure that in the US, biomass feedstocks and bioenergy (fuel, electricity, and co-generated heat) are produced in a sustainable manner, balancing economic, environmental and social imperatives. This standard applies to biomass produced from non-food sources and represents feedstocks considered to be 'advanced' such as dedicated energy crops, crop residues and native vegetation. The draft standard was finalized in April 2010 and focuses entirely on the feedstock side of the full production cycle. The full standard that includes other steps in the supply chain will be developed by 2012 [CSBP 2010].

The Sustainable Biodiesel Alliance (SBA) is a non-profit organization in the US. The primary mission of the Sustainable Biodiesel Alliance is the completion of an independent sustainability certification system for US biodiesel feedstock, production, distribution, and end use. The focus is on community-based biodiesel systems to deliver energy, economic and environmental security.

The American National Standards Institute (ANSI)'s accredited Leonardo Academy is developing a "Sustainable Agriculture Practice Standard for Food, Fiber and Biofuel Producers and Agricultural Product Handlers and Processors" ("SCS-001")". The initiative aims to establish a comprehensive, continuous improvement framework and set of economic, environmental and social metrics to determine whether an agricultural crop has been produced and handled sustainably. The final principles, criteria and indicators have not yet been agreed. The draft standard has therefore not been submitted to ANSI for approval [Sustainable Food News 2010]. Consequently, there is no feedstock or biofuel that meets this standard.

Asia

Indonesia and Malaysia each are developing a National Interpretation of the RSPO standard. Additionally, Indonesia is developing its own Indonesian Sustainable Palm Oil (ISPO) certification.

Africa

No national certification schemes were identified in the African target countries. However, it was noted that other relevant certification schemes are used for other forestry and agriculture products and therefore may hold relevance for biofuels in the future. As an example, in Mozambique the Forest Stewardship Council, GlobalGAP, and Fairtrade standards all applied in other sectors.

3.7 Other mechanisms

There are several other legal and voluntary mechanisms analysed below which could be applied to ensure the sustainability in the production of biofuels. The elements included and described in this section are:

- National voluntary programs;
- Environmental Impact Assessments (EIA).

National Voluntary Programs Related to Biofuel Sustainability

The last category of legal and voluntary programs to address biofuel sustainability are those programs that are neither associated with certification schemes nor legislation. Some of the programs described here apply more broadly than to just biofuels, some take the form of plans, and some are general environmental or social programs. The list is not comprehensive, but a reflection of what the data collectors presented as relevant to biofuel sustainability in their countries.

Central and South America

In Central and South America, the programs identified in the data collection take the form of government plans.

In Bolivia, although not specifically addressing biofuels, the National Plan for the Progressive Eradication of Child Labor (Plan Nacional de Erradicación Progresiva del Trabajo Infantil - PNEPTI), for the period 2000 - 2010 is relevant. It has a 3-year sub-plan (2006-2008) to combat child labor and prioritized the elimination of the worst forms of child labor, the development of national policy against child labor, the participation of child and adolescent workers, and inter-institutional and inter-ministerial coordination. The sub-plan focused its efforts on children working in the mining, sugarcane, and urban sectors of the country. This is enforced by the Ministry of Labor. An independent evaluation conducted on the implementation of the first half of the National Plan found that financing had been lacking.

In Guatemala, the Responsibilidad Social Empresarial is a voluntary corporate social responsibility program, for sugarcane and ethanol producers that focus on support to government social policies, community support, employees' family support, employees' personal development, and labor law accomplishments. This is overseen by the sugar producers' association, ASAZGUA.

In Peru, there is the Strategic Plan for Sustainable Energy and Biofuels, which, among other aspects, will determine the economic and environmental impacts of the biofuel production chain and will plan for the development of biofuels and renewable energy, considering various sustainability themes. There are several other programs related to sustainability of biofuels (although not biofuel exclusive), especially focusing on biodiversity in the Amazon. These include: Biodiversity Project in the Peruvian Amazon, Economic-Ecological Zoning for Sustainable Development of the Region of San Martin, Conservation and Sustainable Use of Biodiversity in the Peruvian Amazon by the Ashaninka Indigenous Population, and an analysis project called Socio-Economic Impacts of Biofuels Production in the Peruvian Amazon.

Peru also has a regional clean air program by Swisscontact, CONAM (National Environmental Council), and Calandria; a Biodiversity Project in the Peruvian Amazon by the Peruvian Agency for Cooperation, CONAM, and the National Institute of Natural Resources; an Economic-Ecological Zoning for Sustainable Development, of the Region of San Martin under the responsibility of the Transitory Council of Regional Administration of San Martin, the Peruvian Institute of Amazon Research, the National University of San Martin, in the framework of the Regional Environmental Commission of San Martin; Conservation and Sustainable use of biodiversity in the Peruvian Amazon by the Asháninka indigenous population developed and implemented by the Peruvian NGO, Promotion and Training Team Amazon; and Socio-Economic Impacts of Biofuel Production in the Amazon, carried out by SNV.

United States

In the US, the Natural Resources Conservation Service's Environmental Quality Incentives Program (EQIP), is a voluntary program that provides technical assistance, cost-share payments, and incentive payments to crop, livestock, forestry, and other agricultural producers adopting practices that reduce environmental and resource problems, such as soil quality, soil erosion, water quality, water shortage, and air quality, and that protect wildlife, and animal and plant species of concern. The five EQIP national priorities are:

- Reductions of nonpoint source pollution, such as nutrients, sediment, pesticides, or excess salinity in impaired watersheds consistent with Total Daily Maximum Loads;
- Conservation of ground and surface water resources;

- Reduction of emissions, such as particulate matter, nitrogen oxides, volatile organic compounds, and ozone precursors and depleters that contribute to air quality impairment violations of National Ambient Air Quality Standards;
- Reduction in soil erosion and sedimentation from unacceptable levels on agricultural land and;
- Promotion of at-risk species habitat conservation.

The degree to which these objectives are met depend upon high levels of participation in 'at-risk' areas. At present participation is voluntary and consequently its potential to deliver optimal outcomes in such areas is limited.

Another program in the US is the Conservation Reserve Program, which provides technical and financial assistance to eligible farmers and ranchers to address soil, water, and related natural resource concerns on their lands and aim to do so in an environmentally beneficial and cost-effective manner. The US Department of Agriculture's Farm Service Agency administers the program. It encourages farmers to convert highly erodible cropland or other environmentally sensitive acreage to vegetative cover, such as tame or native grasses, wildlife plantings, trees, filterstrips, or riparian buffers. Farmers receive an annual rental payment for the term of the multi-year contract. Cost sharing is provided to establish the vegetative cover practices. NRCS provides technical land eligibility determinations, conservation planning and practice implementation.

Asia

In Indonesia, the World Resources Institute (WRI) and NewPage Corporation have developed a land swapping program called Palm Oil, Timber, and Carbon Offsets in Indonesia, or project POTICO. Project POTICO works to avoid direct conversion of forest lands by swapping degraded lands for virgin or primary forest areas, which are then sustainably managed. To conduct a swap, WRI partners with a private company that already has a forested land concession. The company gets a similar size piece of degraded land and sets up an RSPO certified plantation. The private company, supported by WRI, identifies lands on which palm can be grown sustainably, obtains free prior and informed consent of local entities, and engages relevant government officials [WRI n.d.].

Indonesia also has programs to promote organic fertilizers by subsidizing their production costs. In 2008, 68,400 tonnes of organic fertilizer were used in that economy. The 2010 budget allocates IDR 11.86 trillion (USD$1.3 billion) for fertilizer subsidy, which will yield a total of 11.75 million tonnes of bio and organic fertilizer [Soepardjo 2010].

A cooperative program in Indonesia is called Koperasi Kredit Primer Anggota (KKPA), or the Primary Credit Cooperative scheme. Landowners in the KKPA give one third of their land to the "nucleus estate." The remaining "satellite" areas become palm oil smallholdings under contract to sell fresh fruit bunches to buyers at a set price.

Under the KKPA, cooperatives can borrow up to IDR50 (USD$5,000) at a subsidized rate for small business development [Winrock 2009].

In Malaysia, public and private cooperative schemes, such as the Federal Land Development Authority (FELDA) and the National Land Finance Cooperative Society, establish cooperatives for crops, including palm oil, rubber, and coconut. Cooperative members in these schemes receive a share of the ownership and profits from the land. They also have access to loans for education, housing, medical care, and business development support [Lopez 2008].

Malaysia also has support for smallholders through the FELDA. FELDA gives cooperative land ownership rights to low income and landless settlers. Settlers receive a plot of land for housing and another for cultivation. After paying for the development costs of the land, the settler gains ownership and receives a guaranteed minimum income. In 2006, 30% of palm land area in Malaysia was under federal and state land development programs. FELDA represented the highest share of these holdings. FELDA also works to rehabilitate palm oil sites. This program is credited with reducing poverty among agriculture smallholders in Malaysia from 68% in 1970 to 21% in 1990, and among palm oil smallholders from 30% in 1970 to 8% in 1980 [Lopez 2008].

In Indonesia, the Program of Energy Self Sufficient Villages began to stimulate biofuel production on a small scale and make the rural poor less vulnerable to volatile fuel prices. The program aims to create 1,000 energy self-sufficient villages. In 2009, 123 villages were part of the program. Participating villages use local resources to produce the biofuels, which are then consumed locally. The program encourages women's participation in all phases of biofuel production [Ariati 2010].

Additionally, an agreement between Norway and Indonesia was established entitled "Cooperation on Reducing Greenhouse Gas Emissions from deforestation and Forest Degradation." This included a declaration of a two-year suspension on new land concessions that convert natural forests into palm oil plantation between 2011 and 2013. In October of 2010 the details of the mechanism banning palm expansion into forests should be finalized [Soepardjo 2010].

Africa

In Africa, the main programs identified in the data collection that pertain to biofuel sustainability, address sectors wider than biofuels alone. One exception is in Malawi where a social venture was established between Bio Energy Resources Limited (BERL, a Malawian company) and TNT, a Dutch company, to grow sustainable biofuels. Support is given to smallholders to grow Jatropha on underutilized lands. The fuels can then be used locally. TNT aims to obtain carbon credits for the project in the future [TNT 2010].

Mozambique also has other organizations working on moving sustainability initiatives forward that could have implications for biofuel sustainability. For example, the

Ministry of Coordination of Environmental Action oversees the National Council for Sustainable Development (CONDES), a consultative organ of the Council of Ministers for coordination and effective integration of environmental considerations in all development activities in the country. Besides providing views on policy matters, the organ is also charged with discussing incentives to stimulate the adherence of the economic agents to the principles and practices of sustainable management of natural resources and environment in the country. Additionally, there is FEMA, a private sector forum for environmental management. It has been playing a key role in assisting its membership to adhere to international environmental standards, to attain the appropriate certification of products, it has promoted the engagement of the private sector in corporate social responsibility and brought examples from other parts of the world to demonstrate how that pays (as profit it is the main driver of the investors). This forum is also part of the World Council for Sustainable Development.

Table 22 provides an overview of the various schemes introduced in this document and which country they apply to. It is not intended as a comprehensive overview of all sustainability reporting and control mechanisms, but rather the ones identified in this research and data collection.

Table 22. Summary sustainability reporting and control mechanisms discussed in this report.

Region	Country	Intern.Sustainability Certification Standards	National Level Voluntary Certification Standards	National Legislation o Biofuels	National Voluntary Programs Related to Biofuel Sustainability
Central and South America	Argentina	FSC, SAN/RA, RTRS, SA8000	Aapresid		
	Bolivia	Bonsucro, FSC, RTRS, SA8000			National Plan for Progressive Eradication of Child Labor
	Brazil	Bonsucro, FSC, ISCC, PEFC, SAN/RA, RTRS, RSPO, SA8000	Certification system related to fires, INMETRO, Soya Plus	Land Zoning, Vinnase and other sugar industry waste disposal legislation, phase out sugarcane burning, Legal Reserve Area, Permanent Preservation Areas, Brazilian Biodiesel Program	
	Guatemala	FSC, ISCC, SAN/RA, RSPO, SA800			Responsibilidad Social Empresarial
	Peru	FSC, ISCC, SANN/RA, SA8000			Strategic Plan for Sustainable Energy and Biofuels, Regional clean air program, Biodiversity Project in the Peruvian Amazon, Economic-Ecological Zoning for Sustainable Development, Conservation and Sustainable use of biodiversity in the Peruvian Amazon by the Asháninka indigenous population, Socio-Economic Impacts of Biofuel Production in the Amazon
Africa	Ethiopia				
	Malawi				Social venture BERL-TNT
	Mozambique	FSC			National Council for Sustainable Development, FEMA
	Nigeria				
	Sudan				
	Tanzania	FSC, SA800			
	Uganda	FSC			

Table 22 continued. Summary sustainability reporting and control mechanisms discussed in this report.

Region	Country	Intern.Sustainability Certification Standards	National Level Voluntary Certification Standards	National Legislation o Biofuels	National Voluntary Programs Related to Biofuel Sustainability
Asia	India	Bonsucro, FSC, RTRS, RSPO, SA8000			
	Indonesia	FSC, ISCC, SAN/RA, RSPO, SA8000	National Interpretation of the RSPO, Indonesian Sustainable Palm Oil	Limits to palm oil plantations on sensitive lands, Law on Conservation of Biodiversity and Ecosystems, Manpower Law, Child Protection Law	POTICO, promotion of organic fertilizers, Koperasi Kredit Primer Anggota (KKPA), cooperative schemes, cooperative land ownership, Program of Energy Self Sufficient Villages, Cooperation on Reducing Greenhouse Gas Emissions from deforestation and Forest Degradation
	Malaysia	FSC, ISCC, PEFC, RSPO, SA800	National Interpretation of the RSPO	Limits to palm oil plantations on sensitive lands, restrictions on quantities of palm oil used for biofuel, maintenance of permanent forest cover, bans burning to clear land.	
	Pakistan	FSC, SA8000			
United States	United States	Bonsucro, FSC, ISCC, PEFC, RSPO	CSBP, SBA, ANSI's Leonardo Academy	Renewable Fuel Standard, California's Low Carbon Fuel Standard	Environmental Quality Incentives Program, Conservation Reserve Program
Europe	EU-27	Bonsucro, FSC, ISCC, PEFC, RSPO, SA8000	2BSvs, Sekab, Greenergy, Assured Combinable Crops Scheme, Genesis Quality Assurance, Linking Environment and Farming	Renewable Transport Fuel Obligation, German Biofuels Ordinance	
	Ukraine	FSC, ISCC			

Environmental Impact Assessments[21]

Environmental impact Assessments (EIAs) can be an important tool to develop sustainable biofuel projects. EIAs are assessments of the possible positive or negative impact that a proposed project may have on the environment, together consisting of the natural, social and economic aspects. In many countries, EIAs are a compulsory requirement to develop new projects. They are usually commissioned by project developers, to support local or national governments in deciding over permits for the project. Even some banks require that an EIA has been carried out before taking an investment decision on a project. It is a valuable legal mechanism that can provide insight in how countries manage sustainability challenges relevant for EU biofuels or their feedstock. A close analysis can also indicate how far governments tend to develop policies in response to foreign sustainability concerns.

Note that EIAs are not accepted as proof of sustainability under the Renewable Energy Directive, but they could be a good tool to improve biofuel project practices.

In order to evaluate how sustainability in biofuel projects is dealt with, the coverage of 30 features, defined as relevant for the RED, was determined in 19 EIA reports for bioenergy projects. 12 features were sufficiently similarly considered in the EIA reports for the coverage to be determined with an adequate accuracy. These features are presented in Table 23.

Notable differences between EIA reports for different types of projects were found. EIA reports for projects including both plantation establishment and the construction of a biofuel plant had better coverage than EIA reports for projects including either the plantations or the biofuel plant. As might be expected, EIAs for "plantation projects" generally leave out features related to biofuel processing, and EIAs for "biofuel plant" projects generally leave out features related to feedstock production.

Supporting much of our findings, [Gallardo and Bond 2010] assessed 32 EIA reports for sugarcane projects in Brazil and concluded that "water and soil pollution" and "air emissions" were universally considered in EIAs, and "soil erosion" and "jobs" were extensively covered, but "energy balance and GHG" and "food security" were less considered.

Table 23. Coverage of RED features in EIAs found in our study.

High coverage	Low coverage
Impacts on societal development	Impacts on food production
General impacts on biodiversity/species diversity	Impacts on food security
Air quality	Introduction of invasive species
Water quality	GHG emissions from extracting/cultivating raw materials
Soil quality	GHG emissions from transport and distribution
Erosion	Conversion of grass, scrub and woodlands

[21] For additional information see Appendix H

Table 24 shows the probability that EIA reports (for the three project types) are sufficiently comprehensive to provide information of acceptable quality for a RED sustainability assessment. As can be seen, in several instances there was too large variation in coverage among the 19 EIA reports to determine probability.

Table 24. Probability that EIA reports are sufficiently comprehensive to provide information for an assessment where the level of compliance with each of the RED sustainability criteria should be determined, for the three project types

RED sustainability criteria	Estimated probability		
	Plantation	Biofuel plant	Plantations and biofuel plant
Clearing of natural forests (Article 17:3a)	High	Low	High
Impacts on areas designated for nature protection purposes (Article 17:3bi)	1)	Low	1)
Impacts on rare, threatened and endangered species (Article 17:3bii)	1)	High	1)
Conversion of grasslands (Article 17:3c)	1)	1)	1)
Drainage of peatland (Article 17:5)	1)	Low	1)
Conversion of wetlands (Article 17:4a)	1)	Low	1)
Conversion of forested areas (Article 17:4bc)	1)	Low	High

1) Too large variation in coverage between EIA reports to determine probability

For "plantation" projects, EIA reports are likely to be sufficiently comprehensive to provide information about *clearing of natural forests*.

For "biofuel plant" projects, EIA reports are likely to be sufficiently comprehensive to provide information about *impacts on rare, threatened and endangered species*. On the other hand, they are unlikely to provide sufficient information about *clearing of natural forests*, *impacts on areas designated for nature protection purposes*, *conversion of wetlands*, *conversion of forested areas* and *drainage of peatlands*.

For "plantation and biofuel plant" projects, EIA reports are likely to be sufficiently comprehensive to provide information about *clearing of natural forests* and *conversion of forested areas*.

Several countries relevant for EU biofuels seem to have insufficient EIA requirements, most notably Indonesia and Malaysia, see Table 25. Also the enforcement potential in these countries is not optimal.

Table 25. Requirements by law that EIAs need to be conducted for biofuel projects and estimated enforcement potential, for each target country.

Region	Country	EIA required for biofuel projects	Enforcement potential
America	Argentina	Yes	Intermediate
	Bolivia	1)	Low
	Brazil	Yes	Intermediate
	Canada	1)	High
	Guatemala	1)	Low
	Peru	1)	Intermediate
	USA	Yes	High
Asia and Europe	India	No	Intermediate
	Indonesia	1)	Intermediate
	Malaysia	Unclear	Intermediate
	Pakistan	Yes	Low
	Russia	1)	Low
	Ukraine	1)	Low
Africa	Ethiopia	Yes	Low
	Malawi	Yes	Intermediate
	Mozambique	Unclear	Low
	Nigeria	No	Low
	South Africa	1)	Intermediate
	Sudan	1)	Low
	Tanzania	Yes	Low
	Uganda	1)	Low

1) Not enough information has been found to determine whether or not EIAs are required for biofuel projects by law

It becomes clear that even though EIA legislation exists, it is insufficient from a biofuels perspective. However, since the concept of 'EIA' seems to be familiar to the decision-makers it might make an improvement of EIA legislation easier to realize.

Sufficient EIA legislation is, however, not the sole key to EIA success. Even though the legislation itself might be impeccable, it is of little use unless it is sufficiently enforced. The enforcement capacity for selected countries was analysed in the previous section.

3.8 Further legislative readiness of third countries for EU sustainability criteria [22]

To understand how the environmental legislation in third countries connects to EU sustainability criteria and concerns addressed in the Renewable Energy Directive, a total of 1185 environmental laws from the Ecolex database (FAO et al. 2011) have been individually assessed (see Table 28).

The assessment (for more details see Appendix G) was done by evaluating the relevance of each law to the relevant RED criteria and topics. All the countries listed in Table 18 except for the US, Canada and Ukraine were covered by this analysis.

Each country's potential to enforce legislation was assessed by combining the results of four recognised global indexes, *Corruption Perception Index* (Transparency International 2010), *Global Integrity Index* (Global Integrity 2009), *Democracy Index* (The Economist Intelligence Unit 2010) and *Rule of Law Index* (Agrast et al. 2010). In addition, it was assessed to which extent countries specify institutions responsible for enforcement in-text in their biofuel related legislation.

Table 26 shows the regional levels of consideration for the RED criteria in three regions: America, Africa and Asia. For the assessed countries' legislation, it can be concluded that:

- *Impacts on areas designated for nature protection purposes* seems to be universally well considered (+++) in the assessed American countries, generally well considered (++) in the assessed African countries and relatively well considered (+) in the assessed Asian countries.
- *Clearing of forests* seems to be *universally well considered* (+++) in the assessed American countries. *relatively well considered* (+) in the assessed Asian countries and *relatively considered* ( ) in the assessed African countries.
- Impacts on rare, threatened and endangered species seems to be relatively considered ( ) in the assessed American and African countries and universally poorly considered (---) in the assessed Asian countries.
- Conversion of wetlands seems to be generally poorly considered (--) in the assessed African countries and universally poorly considered (---) in the assessed Asian and American countries.
- *Drainage of peatlands and Conversion of grasslands* seem to be *universally poorly considered* (---) in legislation in all assessed countries.

[22] See Appendix G for detailed information on this topic

Table 26. Consideration of RED sustainability criteria in biofuel related legislation: global overview.

	Impacts on protected areas	Clearing of forests	Impacts on threatened species	Conversion of wetlands	Conversion of grasslands	Drainage of peatlands
Asia	+	+	- - -	- - -	- - -	- - -
America	+ + +	+ + +		- - -	- - -	- - -
Africa	+ +			- -	- - -	- - -

+++ Universally well, ++ Generally well, + Relatively well, - Relatively poor, -- Generally poor, --- Universally poor

In summary, the general legislative readiness in assessed countries for producing biofuels complying with the RED criteria seems to be good, what regards *Impacts on areas designated for nature protection purposes* and *Clearing of forests*, provided that legislation is sufficiently enforced.

However, the general legislative readiness for producing biofuels complying with the RED criteria seems to be poor, what regards *Conversion of grasslands, Drainage of peatlands* and *Conversion of wetlands*.

Table 27 shows the regional levels of consideration for the RED topics in the three regions. For the assessed countries' legislation, it can be concluded that:

- *Social sustainability* seems to be universally well considered (+++) in all assessed countries.
- *Land-use* seems to be universally well considered (+++) in the assessed American countries, generally well considered (++) in the assessed Asian countries and relatively well considered (+) in the assessed African countries.
- *Water* seems to be universally well considered (+++) in the assessed American countries, generally well considered (++) in the assessed African countries and relatively well considered (+) in the assessed Asian countries.
- *Biodiversity* seems to be generally well considered (++) in the assessed American countries and relatively considered ( ) in the assessed Asian and African countries.
- *Soil* seems to be relatively well considered (+) in the assessed American countries and relatively considered ( ) in the assessed Asian and African countries.
- *Ecosystem services* seems to be relatively considered ( ) in the assessed American countries, and relatively poorly considered (-) in the assessed Asian and African countries.
- *Carbon stock* seems to be *relatively poorly considered* (-) in all the assessed countries.
- *Air* seems to be *relatively poorly considered* (-) in the assessed American countries and *universally poorly considered* (---) in the assessed Asian and African countries.
- Greenhouse gas emissions seem to be universally poorly considered (---) in all the assessed countries.

Table 27. Consideration of RED topics in biofuel related legislation: global overview

	Social Sustainability	Land-use	Water	Bio-diversity	Soil	Eco-system services	Carbon stock	Air	GHG emissions
Asia	+ + +	+ +	+			-	-	- - -	- - -
America	+ + +	+ + +	+ + +	+ +	+		-	-	- - -
Africa	+ + +	+	+ +			-	-	- - -	- - -

In summary, if additional mandatory requirements related to *Social sustainability*, *Land-use* or *Water* were to be introduced, the results indicate that these are likely to be well considered in national legislation.

If additional mandatory requirements related to *GHG emissions*, *Air* or *Carbon stock* were to be introduced, the results indicate that these are likely to be poorly considered in national legislation.

Enforcement

Unless legislation is sufficiently enforced, the legislative readiness, as previously determined, is of little value. The results, as summarised in Table 28 below, show that seven of the assessed countries were classified as having a low potential to enforce legislation, six countries were classified as having an intermediate potential while no countries were classified as having a high potential to enforce legislation. In addition, most countries do not specify institutions responsible for enforcement in-text in their biofuel related legislation. It is unknown if such responsibilities are specified in other ways in the different countries, but if the responsibilities are not sufficiently clear; it is likely to negatively affect the level of enforcement.

Table 28. Estimated enforcement potential for each of the countries assessed based on Table 72 in Appendix G.

Low	Intermediate
Pakistan	Indonesia
Guatemala	Malaysia
Tanzania	India
Mozambique	Brazil
Uganda	Argentina
Ethiopia	Malawi
Nigeria	

Implications

The results indicate that effectiveness of the legislatation in areas relevant to the EU sustainability criteria cannot be determined other than on a theoretical level, since challenges related to enforcement seem to be consistent among the assessed exporting countries. It is therefore essential that the EU supports the development, or consolidation, of third-party institutions, either national or international, which can monitor developments of biofuel projects and verify that biofuels aimed for the EU market are produced in compliance with the EU biofuel sustainability criteria.

Biofuel sustainability legislation

Regulations and policies guide and provide incentives and boundaries for programs and practices, thereby influencing sustainable biofuel activities. Policies can promote and create incentives for more sustainable biofuels, whereas regulations set the constraints and parameters to ensure that biofuel programs and practices are sustainable. In most of the target countries, there is legislation pertaining to land use, soil, water, air, biodiversity, and social impacts of activities in each country that can then apply to biofuels. In a few cases, there are legal programs that specifically address biofuels' impacts on these factors. Examples are provided here for some key biofuel producing countries of legislation directly related to biofuel sustainability. It can be seen through these examples that compliance with certain sustainability criteria could be safeguarded by well enforced legislation.

United States

The primary legal program in the US with regards to biofuel sustainability is the Renewable Fuel Standard (RFS). It addresses GHG emissions comprehensively, including the contribution from indirect land use change (iLUC) by including an iLUC factor. The RFS applies to those biofuels, expected to be almost 100% of the quantities consumed within the US regardless of country of origin that fuel suppliers seek to have counted as contributing to the annually increasing target for biofuel use. The RFS was established under the Energy Independence and Security Act of 2007 and requires consumption of 36 billion gallons of biofuels annually by 2022. The second version of this standard, the RFS2, came into effect in July 2010. Of the targeted 36 billion gallons of biofuels, RSF2 requires that 21 billion gallons must come from cellulosic biofuel or advanced biofuels derived from feedstocks other than cornstarch. For the purposes of RFS2, the term "advanced biofuels" does not relate to the feedstock to biofuel conversion process but is determined by the provision that, to be "advanced" a biofuel must meet a 50%-60% GHG reduction target compared to its fossil equivalent. Conventional biofuels, the consumption of which is capped at 15 billion gallons per year, must meet a minimum GHG savings of 20%. All land based biofuel, conventional or advanced, must come from land that was cultivated or fallow as of December 2007.Biofuel refineries must be registered with the US Environmental Protection Agency, and biofuel manufacturers or importers must generate a renewable identification number (RIN) for each gallon of renewable fuel and pass the documentation along the supply chain.

As part of the monitoring scheme of this legislation, the US Environmental Protection Agency, Department of Agriculture and Department of Energy are required to report to the US Congress on the domestic environmental and social impacts of biofuels but not on impacts in overseas countries from which biofuels consumed in the US may originate.

In addition to actions taken at the federal level, the California Air Resource Board of the State of California has issued rules on levels of GHG emissions from biofuels consumed in California. The Low Carbon Fuel Standard (LCFS) calls for at least a 10% reduction in the carbon intensity of California's transportation fuels by 2020 [Farrel and Sperling, 2007a,b]. The Secretary of the California Environmental Protection Agency has been instructed to coordinate activities between the University of California, the California Energy Commission and other state agencies to develop and propose a draft compliance schedule to meet the 2020 Target. Note that this scheme includes ILUC impacts.

Central and South America

Because of Brazil's long history with biofuels, it has more biofuel-specific legislation than other countries. Within Brazil, there is more activity at the state level rather than the national level, such as zoning laws for agricultural activities. Some of Brazil's key biofuel sustainability – relevant legal programs are:

Land use zoning for crops that are biofuel feedstocks has taken place in some states. Pará State zoned about 5 million hectares for oil palm plantations. São Paulo state has proposed legislation to zone sugarcane based on environmental, economic, and social criteria. Additionally, the Ministry of Agriculture conducted sugarcane environmental and economic zoning. The enforcing institutions for these activities include the Ministry of Agriculture, EMBRAPA, Ministry of the Environment, IBAMA, and Federal Police when law enforcement is required.

Vinasse and other sugar industry waste disposal legislation in Brazil dates back to 1978. Ordinance no. 323 (1978) prohibits the release of vinasse in surface fountainheads. CONAMA (National Environment Council) Resolutions no. 0002 (1984) and 0001 (1986) requires studies and determination of rules on the control of effluents from ethanol distilleries, and subsequently renders the EIA and RIMA mandatory for new units or extensions, respectively. Law no. 6,134 (1988), article 5th, of São Paulo State provides that waste from industrial and other activities shall not contaminate underground waters.

The São Paulo State Secretary of Environment and the industry sector also developed a technical standard in order to regulate the application of vinasse in São Paulo. The protocol seeks a safe way to apply the vinasse by specifying permitted places, doses, environmental protection and storage, etc.

The enforcing institutions for these legislations include State and Municipality Level Environmental and other Governmental agencies.

Law 11,241 in the state of Sao Paulo aimed to phase out sugarcane burning in order to reduce air pollution by mechanizing cane harvest. This is enforced by the Secretary of the Environment, State of São Paulo.

The Brazilian legislation (in particular the Brazilian Forest Code, Law 4771, 1965, and the Law 7803, 1989) states that farms must preserve a Legal Reserve Area - an area located within a rural property or possession, except for the permanent preservation, required for the sustainable use of natural resources, the conservation and rehabilitation of ecological processes, biodiversity conservation and shelter and protection of the native fauna and flora - with at least 20% of the total area, depending on the region (in Amazon this increases to 80%), and are kept with the original vegetation as Permanent Preservation Areas - areas on the tops of hills, slopes and banks of water bodies. This is enforced by the Federal Government and State Level Environmental Agencies

The Brazilian Biodiesel Program was launched in 2004 to foster social inclusion. All biodiesel processing plants are required by this program to buy at least 30% of their feedstock from small farmers if they want to receive the incentives. This is enforced by the Brazilian National Petroleum Agency.

Asia

Legislatively based programs in the Asia target countries regarding biofuel environmental and social impacts were primarily identified in Malaysia, specifically to address deforestation and conversion of high carbon stock lands, land burning practices, and competition with food, although it is known that relevant laws exist in the other countries as well.

Indonesia and Malaysia both have regulations limiting palm oil plantings on sensitive lands. In Indonesia, the regulation prescribed that oil palm can only be planted on peatlands if: it is on community cultivated land, the peatland is less than three meters deep, the subsoil is not silica sand or acid sulfate, and the maturity of the soil is somewhat or mostly decomposed [Winrock 2009].

The Government of Malaysia has a policy that restricts the amount of palm oil that can be used for biofuels. As palm oil is used for many other products, to assure that those industries (especially food) are not threatened, a maximum of six million tonnes of palm oil can be used for biodiesel annually [Schott 2009].

To protect forest lands, which have been converted to palm oil plantations in the past, Malaysia made a commitment to maintain 55.6% permanent forests for wildlife habitat and biodiversity conservation. As one way of monitoring this, the Malaysian Palm Oil Wildlife Conservation Fund patrols the jungles surrounding palm oil plantations, improves riparian zones and has orangutan protection activities. To ensure that indigenous populations are not forced off their land, there is a law to protect them from palm oil expansion by law [Wahid 2010].

Lastly, to address the highly polluting technique of burning to clear land vegetation in order to establish palm oil plantations, the government of Malaysia banned this practice in 1997. There is high compliance with this regulation because of a combination of strict law enforcement and high penalties [Lopez 2008].

Africa

There are few legislatively based programs aimed specifically at biofuel sustainability issues in the Africa target countries, as there is limited biofuel activity in that region. Nonetheless, several of the target countries have laws that, directly or indirectly, address how biofuels impact the environment and society. For example, in Tanzania, there is a Biofuels Task Force, a water policy (2002), Environmental Policy (1997), an Agriculture and Livestock Policy (1997), a Livestock Policy (2006), an Environmental Management Act (2004), a National Environmental Impact Assessment Audit Regulation (2005), a Water Management (control & Use) Act, a Food Security Act (2001), a Employment and Labour Relations Act (2004), a Local Government (urban & District Authorities) Act (1982), a Food Control Quality Act (1978), and an Occupational Health & Safety Authority Act (2001).

3.9 International agreements

In the RES Directive international bilateral agreements are mentioned as another option to ensure compliance with the EU sustainability criteria. However between 2008 and 2011 no international bilateral agreement has been concluded or is in negotiation. Therefore no additional information is provided here.

3.10 Other international initiatives related to biofuels sustainability

Other International Initiatives Related to Biofuel Sustainability:
In addition to the above certification standards which intend to certify biofuels or feedstock with specific sustainability characteristics, the following international initiatives exist which can act as tools for guiding sustainable biofuels.

1. The Global Bioenergy Energy Partnership Task Force on Sustainability (GBEP);
2. High Conservation Value (HCV) Toolkit;
3. Inter-American Development Bank IDB Sustainable Energy and Climate Initiative (SECCI) and Biofuels Sustainability Scorecard;
4. International Labour Organisation (ILO);
5. The International Petroleum Industry Environmental Conservation Association (IPIECA), Chain of Custody (CfC) (not yet developed);
6. The International Social and Environmental Accreditation and Labelling Alliance (ISEAL).

Some of the initiatives are used guide the development of international certification standards: GBEP's Task Force on Sustainability is developing a set of relevant, practical, science-based, voluntary criteria and indicators and developing examples of sustainable bioenergy best practices [GBEP 2011]; ISEAL develops guidance and helps strengthen the effectiveness and impacts of environmental and social standards through its Codes of Best Practice [ISEAL 2011]; and IPIECA is planning to do work that will be able to inform chain of custody decisions and understanding [IPIECA 2008]. The HCV toolkit can be used to identify areas of land with high conservation values, such as biodiversity, carbon stock, etc., and develop strategies to protect or enhance those qualities. It could be included as a tool in certification standards, and is a part of the RSPO. Alternatively, the SECCI scorecard is a tool that can be used to assess biofuel sustainability in making decisions about going ahead with projects or funding. It addresses similar aspects of sustainability as many of the certification standards address, but does not set criteria that must be met. Lastly, the ILO has labor standards and conventions (several of which are mentioned in the RED) which indicate good practices with regard to labor practices.

1) The Global Bioenergy Energy Partnership Task Force on Sustainability (GBEP)

The Global Bioenergy Partnership Task Force on Sustainability (GBEP), established under the leadership of the United Kingdom, is developing a set of global, science-based criteria and indicators with examples of experiences and best practices including benchmarks regarding the sustainability of bioenergy [GBEP 2011]. These criteria are categorized in four themes: Environmental, Economic, Social, and Energy Security.

GBEP has developed criteria and indicators that are intended to guide any analysis undertaken of bioenergy at the domestic level with a view to informing decision making and facilitating the sustainable development of bioenergy in a manner consistent with multilateral trade obligations. The GBEP Task Force released a report in June 2009 of a common methodological framework for use by policy makers and stakeholders in assessing GHG impacts of bioenergy; the framework is intended to allow the results of GHG lifecycle assessments to be compared on an equivalent and consistent basis [Dam 2010].

2) High Conservation Value (HCV) Toolkit

The High Conservation Value (HCV) Toolkit [HCV Network 2005] should be mentioned as it is both an element of the RSPO and is used independently from the RSPO (such as in companies' Corporate Social Responsibility activities, as is the case for Wilmar International, a palm oil company in Malaysia and Indonesia). The HCV Toolkit is used to identify and protect land areas with high environmental or socioeconomic values. The concept for the HCV Toolkit emerged from the Forest Stewardship Council's well-managed forest standard in 1999.

Six high conservation values are considered in the HCV toolkit assessment. An HCV area contains one or more of these values and must be managed to protect and enhance them. The six values are as follows:

- HCV1: Areas containing globally or regionally significant concentrations of biodiversity values.
- HCV2: Large landscape-level areas of global, regional, or economy-wide significance, where viable populations of most, if not all, naturally occurring species exist in natural patterns of distribution and abundance.
- HCV3: Areas that are in, or contain, rare, threatened, or endangered ecosystems.
- HCV4: Areas that provide basic ecosystem services in critical situations.
- HCV5: Areas fundamental to meeting basic needs of local communities.
- HCV6: Areas critical to local communities' traditional cultural identity.

3) Inter-American Development Bank IDB Sustainable Energy and Climate Initiative (SECCI) and Biofuels Sustainability Scorecard

The Sustainable Energy and Climate Change Initiative (SECCI) and the Structured and Corporate Finance Department of the Inter-American Development Bank have created a Biofuels Sustainability Scorecard based on the RSB's sustainability criteria. The Scorecard has been designed specifically for the private sector at the project level, but could be used more broadly as a tool in situations where sustainability criteria need to be considered in biofuels development.

The Inter-American Development Bank Board approved SECCI in March 2007 in response to the request from Latin American Countries for an expanded role of sustainable energy and climate change activities in Latin America. The biofuel objectives from SECCI are as follows [IADB 2011]:

- Assess the economic viability of biofuels and bioenergy development;
- Provide sustainability assessment to mitigate potential adverse social and environmental impacts;
- Assist Latin America and the Caribbean in becoming a leader in "climate friendly" biofuels production by increasing research and expertise in second generation biofuels;
- Provide country-level policy assistance in support of biofuel development;
- Finance sustainable biofuel and bioenergy programs, including feedstock development, production facilities, and related infrastructure.

4) International Labour Organisation (ILO)

The International Labour Organisation (ILO) sets standards regarding labour conditions and has several conventions related to bioenergy crops, some of which are considered in the RED. The ILO is the only 'tripartite' United Nations agency that brings together government representatives, employers and workers to jointly shape policies and programmes promoting Decent Work for all [ILO 2011].

The conventions shown in Table 29 are those ILO conventions relevant to biofuels. The eight considered in the RED are shown in bold.

Table 29. ILO conventions relevant to biofuels.

ILO Convention	Concerns
ILO Convention 29	Forced Labor 1930
ILO Convention 87	Freedom of Association and Right to Organize 1948
ILO Convention 98	Right to Organize & Collective Bargaining 1949
ILO Convention 100	Equal Remuneration 1951
ILO Convention 105	Abolition of Forced Labor 1957
ILO Convention 111	Convention concerning Discrimination in Respect of Employment and Occupation
ILO Convention 129	Labor Inspection Agriculture 1969
ILO Convention 138	Minimum Age 1973
ILO Convention 182	Worst Forms of Child Labor 1999
Other conventions	
C110, 1958	Plantations Convention[23] - There is a P110 (protocol)
C141, 1975	Rural Workers' Organisations Convention[24]

5) The International Petroleum Industry Environmental Conservation Association (IPIECA), Chain of Custody (CfC).

The International Petroleum Industry Environmental Conservation Association (IPIECA) is a global association representing upstream and downstream components of the oil and gas industry on key global environmental and social issues. Activities of IPIECA demonstrate that oil and gas companies have an increasing role in the development of biofuel sustainability and accreditation issues. Biofuels are viewed as a potential extension of these companies' sustainable development and corporate social responsibility strategies.

In 2008, IPIECA held a seminar in London on Biofuel Sustainability and Chain of Custody where it was announced that they were planning to commission a Chain of Custody (CfC) document in 2009 to delineate best practices for biofuels blends supply chain [IPIECA 2008].

6) The International Social and Environmental Accreditation and Labelling Alliance (ISEAL)

The International Social and Environmental Accreditation and Labelling Alliance (ISEAL) is an association of international organisations engaged in standard-setting, certification and accreditation focused on social and environmental issues [ISEAL 2011]. ISEAL has a code of good practice that provides a benchmark to assist standard setting organisations to develop their social and environmental standards. The normative documents that ISEAL used to draw its Code are the ISO/IEC Guide 59 Code of Good Practice for standardization, the ISO/IEC 14024 (environmental standards) and also the World Trade Organisation (WTO) Technical Barriers to Trade Agreement, among others [ISEAL 2011]. Although ISEAL does not provide direct

[23] For the purpose of this Convention, the term ***plantation*** includes any agricultural undertaking regularly employing hired workers which is situated in the tropical or subtropical regions and which is mainly concerned with the cultivation or production for commercial purposes of coffee, tea, sugar-cane, rubber, bananas, cocoa, coconuts, groundnuts, cotton, tobacco, fibres (sisal, jute and hemp), citrus, palm oil, cinchona or pineapple; it does not include family or small-scale holdings producing for local consumption and not regularly employing hired workers.

[24] For the purposes of this Convention, the term ***rural workers*** means any person engaged in agriculture, handicrafts or a related occupation in a rural area, whether as a wage earner or, subject to the provisions of paragraph 2 of this Article, as a self-employed person such as a tenant, sharecropper or small owner-occupier.

standards related to specific topics (e.g. agriculture, biofuels), the points marked in their Code of Practice are also relevant to set a standardization system with reference to biofuels from its production to all the chain (e.g. 7. Effectiveness, relevance and international harmonization) [Diaz-Chavez 2007]. The new code launched in 2010 is the Impacts Code.

The ISEAL Impacts Code provides a framework for standards systems to better understand the social and environmental results of their work, as well as the effectiveness of their various activities and programs. The Impacts Code will apply primarily to social and environmental standard-setting organisations, though many of the requirements are applicable to other organisations that support social and environmental change [ISEAL, 2011]. The Impacts Code is not itself a standard but will require standards systems to develop an Assessment Plan that includes all the steps required to assess their contributions to impact.

4 Environmental and social aspects

4.1 Major findings

In this chapter a set of environmental and social aspects related to biofuel consumption in the EU are analysed. The major findings are:

- The total gross land use associated with EU biofuel consumption in 2008 is estimated to be 7 Mha, of which 3.6 Mha in the EU and 3.3Mha in third countries[25]. It is estimated that 590 kha is required per Mtoe of biofuels[26]. If accounting for co-products that reduce land needs elsewhere, the total net land use for EU biofuels is estimated at 3.6 Mha. The macro economic modelling done in Chapter 5 shows an increased global agricultural land use of 1.3 Mha related to biofuel production between 2000 and 2008, indicating that not all land used for biofuels is expansion of agricultural land;
- The countries that appear to have been mostly influenced in their land use by biofuel export to the EU market are Argentina (soybean), Brazil (soybean and sugarcane), USA (soybean) and Ukraine (rapeseed), as well as Malaysia and Indonesia (both oil palm) - although to a smaller extent;
- The expansion of cropland is likely to have different effects in different countries. Some countries may be able to expand their cropland for specific crops by changing the crop rotation patterns, including reducing the amount of land in fallow, while others may have to expand on to pastures or natural vegetation. The effects of the latter are also likely to vary between different countries, depending on the types of land that become converted to cropland;
- Land use analysis in key biofuel producing regions indicate that land use for biofuel crops does not automatically imply expansion of cropland in the country where the biofuels are being cultivated. In the period 2001-2008, the EU, Argentina and Brazil experienced a net gain of cropland. Indonesia, Malaysia and USA have seen a net decrease of cropland;
- Total supply chain green house gas (GHG) savings related to the EU biofuel consumption in 2008 are estimated to amount 15.3 Mtonnes CO_{2eq}. This is a saving of 53% compared to the situation where only fossil fuel would be used, this figure does not include direct or indirect land use change;
- According to water analysis of key producing regions Argentina, Brazil and the USA typically have low water stress risks and high availability of water for agriculture, including biofuel crops. Countries within the EU can range from low to high water stress risks;
- According to soil risk analysis Indonesia and Malaysia are estimated to have higher risks for soil erosion, fertility and vulnerability to pests. The EU, Argentina and USA have lower risks, while Brazil is classified as medium category on soil risks;

[25] The land use is based on the ultimate feedstock origin as analysed in section 2.4, combined with yield data. More information is provided in Appendix I.

[26] Total land used for the production of EU biofuels divided by the total consumption of EU biofuels

- The EU biofuel demand is estimated to account for a rather small share of local environmental impacts from biofuel crop cultivation in most exporting countries;
- For the countries providing the EU with biofuels or their feedstocks in 2008, it can be stated that biodiversity monitoring is in place to a certain degree, but several countries could improve on specific aspects;
- Estimates for employment resulting from biofuels production vary widely. In the EU, over 100,000 people may have a job relating to biofuels. The global employment related to biofuels may be over 1.5 million, half of which in Brazilian cane and related ethanol production.

4.2 Direct Land use

Land use is addressed from several points of view. First of all land used for EU consumed biofuels is described in land use patterns & land use dynamics. After that, the 2008 land cover baseline and the land cover change developments are presented. Finally this section adressses the estimated GHG impacts for recent land cover changes.

Land use acreages

Land use change – especially conversion of natural vegetation to cropland – can result in a range of environmental impacts, e.g. on biodiversity and greenhouse gas savings. At project level it should be possible to monitor and analyse the direct land use change consequences with acceptable levels of confidence. But assessments of indirect land use change require modelling of complex interactions between countries/regions as well as between different sectors in societies, which introduces large uncertainties.

The land use change consequences of EU biofuel policies can at present not fully be understood on basis of supply chain or project level information, since it is not known exactly where the biofuels supplying the EU market have been produced. The location for the biofuel crop production is unknown, which means that modelling is required for assessing both the direct consequences of land use change to produce biofuels for the EU market and the indirect consequences of this biofuels production. In future, through certification and verification of compliance with the sustainability criteria, there may be more transparency on the location of biofuels feedstock production.

In Table 30, the crop acreage necessary for EU biofuels consumption is estimated for the main countries of supply. Since the EU biofuel import demand was small before 2004 it can be assumed that the area used for producing biofuel crops for the EU market was negligible before 2004. Thus, comparing the required area for a given biofuel crop in 2008 with the total expansion of the same crop between 2004-2008, gives an indication of the role of EU biofuel demands in driving cropland expansion. As mentioned above, the mechanisms for EU biofuel demands driving land-use change can be both direct (i.e. new land is converted to cropland for biofuels exported to EU) and indirect (i.e. already existing cropland is used, which requires cropland for other purposes to be expanded elsewhere). Even so, the comparison made in Table 4 makes it possible to identify the countries where EU biofuel import demand has been significant in comparison to the total crop production in a country.

Table 30. Cropland used for production of feedstock for EU biofuels in 2008 compared to total crop expansion. Note that both total cropland and net cropland requirements are given, where net is calculated using RED allocation principles.

Country	Crop	Total harvested area in 2008	Crop expansion 2004-2008	Cropland used for production of EU biofuels in 2008 – total and net after allocation		Cropland needed for EU biofuels in 2008 compared to total crop expansion 2004-2008	
		kha	(kha)	total (kha)	net (kha)	total	net
Argentina	Soybean	16,387	2,083	542	178	26%	9%
Bolivia	Sugarcane	160	53	11	11	21%	21%
	Soybean	786	-18	1.2	0.4	-	
Brazil	Sugarcane	8,140	2,508	91	91	4%	4%
	Soybean	21,057	-482	782	257	-	
	Oil Palm	66	11	0.2	0.2	2%	2%
Ethiopia	Sugarcane	21	-2	0.1	0.1	-	
Guatemala	Sugarcane	287	61	3	3	5%	5%
USA	Maize	31,796	1,999	0.3	0.2	0%	0%
	Soybean	30,223	293	1,270	418	434%	434%
Indonesia	Oil Palm	5,000	1,680	190	173	11%	10%
Malaysia	Oil Palm	3,900	498	98	90	20%	18%
Pakistan	Sugarcane	1,241	167	16	16	10%	10%
Peru	Sugarcane	69	-2	2.5	2	-	
Ukraine	Rapeseed	1,380	1,272	366	214	29%	17%
	Sugarbeet	377	-319	0.3	0.2	-	

The total land use[27] associated with EU biofuel consumption amounts 3.3 Mha in third countries (sum of total kha for EU biofuels in Table 30 above) and 3.6 Mha in the EU (see Appendix I 2). This means that 7 Mha of agricultural land is used for the production of 11.9 Mtoe biofuels, or 0.59 Mha is required per Mtoe of biofuels. The average productivity is thus 1.7 ktoe per ha. Even though the majority of EU biofuels are produced in the EU, still about half of the acreages required for the feedstock production reside in third countries. This is because part of the EU feedstock is imported and some of this feedstock has a relatively high acreage usage, such as soybean, because significant volumes of animal feed are co-produced.

[27] The land use is based on the ultimate feedstock origin as analysed in section 2.4, combined with yield data. More information is provided in Appendix I.

When accounting for the by-products, the total net land use in third countries decreases to 1.4 Mha and the land use in the EU decreases to 2.1 Mha, so that the total becomes 3.6 Mha.

In 2008, particularly large areas were used for cultivation of feedstock for EU biofuels in USA (soybean), Brazil (soybean), Argentina (soybean) and Ukraine (rapeseed). Large amounts of land were also used in Indonesia (oil palm), Malaysia (oil palm) and Brazil (sugarcane). As can be seen in Table 30, the net cropland demand is substantially smaller for maize ethanol and soybean biodiesel due to the co-production of animal feedstuff replacing other feed. However, it should be noted that the land savings associated with this co-production could take place somewhere else than in the country where the soybean is cultivated.

Cropland expansion pressure can be reduced by improving yields. Table 31 shows how much the national average yields would have to increase to avoid crop expansion in case of a doubled EU demand for biofuels, compared to 2008. In most countries, cropland used for production of feedstock for EU biofuels constitutes a small share of the total cropland, such as in Brazil, see Figure 24. Therefore, small yield increases may help to avoid crop expansion that otherwise would occur as the EU demand for biofuels increases.

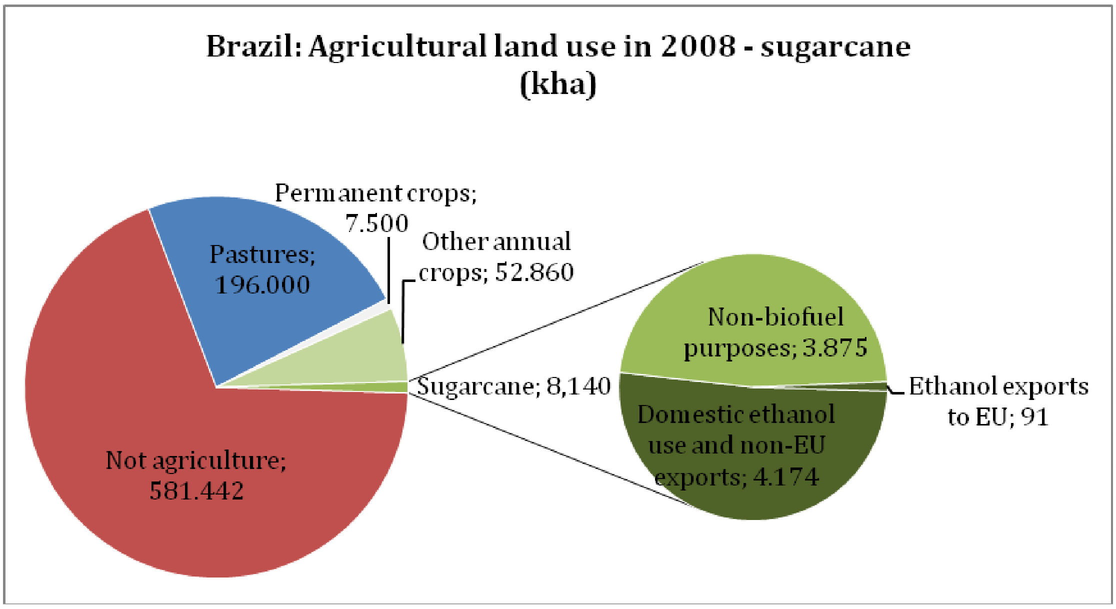

Figure 24. Agricultural land use in Brazil in 2008, focused on sugarcane production

However, in some countries, cropland used for production of feedstock for EU biofuels constitutes a large share of the total cropland. This implies that large yield increases would be necessary to avoid crop expansion as the EU demand for biofuels increases. This is particularly the case for sugarcane in Bolivia, soybean in USA and, most significantly, rapeseed in Ukraine (Figure 25).

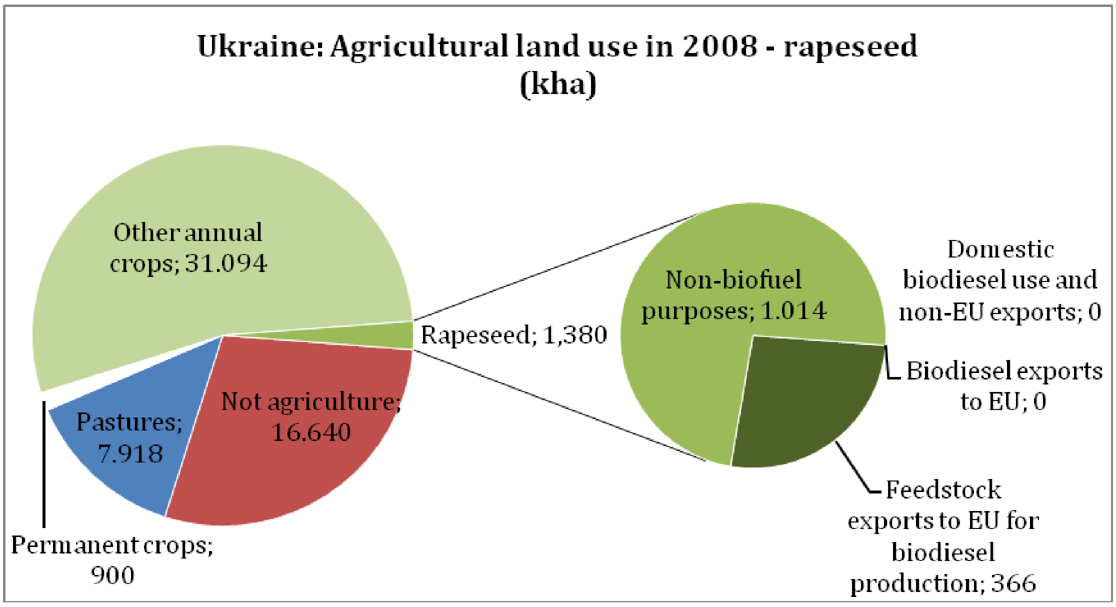

Figure 25. Agricultural land use in Ukraine in 2008, focused on rapeseed production

To conclude, the countries that appear to have been mostly influenced in their land use by EU biofuel import demands are Argentina (soybean), Brazil (soybean and sugarcane), USA (soybean) and Ukraine (rapeseed) Malaysia and Indonesia (both oil palm) are also likely to have experienced significant land use changes, although to a smaller extent. Bolivia has a relatively small area dedicated to sugarcane production, but a significant part of this production was for the purpose of producing ethanol for export to EU.

Table 31. Yield increases needed to avoid crop expansion in case of doubled EU demands for biofuels compared to 2008

Country	Crop	Total production in 2008	Production for EU biofuels in 2008	Average yields in 2008	Yield increases needed to avoid crop expansion if production for EU demands would double
		kt	kt	(t/ha)	%
Argentina	Soybean	46,238	1,528	2.8	3.3%
Bolivia	Sugarcane	7,009	480	43.8	6.8%
	Soybean	1,260	2	1.6	0.2%
Brazil	Sugarcane	645,300	7,226	79.3	1.1%
	Soybean	59,242	2,201	2.8	3.7%
	Oil Palm	660	2	10.0	0.3%
Ethiopia	Sugarcane	2,300	12	107	0.5%
Guatemala	Sugarcane	25,437	12	88.6	0.9%
USA	Maize	307,142	218	9.7	0.001%
	Soybean	80,749	3	2.7	4.2%
Indonesia	Oil Palm	85,000	3,394	17.0	3.8%
Malaysia	Oil Palm	83,000	3,236	21.3	2.5%
Pakistan	Sugarcane	63,920	2,096	51.5	1.3%
Peru	Sugarcane	9,396	334	136	3.6%
Ukraine	Rapeseed	2,873	831	2.1	26.5%
	Sugarbeet	13,438	334	35.6	0.1%

Land use dynamics

The means of increasing production determines the environmental effects. Crop expansion may cause moving on to new land, some of which may be with high carbon value, and loss of biodiversity, while intensification may result in, e.g., eutrophication, water pollution and damage to neighbouring ecosystems from an increased use of fertilizers and pesticides. Assessing past-to-present land use dynamics associated with the cultivation of biofuel crops helps to understand which environmental effects that might arise due to increasing crop production in the different countries. Table 6 shows the extent to which crop production increases were obtained based on cropland expansion during 1990-2008 and 2004-2008, for crops that were used as feedstock for EU biofuels in 2008. The country profiles (they can be found in Chapter 6) include more detailed information about previous land use dynamics in the countries that were supplying biofuels to the EU market in 2008.

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Table 32. Means of increasing crop production during the last two decades. Orange: mainly expansion; Yellow: rather equal contribution from expansion and intensification; Green: mainly intensification; Black: production decreased during the period. Each country-crop combination consists of two cells. The first cell shows the result for 1990-2008 and the second for 2004-2008.

Country	Biodiesel feedstock						Ethanol feedstock			
	Soybean		Oil palm		Rapeseed		Sugarcane		Maize	
Argentina	Orange	Yellow								
Bolivia	Orange	Black					Orange	Orange		
Brazil	Yellow	Green	Orange	Orange			Yellow	Orange		
Guatemala							Orange	Orange		
USA	Yellow	Black							Yellow	Orange
Indonesia			Orange	Orange						
Malaysia			Orange	Orange						
Pakistan							Yellow	Orange		
Ukraine					Orange	Orange				

Source: FAOSTAT data

Interpretation: Orange: ≥80% of the production increase was obtained from crop expansion; Yellow: 21-79%; Green: ≤20%.

Seen over the last two decades, increased soybean production in Argentina and Brazil was mainly obtained from expanding the area used for soybean cultivation, while the contribution from yield increases has been relatively larger during the most recent years. Yield increases are indicated in Table 32 to have become less important contributors to increased sugarcane production the most recent years in Brazil and also in Pakistan. This may be explained by the significant increase in ethanol production capacity in these countries recent years, given the character of sugarcane ethanol expansion - new ethanol plants are built with simultaneous establishment of surrounding sugarcane plantations.

The dynamics for soybean and maize in USA (these crops are commonly cultivated in rotations) is described in some detail in the country profile section. It can be noted here that maize yields have grown steadily over practically the whole period 1990-2008, while soybean yields have varied more over time. Both crops have expanded over the last two decades. Oil palm production in the assessed countries seems to continue to be increasing almost entirely due to expansion and the same trend can be seen for rapeseed production in Ukraine.

It should be noted that expansion of cropland is likely to have different effects in different countries. Some countries may be able to expand their cropland for specific crops by changing the crop rotation patterns, including reducing the amount of land in fallow, while others may have to expand onto pastures or natural vegetation. The effects of the latter are also likely to vary between different countries, depending on the types of land that become converted to cropland. For example, conversion of tropical peat forests would result in more adverse impacts on e.g. biodiversity and GHG balances than conversion of degraded grasslands. Country specific treatments of these issues are included in the country profiles in Chapter 6.

This summary has mainly focused on land use patterns over the last decades and paid particular attention to land use dynamics in countries that have become relevant to the EU market as of 2008. Undesired consequences of increasing production for food and biofuels can be expected to trigger governments to implement mitigating measures. The character and implementation patterns for such measures will influence the future land use patterns, which may well deviate significantly from the historic patterns. A separate section (see appendix) contributes three illustrative case studies intended to show how different types of measures can alter the way land use for biofuels evolves into the future.

2008 land cover

The baseline land cover for each country in the study region in January 2008 was quantified using the MODIS 2007 Global Land Cover Type Yearly product (for detailed information see Appendix I). It is important to note that the Renewable Energy Directive specifies January 2008 as its baseline for assessing land cover patterns. Most global land cover products derived from remote sensing imagery are produced at an annual timestep, with the final product derived from compositing monthly or sub-monthly images. This is done to account for seasonal and phonological differences in certain land cover types (e.g., presence or absence of snow/ice/cloud cover, changes in leaf out and leaf fall in deciduous forests, etc.) that would not be detected if only one image from the year in question were used for land cover classification. Therefore, the 2007 land cover product was used to assess land cover in January 2008.

EU

Figure 26 represents the baseline land cover for the EU in 2008. Cropland and forest cover the larger part of the region, about two thirds of the EU.

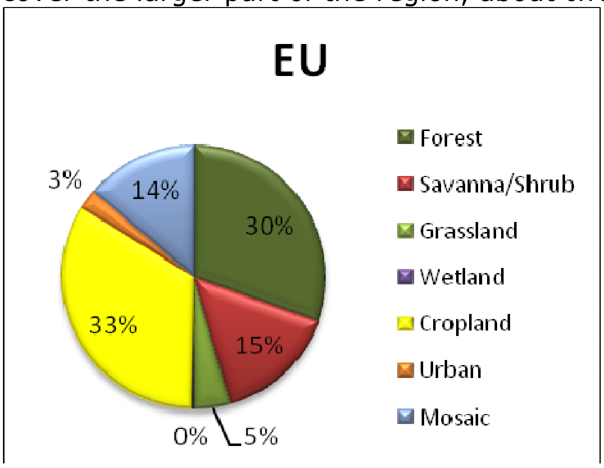

Figure 26. Baseline distribution of land cover types in January 2008 for EU (MODIS 2007 land cover data).

Countries supplying EU biofuels

The distribution of land cover types varied among countries. For five key countries exporting biofuels or their feedstocks to the EU, the baseline land cover is presented in Figure 27.

Malaysia and Indonesia had the highest percentage of land in forest (82% and 74%, respectively), although Russia and Brazil had the largest forest cover on an absolute basis (609 and 373 million hectares, respectively). Most African nations are covered primarily by savanna/shrubland, and all countries except Indonesia, Malaysia, Peru and Ukraine had at least 25% of land area in this land cover type. Cropland made up a significant portion of land area in India, Ukraine and Pakistan.

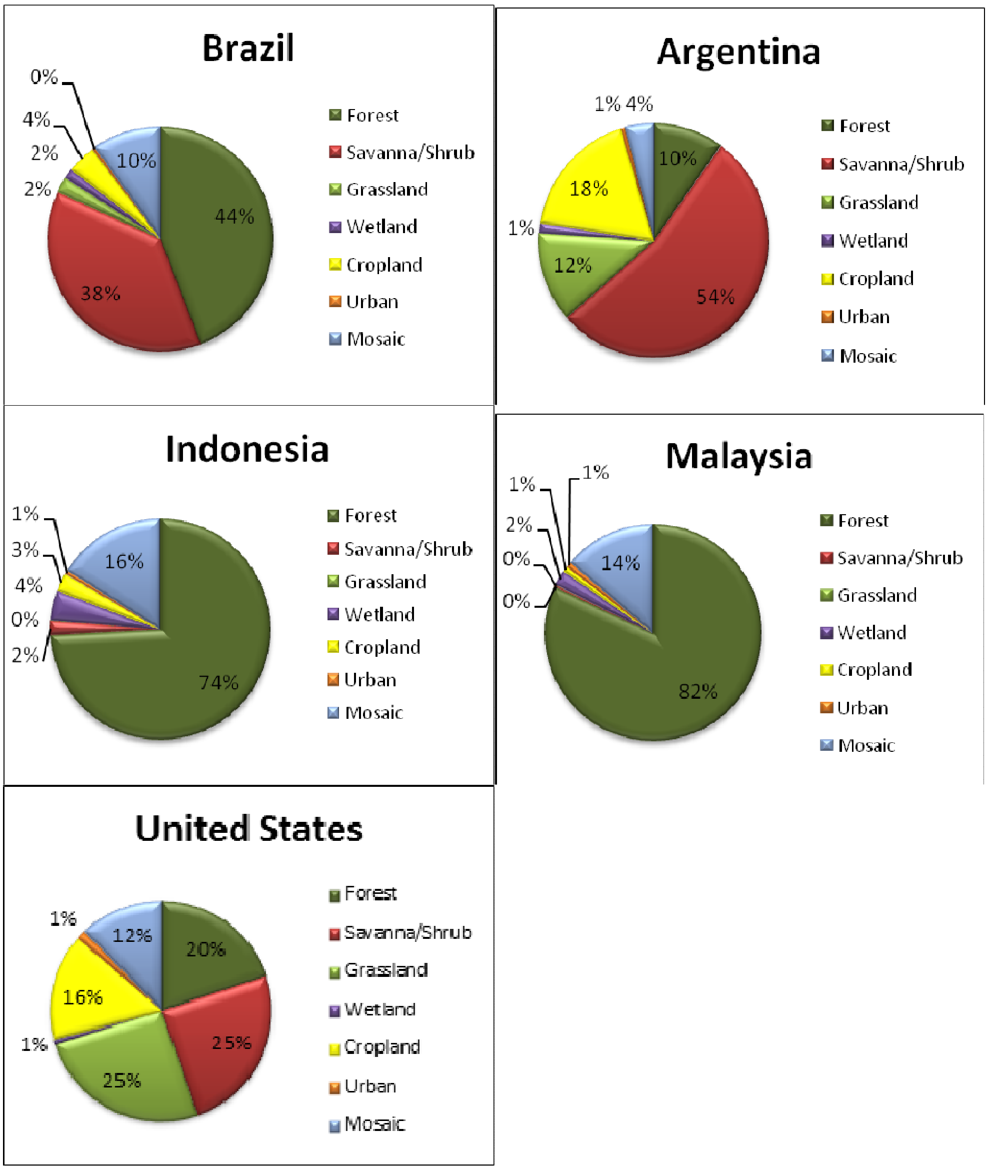

Figure 27. Baseline distribution of land cover types in January 2008 for Brazil, Argentina, Indonesia, Malaysia and USA based on the seven land cover classes according to MODIS 2007 land cover data.

Land cover change developments, 2001-2008

Although the basic idea of this report is to define the baseline land cover in January 2008, baseline land cover must also be linked to past and future years to evaluate land cover change through time. Therefore, historical land cover change in each administrative unit within each country of the study region was analyzed using 2001 and 2007 MODIS data (for details see Appendix I). The same two classification systems were used as in setting the baseline, namely one by 7-category land cover type and the other by canopy cover/height thresholds.

The degree of persistence (i.e., land that stayed in the same land cover category) versus land cover change between 2001 and 2007 varied among countries, with all countries showing both gains and losses in different land cover classes (for an overview of all countries included in this study, see Figure 178).

EU

Figure 28 presents an overview of the land cover changes in the EU for the period 2001-2008. In this period, the EU experienced a net gain in cropland area.

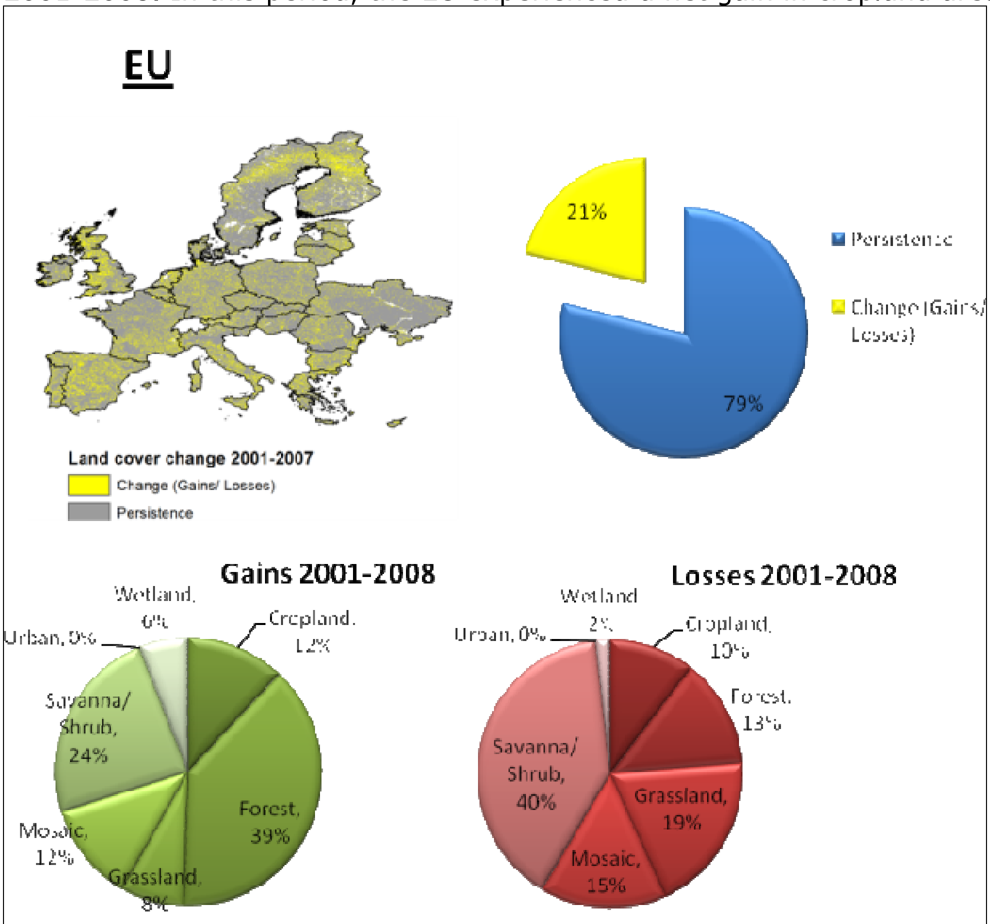

Figure 28. Land cover change between 2001 and 2008 for the EU (MODIS land cover data). The top right pie chart presents the percentage of land that changed in land cover during 2001-2008. The change (in this case 21%) is further detailed in the bottom two pie charts. E.g. the net change in grassland is 8% -19% is -11%, i.e. 11% of the 21% land cover change concerned a loss of grassland.

Countries relevant to the EU biofuel market

At the country level, some countries such as Argentina and Brazil experienced a net gain in cropland area while other countries such as Indonesia, Malaysia, and the US showed a net decrease in total cropland area (Figure 33). However, it must be underlined that these land use changes occurred irrespectively of the EU biofuel market development as the EU biofuel consumption until 2007 was quite limited and most of the EU biofuels and their feedstocks until 2007 were produced in the EU.

This analysis highlights some of the issues with using global, coarse-resolution remote sensing products to assess specific land cover changes in isolation. For example, these products do not capture well the transition between forest and perennial cropland such as palm oil plantations.

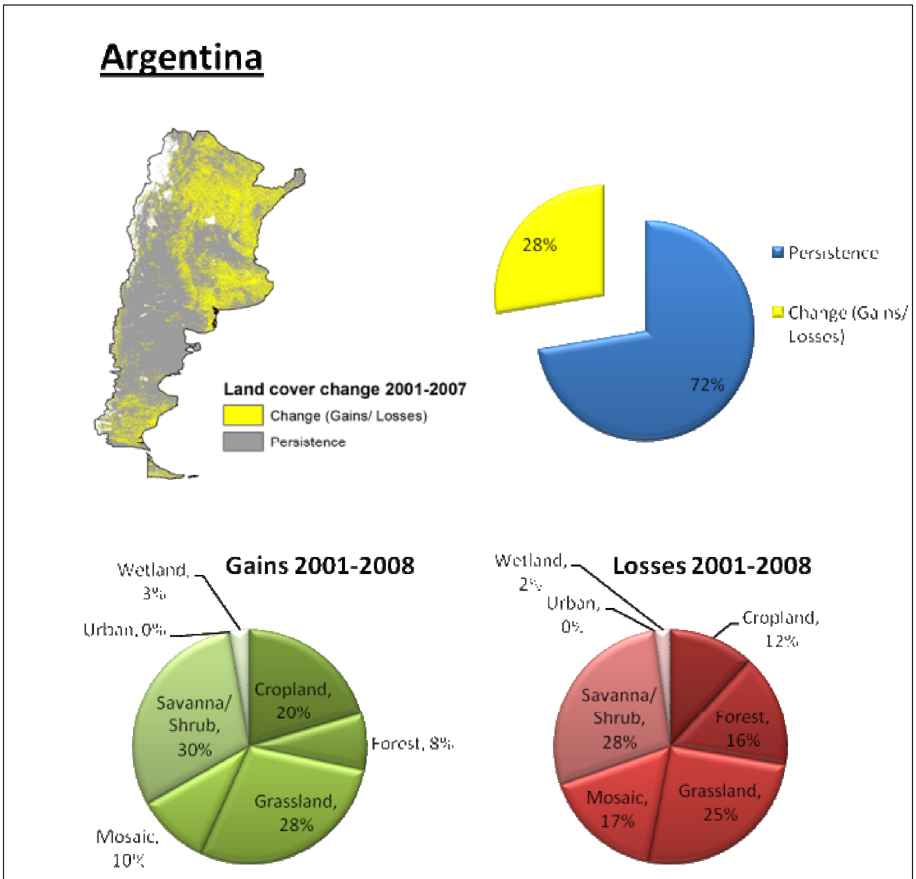

Figure 29. Land cover change between 2001 and 2007 for Argentina (MODIS land cover data). For more explanation on how to read the charts, please see Figure 28.

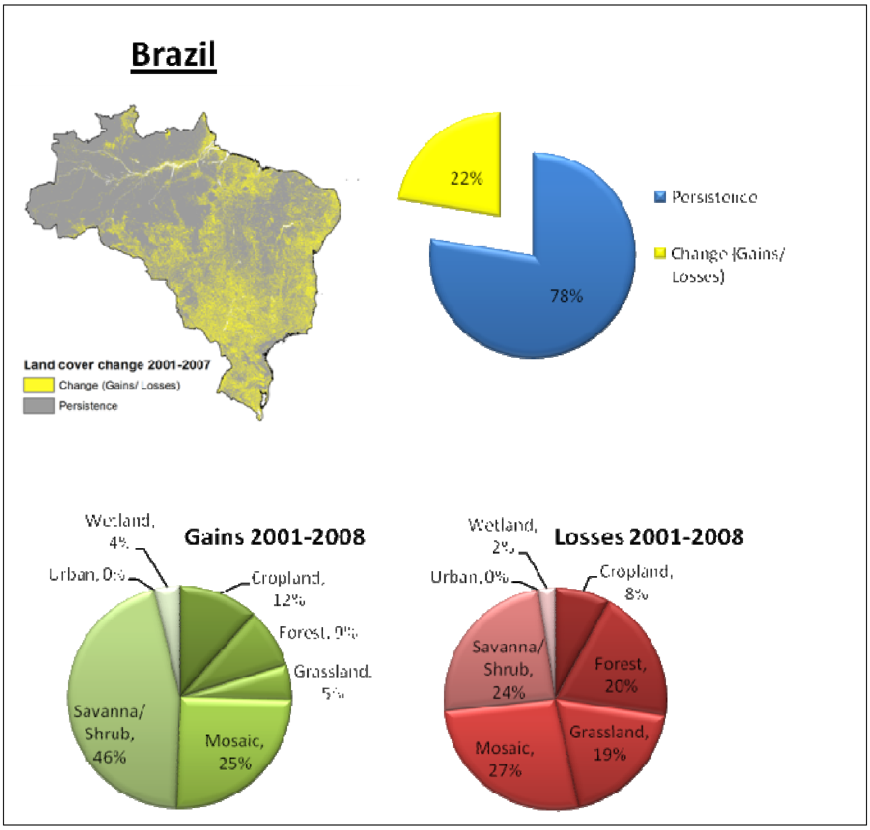

Figure 30. Land cover change between 2001 and 2007 for Brazil (MODIS land cover data). For more explanation on how to read the charts, please see Figure 28.

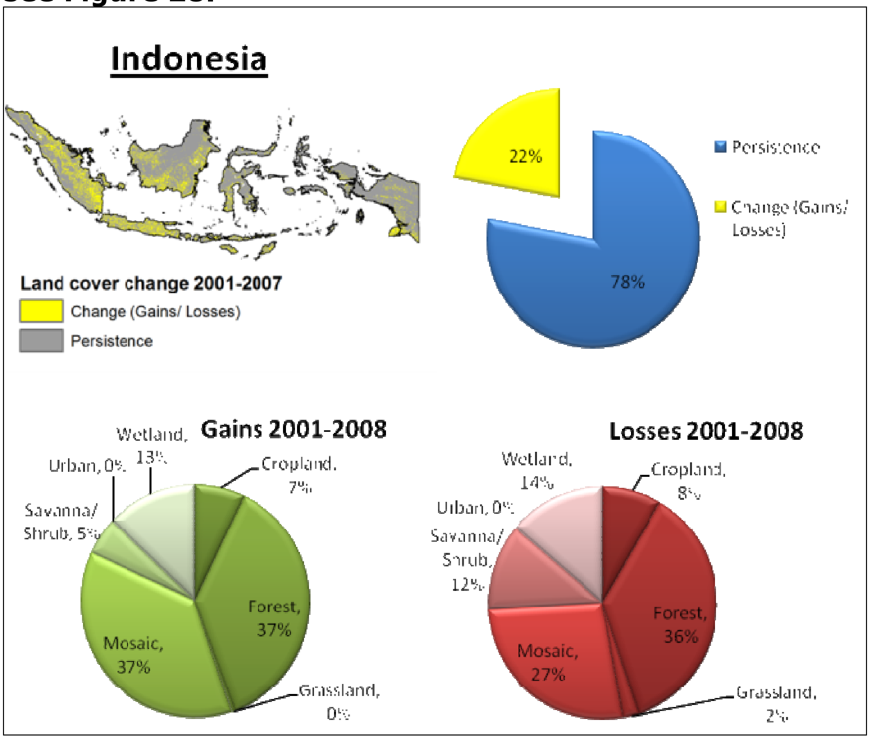

Figure 31. Land cover change between 2001 and 2007 for Indonesia (MODIS land cover data). For more explanation on how to read the charts, please see Figure 28.

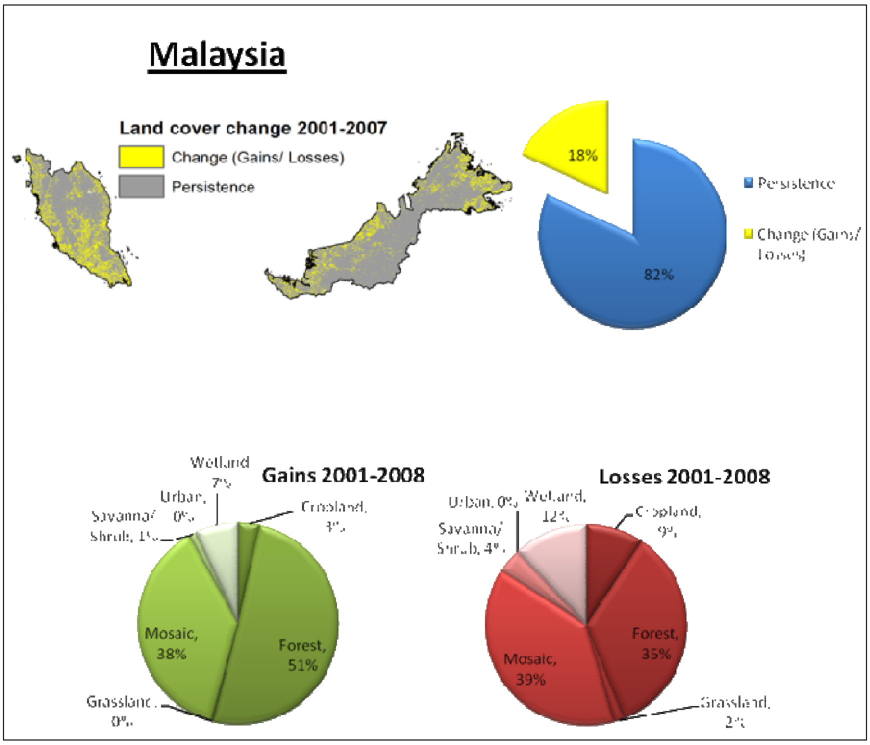

Figure 32. Land cover change between 2001 and 2007 for Malaysia (MODIS land cover data). For more explanation on how to read the charts, please see Figure 28.

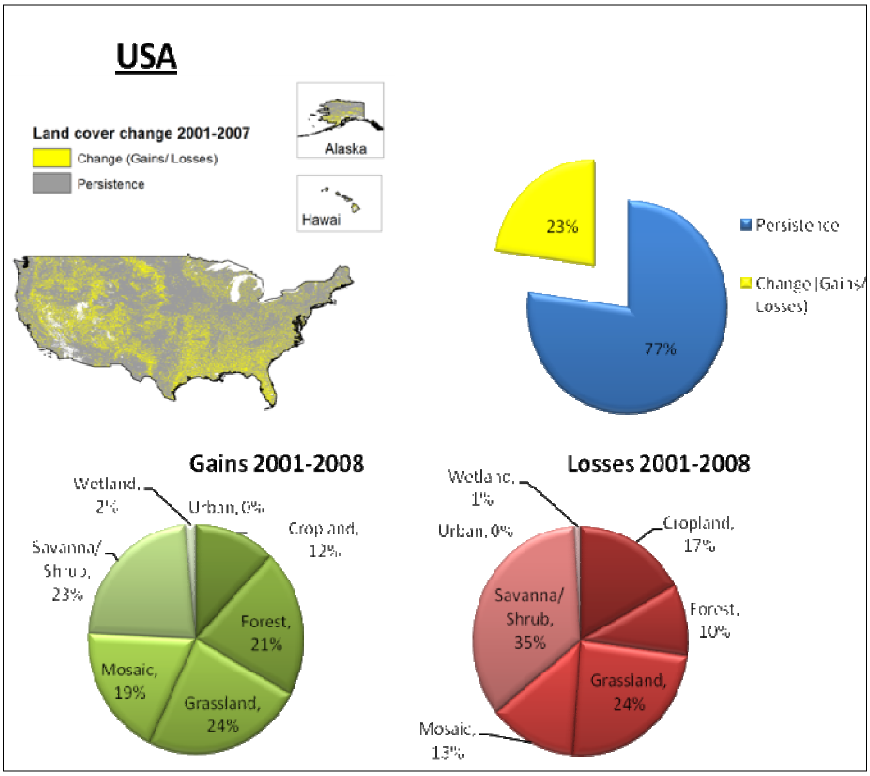

Figure 33. Land cover change between 2001 and 2007 for the US (MODIS land cover data). For more explanation on how to read the charts, please see Figure 28.

Estimated GHG impacts from 2001-2007 land cover changes

Emission factors were calculated as the sum of changes in aboveground and belowground biomass carbon stocks, changes in soil carbon stocks, emissions that occur from peat drainage where applicable, lost sequestration from cleared forests, and non-CO_2 emissions resulting from land clearing with fire where applicable (for details see Appendix I). Emission factors were developed for a 20-year timeframe.

Countries relevant to the EU biofuel market

The emission factors for forest to cropland and grass to cropland for the main countries that have become biofuel or feedstock suppliers to the EU market in 2008 are presented in the table below.

Table 33. Emission factors for forest to cropland and grass to cropland in 2008.

	Emission factor forest to cropland (t CO_2e ha^{-1})	Contribution of changes in biomass stocks	Emission factor grass to cropland (t CO_2e ha^{-1})	Contribution of changes in soil carbon stocks
Argentina	207	61%	42	106%
Brazil	756	76%	100	93%
Indonesia	833	73%	142	92%
Malaysia	812	78%	96	88%
USA	294	69%	35	49%

Emission factors were highest for conversions from forest to cropland, with a maximum of 1,199 t CO_2e ha^{-1} in Papua, Indonesia. For forest conversions, the largest component of the emission factor was the initial change in biomass from forest to the new land cover type. Soil emissions made up a higher proportion of the total emission factor when non-forest land cover types were converted to cropland.
Emission factors for land conversion are highest in Indonesia, Malaysia and Brazil compared to lower emission factors in Argentina and USA. Ranges within Indonesia, Malaysia and Brazil between different regions are large.

However, it must be underlined again that emissions resulting from the land use changes in 2001-2007 can barely be attributed to the EU biofuel market. The purpose of presenting the historical land cover changes in each administrative unit within each country of the study region is to present land cover developments over time and to provide a baseline for future evaluation of land cover change related to EU biofuels consumption.

4.3 Greenhouse gas emissions

Estimated GHG savings without land use change

The greenhouse gas (GHG) emissions of the main biofuels supplied to the EU market in 2008 are calculated and disaggregated per feedstock and main production region.

Through this an estimate of the GHG savings of the biofuel mix in 2008 can be made. The feedstock composition and country of origing are taken from the analysis done in Chapter 2.

Using the data in first four columns of Table 34 an estimate of the GHG emissions of the biofuels supplied to the EU market in 2008 can be made. This estimate makes use of the 'Typical' values presented in the Renewable Energy Directive[28]. The typical values were adjusted where it was clear that their use was not appropriate. This resulted in the GHG emission value for waste oil produced in the United States being updated from 10 gCO_2/MJ to 13 gCO_2/MJ (transport emissions were increased to take into account the shipping of the waste oil).

The Renewable Energy Directive does not list typical values for both barley to ethanol and other grains. For these biofuel supply chains the conservative values provided in the UK Renewable Transport Fuel Obligation[29] were used. Typical values for supply chain emissions were estimated as being 23% lower than these (conservative) values[30]. It should be noted that the RTFO values are not completely in lign with RED methodology.

The Directive provides a range of typical values for both wheat to ethanol and palm oil to biodiesel. These take into account the different 'Processing' emissions resulting from the use of different process fuels or method. For these feedstocks an estimate of the relative split of each process type was made[31]. The process split for wheat used was: Natural gas as process fuel in conventional boiler – 75%, Natural gas as process fuel in CHP[32] – 20%, Straw as process fuel in CHP – 5%, Lignite as process fuel in CHP - 0% (expert assumption since exact split is unknown).
The process split used for palm oil used was: process not specified - 95%, with methane capture at the mill – 5% (expert assumption since exact split is unknown).

Furthermore, as indicated in this chapter 2, not for all ethanol produced the exact origin is known. This is probably a mixture of sources, including residues. In this section, it is assumed that the 'Others' category of ethanol production is regarded as waste, with a typical GHG emission value of 11 gCO_2/MJ (like the value provided by the Directive for wheat straw ethanol).

The table below indicates how the GHG contribution for each biofuel type will be estimated (i.e. using the typical GHG emissions and the % contribution of that

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[28] Annex V of the Renewable Energy Directive provides 'Typical' values for a wide range of biofuels (disaggregated by Cultivation, Processing, Transport & Distribution GHG emissions).
[29] UK Renewable Fuels Agency (2010), Annex G, Page 144: Refer to: http://www.renewablefuelsagency.gov.uk/sites/rfa/files/RFA_C_and_S_TG_%20Part_One_v3_2.pdf
[30] This estimate was based on the difference between the 'Typical' and 'Default' GHG emissions for a selection of biofuel supply chains specified in the RED.
[31] The estimate of the splits was based on Ecofys' expert insight. No data on actual split over the various techniques has been found. 'Overestimation' by assuming 5% of the palm oil production with methane capture and 'underestimating' by assuming no use of lignite (plants in East Germany used to use this) do not influence the results considerably.
[32] Combined Heat and Power

biofuel supplied). This then enables the GHG savings for the total biofuels supplied to the EU market in 2008 to be estimated.

Table 34. Production data and GHG emissions[33] of ethanol and biodiesel supplied to the EU market in 2008, disaggregated by feedstock type and country of origin.

Feedstock	Country of origin	Biofuel supplied to EU market in 2008 (ktonne)	% of total biofuel supplied to EU market in 2008	Typical GHG contribution (g_{CO2e}/MJ_{fuel})	Weighted typical GHG contribution (g_{CO2e}/MJ_{fuel})
Biodiesel					
Rapeseed	EU	3633	34,8%	46	16,01
	USA	14	0,1%	46	0,06
	Others	549	5,3%	46	2,42
Soybeans	Argentina	267	2,6%	50	1,28
	USA	593	5,7%	50	2,84
	Brazil	384	3,7%	50	1,84
	Others	182	1,7%	50	0,87
Palm Oil	Indonesia	670	6,4%	43	2,76
	Malaysia	434	4,2%	43	1,79
	Others	17	0,2%	43	0,07
Sunflower	All	139	1,3%	35	0,47
Waste oils	EU	502	4,8%	10	0,48
	USA	149	1,4%	13	0,19
	Others	11	0,1%	13	0,01
Ethanol					
Wheat	EU	592	5,7%	44	2,47
	Others	13	0,1%	44	0,05
Maize	EU	329	3,2%	37	1,17
	Others	32	0,3%	51	0,16
Barley	EU	31	0,3%	64	0,19
Other	EU	92	0,9%	64	0,56
Sugar beet	EU	679	6,5%	33	2,15
Sugar cane	Brazil	459	4,4%	24	1,06
	Pakistan	53	0,5%	24	0,12
	Bolivia	30	0,3%	24	0,07
	Others	111	1,1%	24	0,25
Residues	All	235	2,3%	11	0,25
Other	All	237	2,3%	11	0,25
	Total	10.436	100%		
	GHG saving				39,84gCO2e/MJ
					or 52.46%

[33] Not including emissions from land use change

From the data & results presented in Table 34, the total amount of GHG emissions reductions related to the biofuel consumption in 2008 can be estimated. The results are presented in Table 35. Emissions related to indirect land use change are not included in these values.

Table 35. Overview of total GHG savings[34] related to EU biofuel consumption 2008.

	Total production 2008 (ktonne)	Total production 2008 (GJ)	Weighted typical GHG contribution (g_{CO2e}/MJ_{fuel})	Fossil fuel comparator (g_{CO2e}/MJ_{fuel})	GHG savings (Mtonne CO_{2e})
Bioethanol	2.892	73.923.366	31,6	83,8	3,8
Biodiesel	7.544	281.382.882	43,0	83,8	11,5
Total	10.436	355.306.248	39,3	83,8	15,3

The total savings related to biofuel consumption are estimated to amount 15.3 Mtonnes CO_{2e}, indicating a saving of 53% compared to the situation where only fossil fuel would be used.

Discussion on weighted GHG balance

In the two previous sections greenhouse gas emissions related to biofuel production have been discussed. The first section indicated possible effects on GHG emissions related to carbon stock and land changes. The second section dealt with GHG emissions over the supply chain of biofuels, compared to the supply chain emissions of fossil fuels and the related savings.

It is difficult to asses the complete picture concerning GHG emissions combing these two elements mainly because from the land cover analysis with associated GHG changes, it is unclear what amounts of hectares concern the actual conversion of land types due to biofuel feedstock production. The actual geographical location of the land use changes can not easily be linked to biofuel expansion or related supply chain emissions.

However, considering the results from both sections, it can be indicated that total GHG savings may be strongly influenced by carbon stock emissions resulting from indirect land use change. Largest areas outside the EU dedicated to biofuel crop production can be found in USA (1270 kha soy), Brazil (782 kha soy) and Argentina (542 kha soy). However in most of these countries areas were not obtained through expansion, but more intensification or sometimes even reduction of total area related to that crop. So these areas did not necessarily result in GHG emissions related to land use change.

[34] Not including emissions from land use change

In countries like Indonesia and Malaysia where expansion was the prime reason for increasing hectares of palm oil plantations, risks of severe impacts on GHG savings due to land use change are present.

4.4 Water risks[35]

Production of biofuel feedstock requires much more water than the subsequent processing to biofuels. Water use in feedstock roduction is also different to water use in processing in that much of the water is evapotranspirated back to the atmosphere and is therefore no longer available for further use until it returns as precipitation.

Based on data about the share of specific crops in different countries that are used for biofuel consumption in the EU (Chapter 2), water risk analysis was made for the countries that were relevant to the EU biofuel market in 2008 (Table 36). The quantifications[36] were made on basis of the total water footprints per crop-country combination, as reported by Mekonnen and Hoekstra [2010]. Figure 34 shows that for some crops, the water consumption varies hugely between countries. Generally, Europe and North America show the highest values of bioenergy production per unit water, while South Asia and Sub-Saharan Africa have the lowest values, which is due to a combination of differences in climate and crop management. The latter can be viewed as a large window of opportunity for improved water efficiencies through better agricultural management in tropical regions.

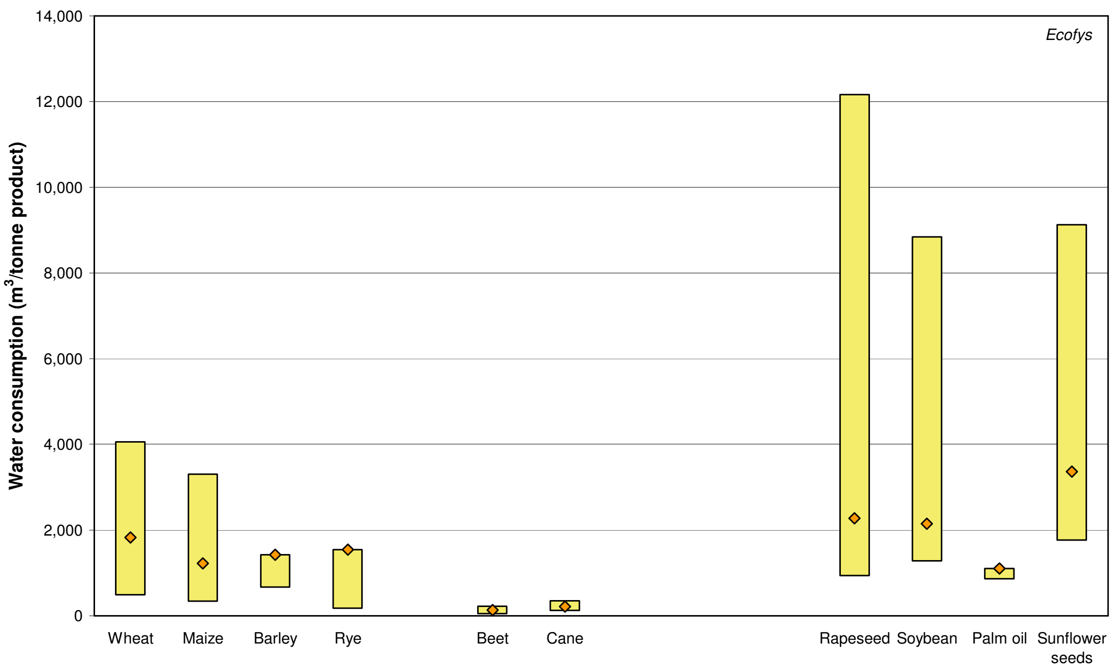

Figure 34. Total water footprint (green+blue+grey) for selected crops in the countries analysed (bars) and global average (diamonts).

[35] for more details see Appendix K
[36] Initially, the quantifications were made using the physically based ecosystem model LPJmL.

Compared with the total water use for agricultural production globally, water use associated with EU biofuel consumption 2008 is low (less then 0.01% of total agricultural water use). However, as Table 36 shows, a few countries allocate a relatively large share of their total water consumption for agricultural production of the biofuel feedstocks. Most notably in Slovakia and Slovenia respectively 16% and 20% of the water use in agriculture is to produce feedstock for EU consumed biofuels. The reason is, that, relative to the total agricultural production in these countries, much rapeseed was produced that almost completely found its way into into EU biofuels in 2008.

In Table 36, the included countries are classified into five bandwidths related to the current water stress situation as reported in the 2010 Environmental Performance Index [Yale University 2010], which indicates whether specific countries face a challenging water situation and even a relatively small water use may already create problems. Note that todays investments in biofuel (or biofuel feedstock) production may further influence the development of water demand in these countries. Substantially expanded biofuel production may impose water related food security challenges in low income countries.

Table 36. Water footprint as a result of EU biofuels consumption, in absolute volume (second column) and relative to the water footprint of all the country's crop production. Countries of feedstock origin are ranked by water stress score (last column). The water stress score is an logarithmic indicator for the territory under water stress; a score less than 20 indicates that more than about 30% of the country's territory faces water stress.

	Water footprint (km3/yr)	Fraction of total agriculture water footprint	Water stress score
Water stress score 0-20 (most stress)			
Moldova	0.10	1.4%	4
Belgium	0.10	6.6%	6
Australia	0.20	0.2%	8
Spain	0.42	0.6%	13
Bulgaria	0.17	1.3%	14
Pakistan	0.29	0.2%	16
Water stress score 20-40			
Egypt	0.06	0.1%	22
Hungary	1.28	6.0%	23
Ukraine	3.20	3.0%	23
Argentina	3.35	2.0%	23
Netherlands	0.03	0.7%	23
Paraguay	0.66	2.2%	24
USA	5.80	0.7%	26
Italy	0.58	1.1%	30

Romania	0.74	2.0%	31
Peru	0.04	0.2%	32
Germany	3.56	7.8%	33
Water stress score 40-60			
Portugal	0.23	2.0%	43
France	6.87	9.3%	47
UK	1.02	4.4%	47
Poland	1.16	2.4%	55
Lithuania	0.29	3.3%	56
Greece	0.04	0.3%	60
Water stress score 60-80			
Czech Republic	0.95	7.9%	70
Estonia	0.09	3.0%	70
Denmark	0.13	1.5%	72
Brazil	5.88	1.8%	72
Bolivia	0.08	0.6%	73
Russia	0.35	0.1%	73
Canada	1.30	0.9%	77
Serbia	0.18	1.1%	78
Water stress score 80-100 (least stress)			
Austria	0.34	6.9%	100
Finland	0.03	0.5%	92
Ireland	0.08	3.8%	100
Latvia	0.15	4.1%	100
Luxembourg	0.02	8.8%	100
Malta	0.00	1.3%	100
Slovakia	0.94	16.2%	100
Slovenia	0.25	20.4%	100
Sweden	0.28	3.3%	93
Costa Rica	0.04	0.8%	100
El Salvador	0.06	1.1%	100
Guatemala	0.04	0.3%	100
Indonesia	0.72	0.2%	95
Malaysia	0.43	0.5%	87
Norway	0.01	0.5%	100
Trinidad and Tobago	0.00	0.1%	100

It should be noted that national level assessments are not likely the most appropriate, especially in some large countries that contain many watersheds, which may differ substantially in water stress. Also, some nations share watersheds. Assessments on a watershed basis may provide better indication of water stress, but information is not available to link EU biofuel demand to biofuel feedstock cultivation and associated water use within specific watersheds.

Proper land, water and agricultural management practices can mitigate water related impacts associated with increasing water demand for biofuel production. There is significant potential to increase the currently low productivity of rainfed agriculture in large parts of the world through improved soil and water conservation including on-site water management. Crop selection, land use planning to optimize the water use in agriculture and the cultivation of drought resistant crops as biofuel feedstock offer opportunities for adaptation to water scarcity.

Targeting degraded/marginal land may give access to water flows otherwise little used, but competition between upstream and downstream water uses (including environmental flow requirements) needs to be considered in water scarce areas. Water basin planning and plantation establishment matching the local hydrological context can provide a balance and can also reduce some water related problems such as flooding, soil erosion and impacts of high sediment load on aquatic ecosystems.

4.5 Impacts on soil

The impacts that biofuel feedstocks have on soils vary widely, depending on the agriculture practices used (including fertilizers and pesticides used, tilling and mechanization practices used, rotation patterns) and the strengths and vulnerabilities of the soils they are grown on. The following discusses the conditions of soils in the EU and 5 major exporting countries (ordered accorded to importance to EU biofuel consumption), and the potential impacts that feedstock production in each country may have on them.

EU

European soils face a wide range of conditions. Some of the most common are: low moisture and nutrient status, calcareous, gypseous conditions, seasonal moisture stress, impeded drainage, seasonally excess water, and low organic matter[37]. These conditions are due part to natural conditions (e.g. amount of rainfall and wind impact, soil types) and partly to bad management practices. It is therefore difficult to attribute to one particular crop (even less so – to the biofuel production) the responsibility for these impacts. In the European Union, an estimated 52 million hectares, representing more than 16% of the total land area, are affected by some kind of degradation process. In the new Member States this figure rises to 35%.

A Communication by the European Commission, Towards a Thematic Strategy for Soil Protection [COM (2002) 179 final] identified eight main threats to soil:

- **Soil sealing**, due to infrastructure and urban development;

[37] http://www.eea.europa.eu/soer/europe/soil/?b_start:int=12&-C=

- **Erosion**, mainly due to the inadequate use of soil by agriculture and forestry, but also through building development and uncontrolled water runoff from roads and other sealed surfaces;
- **Loss of organic matter (OM)**, mainly due to intensive use of the land by agriculture, especially when organic residues are not sufficiently produced or recycled to soil;
- **Decline in biodiversity**, linked to the loss of organic matter, because biodiversity depends on organic matter, which means that all soil biota live on the basis of organic matter;
- **Contamination**, which can be diffuse (widespread) or localised and is due to many human activities, and/or agricultural activities;
- **Compaction of soil**, which is a rather new phenomenon caused mainly from high pressures on soil through heavy loads by vehicles in agricultural and forest land use. An estimated 4% of soil throughout Europe suffers from compaction (e.g. big tractors used for sugar beet harvest);
- **Hydro-geological risks**, resulting in floods and landslides deriving partly from uncontrolled;
- **Soil and land uses**;
- **Salinisation**. This is mainly a regional problem but in those areas where it occurs, such as the Mediterranean basin and Hungary, agricultural, forestry and the sustainable use of water resources are severely endangered. An estimated 1 million hectares in the EU are affected.

BRAZIL

Brazil is a significant source of sugar cane and soybean feedstock for EU consumed biofuels (see Section 2.5) though most of these feedstocks are cultivated for domestic use and other export markets, therefore these soil impacts can not simply be attributed to the EU biofuel consumption. The impacts of biofuel feedstock growth in Brazil relate to land clearing and agricultural management practices. In Brazil, sugar cane and soybean are increasingly grown as mono crops. This can reduce soil fertility and increase vulnerability to pests, as and can have other negative environmental impacts.

The main areas of sugar cane production are the east center and a small part in the north. Brazilian soil stresses are characterized primarily by low nutrient holding capacity in the north, seasonal moisture stress in the middle with patches of seasonally excess moisture and high temperatures. In the south there are areas of low nutrient holding capacity, high P, N, and organic retention, and excessive nutrient leaching.[38] The current production of sugar cane in Brazil does not represent a risk for soil erosion (as compared to soy production) and the avoidance of soil erosion per year was calculated as 74.8 million tonne of soil (soil erosion associated with sugar cane in Brazil is 12.4 t/ha/year compared to 20.1 t/ha/yr in the case of soybean). Brazilian sugarcane fields have relatively low levels of soil loss due to the semi-perennial nature of the sugarcane that is only replanted every 6 years. It is

[38] http://soils.usda.gov/use/worldsoils/mapindex/

expected that current (already limited) losses will decrease significantly in coming years through the use of sugarcane straw, some of which is left on the fields as organic matter after mechanical harvesting [UNICA, 2011[39]]. This situation continues to improve as, increasingly, harvesting is carried out without burning [Donzelli, 2007]. The State of Sao Paulo has a "Green Certificate" that bans the burning of sugar cane.

Several studies conducted in Brazil showed that the expansion of sugar cane into areas of "cerrado with human activities" (which constitute in its majority pastureland), do not detrimentally affect soils. On the contrary, the studies showed that with little organic matter and fertiliser added the originally poor soil fertility improved [Donzelli, 2007][40].

More than half of grain crops, including soybean, in Brazil were grown under no-till cultivation in 2008/9.[41] No-till cultivation reduces erosion and gullies associated with use of cultivation machinery and improves soil fertility and yields.[42]

UNITED STATES

The US is a significant source of soybean for EU consumed biodiesel in 2008 though it is also cultivated for other uses, therefore these soil impacts can not simply be attributed to the EU biofuel consumption..
Much of the western US experiences continuous moisture stress as the main soil quality issue. Soil erosion is a major concern related to soil preparation for crops in the US. Government conservation programs contributed to reducing soil erosion 40% between 1982-1997. [43] More than 84% of US soybeans are grown with reduced tillage, increasing carbon sequestration.[44] Most soy in the US is grown in the Midwest, Midsouth, and Southeast. Conservation tillage results in 93% decreased soil erosion and annual soil moisture evaporation loss reduction of 5.9 inches.[45] There are fears that demand for biofuel crops will lead to intensification of management practices, including monocropping, increased fertilizer applications, and intensive tilling.

Maize, mainly produced for domestic markets, requires intensive farming, affecting the soil and water more than most other crops. The maize producing states of the Midwest are also very vulnerable to soil erosion. Despite extensive research and educational programs to encourage no till farming, more than 75% of Midwestern maize acreage is tilled before planting.[46]

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[39] http://english.unica.com.br/noticias/show.asp?nwsCode={4DA7B805-BCAE-4280-A65D-427ADBC325F3}
[40] Donzelli, J. 2007. Soil used in Brazil for sugar cane production: tendencies for expansion. In Macedo, I. 2007. Energy from sugar cane. Twelve studies on the agroindustry of sugar cane in Brazil and its sustainability. UNICA. Pages. 141-148.
[41] http://www.intechopen.com/source/pdfs/15781/InTech-Benefits_of_cover_crops_in_soybean_plantation_in_brazilian_cerrados.pdf
[42] http://deltafarmpress.com/no-till-increases-production-and-soil-tilth-brazilian
[43] http://www.epa.gov/agriculture/ag101/cropsoil.html
[44] http://www.usbthinkingahead.com/docs/US_Soy_Sustain_QandA.pdf
[45] http://www.soyconnection.com/pdf/9001_USB_CAST_V1r1May11.pdf
[46] http://arec.oregonstate.edu/sites/default/files/faculty/perry/qadocument5.pdf

Better management practices that do not remove excessive amount of soil organic matter and do not remove top soil (e.g. tillage) have been promoted in the USA to avoid the risk of soil erosion and removal of nutrients. The USDA and DOE acknowledge that converting all cropland to no-till may be unrealistic, but, nevertheless, point out that a strong market for bioenergy could be a forceful driver for large increases in the no-till acres which are key to meeting the targets. The importance of increasing the area of no-tilled cropland and recognizing this in policy is noted in the 2007 Farm Bill Theme Paper Agriculture and Energy [47].

INDONESIA

Indonesia is a source of palm oil feedstock for EU consumed biofuels though most of oil palm is cultivated for other uses, therefore the soil impacts can not simply be attributed to the EU biofuel consumption. The major soil stress in Indonesia is excessive soil leaching in many areas of the country. Additional major stresses that are concentrated in specific areas are high temperatures, high aluminum, low moisture and nutrient status, low nutrient-holding capacity, high anion exchange capacity, steep lands.

When forests are converted to grow oil palm, there is increased risk of erosion. When peat soil is drained for oil palms, there is loss of retention capacity and large emissions of greenhouse gases. Depending on the fertilizers used, there is a risk of soil and water pollution. However, some plantations are beginning to use organic fertilizer produced from the palm oil mill effluent. Fire may be used to clear peat soils. Depending on the type of land, the impact of oil palm plantations may be more erosion, leading to soil degradation. The biggest impacts are during periods of plantation establishment and replanting. It is possible, however, to mitigate against many of these threats. Erosion can be minimized and controlled.[48]

MALAYSIA

Malaysia is a significant source of palm oil feedstock for EU consumed biofuels, though most of oil palm is cultivated for other uses, therefore the soil impacts can not simply be attributed to the EU biofuel consumption. The major soil stress is excessive soil leaching mainly due to deforestation in many areas of the country. There are also areas with high P, N and organic retention, and along parts of the coastlines there is impeded drainage, high organic matter, and to a lesser extent, an acid sulfate condition.

Soil impacts related to palm oil production in Malaysia are primarily due to land conversion and replanting. When forests are converted to grow oil palm, there is increased erosion, especially if the soil is left exposed for longer time. When peat soil is drained for oil palms, there is loss of retention capacity and large emissions of

[47] http://www.paraquat.com/knowledge-bank/crop-production-and-protection/no-till-and-biofuel-crops
[48] http://www.nbpol.com.pg/wp-content/uploads/downloads/2011/02/EnvironmentalImpactOfOilPalm.pdf

greenhouse gases. Both in the case of former forest or former agriculture land, burning is a common technique for preparing land for replanting oil palm, but zero-burning is also being practiced, which allows the plant tissue from previous crops to be recycled, improving soil fertility.[49] Additionally, use of machinery in the oil palm industry is increasingly common in Malaysia, due to labour shortages, however, this can lead to soil compaction which negatively impacts soil quality.[50] With increased demand for palm oil, it is now being grown on a greater variety of soils than it once was, including marginal environments.[51]

ARGENTINA

The soil resources in Argentina have been the main driver of economical development in the country. No-till farming system has been developed in the late 1980s. The first objective was to reduce soil erosion and degradation. Based on a collection of Good Agricultural Practices, this system allows producing without degrading the soil (96% less soil erosion), while improving its physical, chemical and biological conditions: increase in soil fertility, greater production stability and yield increase. Also, it allows using soil water more efficiently – a natural resource that is commonly a limiting factor in dryland crops production [AAPRESID, 2011]. The no-till farming system has been adopted by approximately 85% of the farmers [PAA-FAUBA, based on AAPRESID data; Hilbert 2011].

These concepts are relatively true for the Humid Pampa that occupies somewhat less than one third of the territory, where plains are dominant, formed by modern unconsolidated sediments, with natural grasslands and temperate climate (Hall et al., 1992). Highly contrasting are the other two thirds of the surface of Argentina which are dominated by arid climate.

The main causes for land degradation in the Pampean Region are the "agriculturization" process or intensification of agriculture, the introduction of the double annual cropping wheat-soybean; the change from the rotation cattle-agriculture to continuous agriculture, and an inadequate land use with excessive and/or untimely tilling sometimes along the slopes [Moscatelli 2000].

To prevent and control the degradation processes, many alternative practices of land reclamation and land and water conservation are applied. An effective system to prevent erosion and maintain soil structure that has been widely incorporated in the Pampean Region is the no-tillage or direct planting, which presently covers five million hectare in the country. In relative terms, places Argentina as the country with the higher extension of this practice. It is worth to mention the permanent work of AAPRESID, the Argentine No-till Farmers Association that intensively promotes the application of no till agriculture. AAPRESID has joint research projects with research and technological centers, universities, and extension and experimentation

[49] http://www.americanpalmoil.com/sustainable-zero.html
[50] http://www.scipub.org/fulltext/AJAB/AJAB5115-19.pdf
[51] http://www.aarsb.com.my/AgroMgmt/OilPalm/FertMgmt/Research/FertMgmt&Product.pdf

organisms in order to evaluate the advantages and drawbacks of the system in the different ecological regions.

Summary

Although it is very difficult to attribute soil impacts to particular crops, even less so to link those with specific quantities of biofuel feedstocks or biofuels consumed in the EU, an attempt to provide a qualitative risk assessment to the feedstocks in the case studies presented above is made in Table 37. The table considers 5 of the main important impacts as to the EU Atlas classification: erosion, compaction, loss of OM, reduction on biodiversity, contamination. All these impacts are mainly associated to bad agriculture management or practices.

Table 37. Classification of soil risks for regions relevant to the EU biofuel market.

Country	Region	Feedstock	Risk of soil degradation	Main form of degradation	Main causes
	EU	Cereals, rapeseed, sugar beet	Low-Medium	Erosion, compaction	Intensification of agriculture; intensification in use of mechanisation
Brazil	Cerrado	Sugar Cane	Medium	Erosion and compaction.	Not growing on pasturelands in the Cerrado; intensification in use of mechanisation.
USA	Midwest	Maize, soy	Low-Medium	Erosion, compaction	Intensification of agriculture; use of more machinery
Indonesia		Oil palm	Medium-High	Erosion; Loss of OM; reduced biodiversity;	Deforestation;Dry peatlands
Malaysia		Oil palm	Medium-High	Erosion; Loss of OM; reduced biodiversity	Deforestation
Argentina		Soy	Low-Medium	Erosion, Loss of soil structure	Intensification of agriculture; untimely tilling;

It is important to note that this qualitative assessment is just indicative and for specific areas within each of the above countries or regions, it is necessary to do a particular assessment.

4.6 Other local environmental impacts

Feedstock production and conversion to biofuels can affect the local environment in many different ways. Given that biofuels presently mostly are produced from conventional food crops, impacts resemble those characterising the present day agriculture. These depend on the crops produced, the production systems employed, governance conditions, and local environmental conditions. In the detailed appendix, production system characteristics and current documented environmental impacts

(Table 38) – related to e.g. air and water quality and biodiversity – associated with the production of relevant biofuel crops are presented in each country land-use profile.

Table 38. Assessed local environmental impacts

Assessed local environmental impacts
Deforestation
Loss of agro-biodiversity
Loss of biodiversity
Air pollution
Water pollution
GMO contamination
Eutrophication
Soil fertility decline
Erosion

Environmental Impact Assessments (EIAs) provide information about specific local environmental impacts for a given biofuel feedstock and/or biofuel conversion option (see separate chapter for an overview of impacts that are typically covered by EIAs). Reports, scientific articles and other documentation provide complementary information about environmental impacts associated with biofuel crop production and agriculture in general in a country. In this report, local environmental impacts have been assessed particularly for (a) domestic biofuel production in 2008, and (b) the estimated EU biofuel demand in 2008.

In the assessment, the cultivation of crops as feedstock for production of biofuels was assumed to have the same characteristics – including environmental impacts – as cultivation of the same crop for other purposes[52]. Potential indirect effects were not assessed.

Since the biofuel crops are mainly produced for non-biofuel purposes, biofuel demand plays a minor role in causing local environmental impacts (Table 39 and Table 40). Exceptions include sugarcane in Brazil and jatropha in Guatemala where the biofuel production – primarily for domestic markets – uses a large part of the total crop harvest (although the jatropha acreage in Guatemala in 2008 was only 200 ha). EU biofuel import demand in 2008 was estimated to play a significant role only for the case of biodiesel production from Ukrainian rapeseed, with minor role in most other cases: Bolivia (sugarcane), Peru (sugarcane), Indonesia (oil palm), and Malaysia (oil palm).

Thus, EU biofuel demand accounts for a rather small share of local environmental impacts from biofuel crop cultivation in most exporting countries. As described in more detail in the respective countries' land use profile, environmental impacts differ significantly between the assessed biofuel crops.

[52] The contribution to environmental impacts of biofuel feedstock production for (a) domestic use and (b) export to EU was assumed to be proportional to the share of the total cropland that is used for these purposes.

Table 39. Local environmental impacts allocated to domestic biofuel production and EU biofuel demands: Ethanol feedstock crops

Country	Crop	Impacts allocated to domestic biofuel production in 2008	Impacts allocated to EU biofuel demand in 2008
Bolivia	Sugarcane	18%	7%
Peru	Sugarcane	5%	4%
Pakistan	Sugarcane	8%	1%
Guatemala	Sugarcane	9%	1%
Brazil	Sugarcane	52%	1%
Ethiopia	Sugarcane	0%	1%
Ukraine	Sugarbeet	3%	0.1%
USA	Maize	15%	0%
India	Sugarcane	7%	0%
Indonesia	Sugarcane	10%	0%
Malawi	Sugarcane	10%	0%
EU	Wheat	0.8%	0.8%
EU	Sugarbeet	6%	6%
Mozambique (sugarcane), **Nigeria** (cassava), **Sudan** (sorghum, millet, sugarcane), **Tanzania** (sugarcane), **Uganda** (sugarcane, sorghum), **Pakistan** (maize)		0%	0%

Table 40. Local environmental impacts allocated to domestic biofuel production and EU biofuel demands: Biodiesel feedstock crops

Country	Crop	Impacts allocated to domestic biofuel production in 2008	Impacts allocated to EU biofuel demand in 2008
Ukraine	Rapeseed	0%	16%
EU	Rapeseed	30%	30%
Indonesia	Oil palm	3%	3%
Malaysia	Oil palm	1%	2%
USA	Soybean	4%	1%
Brazil	Soybean	3%	1%
Argentina	Soybean	3%	1%
Brazil	Oil palm	0%	0.3%
Bolivia	Soybean	0%	0.1%
Guatemala	Jatropha	100%	0%
Peru (oil palm), **Ethiopia** (castor, jatropha), **Malawi** (jatropha), **Mozambique** (jatropha), **Nigeria** (oil palm, soybean), **Tanzania** (oil palm, jatropha), **Uganda** (jatropha), **India** (jatropha, neem), **Pakistan** (rapeseed)		0%	0%

Data sets on water, air & soil

The absence, incompleteness or out of dateness of information on environmental effects and risks give an indication of the awareness of a country of possible risks and presence of monitoring. When high awareness and monitoring systems are combined, risks on environmental impacts resulting from crop production can be regarded as lower. Table 41 indicates what data on water, air and soil is available in several countries.

Table 41. Summary of data availability in selected countries.

Country	Water	Air	Soil
Americas			
Argentina	NA	NA	NA
Bolivia	√ P	√ C	NA
Brazil	√ C	√ P	√ C
Guatemala	√ C	√ P	NA
Peru	√ C	√ C	√ P
Asia			
India	√ C	√ C	NA
Indonesia	√ C	√ C	√ P
Malaysia	√ C	√ P	√ P
Pakistan	√ C	√ C	√ P
Africa			
Ethiopia	NA	NA	NA
Malawi	√ C	√ C	NA
Mozambique	√ P	√ P	√ P
Nigeria	√ P	√ P	NA
Sudan	NA	NA	NA
Tanzania	√ P	NA	NA
Uganda	√ P	NA	√ P
Others		√	
Ukraine	NR	NR	NR
USA	√ C	√ C	√ P

Code: √ available data; P partial; C: complete; NA: Consultant indicated the information is not available; NR: No information reported.

Countries supplying EU biofuels

Argentina is indicated as not available which means that the data sets are not easily identifiable. However as indicated in the section on soil, Argentina is classified as low-medium category concerning soil risks and in the water stress categories it is qualified as category D (low/no stress). For Brazil, classified as medium category of soil risks and category D on water stress, also available & complete datasets are reported on water and soil, while a partially complete dataset is reported on air.

Indonesia and Malaysia have available and complete data sets on water and air. A partially complete set is available soil. As indicated in the section on soil, for both Malaysia and Indonesia soil risks are categorized as medium-high, regarding the growth of biofuel feedstock. The availability of data sets does indicate that an awareness of the importance of soil monitoring exists in both countries.

For the United States, complete datasets were available for water & soil and partial sets for air. A large part of the feedstock of biofuels from the USA concerns maize, for which there are risks in the use of water and soil degradation. However USA is categorized as low-medium on soil risks. Furthermore the USA is qualified as a water stress category D, indicating low water stress. Risks on environmental impacts resulting from EU biofuel production in the USA are therefore assumed low-medium.

4.7 Biodiversity

The awareness of biodiversity and its recognized importance in the economic welfare of targeted countries can be assessed by the active legal, technical and social structures in place and being used by individual countries to manage and protect their biodiversity. Taken together, these factors provide an indication of how much of the biological resources of a country may be at risk from land use changes linked to economic development activities such as biofuel production. More background information can be found in Appendix L.

Although collection and analysis of specific datasets on species and diversity was beyond the scope of this study, the individual country information provided does give good proxies about the availability of biodiversity-specific data as well as its general quality and accessibility. In order to ensure biodiversity conservation and sustainable use, the creation and management of protected areas and the regulation of the harvesting of species and pressures or threats to biodiversity such as habitat loss indicators need to be established and monitored over time.

Status of risk to biodiversity from biofuels in selected countries

Biofuel production, and other commercial and industrial development that can bring change to land cover uses introduces elements of risk to the conservation of biodiversity and the protection of environmental service functions. A country's ability to mitigate and even lower the risks from these types of economic development is dependent on a large variety of factors:

- **Societal awareness** of the importance of biodiversity **and political will** to confront and resolve issues and threats as they arise;
- **Tools** (legal instruments and policies) need to be in place as well as **responsible institutions** to deal with them
- Being a **signatory to international and transboundary agreements and protocols on biodiversity** shows a willingness to adhere to global standards;
- **Periodic reporting of the status of biodiversity** shows a level of transparency in the process;
- **Monitoring** of species, invasive alien species, threatened and endangered flora and fauna are indicative of the awareness threats to biodiversity.

The robustness of the information, its accessibility and its accuracy all contribute to the qualitative risk index for the monitored countries in Table 153. The index shows how the selected countries biological resources stand relative to risks that might be posed from biofuel production. Note that the index is not a composite of the assigned numbers – the components evaluated cannot be assigned equal weight, some are significantly more important (e.g., enforcement of an EIA law) than others. It is rather an interpretation of their frequency. A country with more 0s and 1s, for example, would be at greater risk than a nation that has predominantly 2s and 3s for qualitative scores. The data provides an incomplete picture of the risk. Used in combination with a Milennium Policy Scorecard [www.mcc.gov], looking at indices linked to the control of corruption index, government voice and accountability effectiveness, natural resources management, and land right and access would help to provide a more complete picture of the risks posed to biodiversity. Table 42 also shows areas where a country could improve its overall environmental governance.

Table 42. Status of biodiversity risk from biofuels production by country.

REGION/ COUNTRY	Environmental legislation/policies	EIA law in place	EIA law rigorously enforced	NEAP or similar in place	CBD signatory	CBD report <5 years	Other biodiversity assessments	Active management of PAs & HCV areas	Country-wide land cover mapped	Biodiversity inventories exist	IUCN Red List in use	Invasive exotic species monitored	Active env. NGOs and civil society	Relative risk index
Central/South America														
Argentina	3	2	2	1	3	0	1	3	1	3	3	0	3	Medium
Bolivia	3	2	2	1	3	0	2	3	2	1	0	2	3	Medium
Brazil	3	3	2	2	3	0	1	3	3	2	1	2	3	Low
Guatemala	3	2	2	0	3	3	3	3	3	2	0	1	3	Low
Peru	2	2	1	3	3	3	2	2	1	2	2	2	3	Medium
Africa														
Ethiopia	2	2	1	2	3	3	2	1	0	0	0	0	1	High
Malawai	2	0	0	3	3	3	2	3	2	2	2	2	3	Low
Mozambique	2	2	2	3	3	3	3	3	3	3	3	0	2	Low
Nigeria	2	2	1	2	3	0	1	1	0	1	1	0	2	Very High
Sudan	2	2	0	2	3	3	1	1	0	1	0	1	1	High
Tanzania	2	1	1	1	3	3	2	3	0	2	3	2	3	Medium
Uganda	2	1	0	2	3	3	1	3	3	2	2	0	2	Medium
Asia														
India	2	2	1	3	3	3	2	2	2	2	3	0	2	Low
Indonesia	3	3	1	2	3	3	3	2	2	3	3	1	3	Low
Malaysia	2	2	1	0	3	3	1	2	1	1	2	2	1	Medium
Pakistan	2	1	1	1	3	3	1	1	1	1	1	0	1	Very High
Europe/North America														
European Union	3	3	3	2	3	3	3	3	3	3	3	3	3	Low
Ukraine	2	2	1	2	3	3	2	1	2	1	0	0	3	Medium
United States	3	3	3	2	0	0	3	3	3	3	0	3	3	Low

Components affecting risk to biodiversity from biofuels

0 = None, or unknown; 1 = Some information; 2 = Average to good accessible information; 3 = Solid, rigorous, easily accessible data and up-to-date inform

Risk: Low, Medium, High, Very High

The EU Member States, the US and some others have expended substantial time and fiscal resources to develop and track biodiversity indicators which specialists acknowledge to be a never-ending task. From this perspective, the targeted countries surveyed for this report face the same dilemma – collecting, managing and interpreting relevant biodiversity information is purpose dependent and it requires societal awareness, political will, responsible institutions, technical savvy and budgets sufficient to back up the needed actions. In general terms, the capacities of the non-EU countries to collect data relevant to addressing threats to biodiversity and mitigating risks is substantially lower than that of the EU countries and the US. However, based on the data collected in the targeted countries, the institutions, policies and laws are largely in place. Although there were several notable exceptions observed in these countries, the fiscal resources, a sufficiently trained cadre of expertise, an enforcement ethic, and the technological tools often are not available. This leads to the conclusion that for many countries, even if a baseline assessment were established, ongoing effective biodiversity monitoring could not be guaranteed. Based on an overall qualitative assessment of available data, risks to biodiversity associated with economic development activities, like biofuel production, vary substantially in the targeted countries.

One good indicator of the vitality of an effective and dedicated environmental institution that recognizes the importance and contribution of biodiversity to a society's well being is the capacity to establish and maintain protected areas and continually monitor areas of high conservation value. All of the countries assessed have established protected areas (PAs) and most have dedicated institutions that oversee these areas. Unfortunately, the enforcement of boundaries, the management, and ultimately, the value of a significant number of these PAs are compromised (by weak governments, a lack of political will, and low budgets) as functioning protective units. Management plans do exist for at least some of the PAs, although less than twenty percent reported that management plans were current, covered more than half of the PAs existing in the country and that the borders could be delineated on a map – that is, that they knew where they were in the territory. If biodiversity is important to a government and its citizens institutions charged with the governance of these resources need the budgetary and technical wherewithal to address the task at hand. For the majority of the analysed countries this seems not the case.

Table 43 provides a summary of selected conservation and biodiversity attributes based on information collected from the targeted countries. African countries as a whole hold a weaker position in terms of available information. Overall, where data on biodiversity is available, there is a broad awareness of its importance and the essential policies, laws and institutions exist. These are essential attributes for collecting more purpose dependent information as needed for monitoring impacts on biodiversity from economic development.

Table 43. Summary of selected national conservation and biodiversity attributes

Conservation and biodiversity attributes	Central/South America					Africa							Asia				Europe/North America		
	Argentina	Bolivia	Brazil	Guatemala	Peru	Ethiopia	Malawi	Mozambique	Nigeria	Sudan	Tanzania	Uganda	India	Indonesia	Malaysia	Pakistan	EU	Ukraine	USA
Protected areas (PAs) established	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Percent of national land area within PA designation	4.2	15.5	21.5	29.3	15.1	19.0	11.1	16.0	5.5	4.9	25.0	26.4	5.0	10.6	4.6	11.5	18.0	5.5	3.7
Dedicated PA oversight institution named	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■		■	■	■
Management plans exist for at least some PAs		■		■			■	■	■	■	■	■	■	■	■		■		■
Additional areas of high conservation value are recognized within the national border		■		■			■	■				■	■	■			■	■	■
Biologically significant areas (PAs, HCV lands, wetlands, etc.) are delineated on national maps	■	■	■	■	■		■	■			■	■	■	■	■	■	■		■
A plant inventory has been taken/recorded within the last 10 years	■	■	■	■	■		■	■			■	■	■	■	■		■		■
An animal inventory has been taken/recorded within the last 10 years	■	■	■	■	■		■	■			■	■	■	■	■		■		■
Endangered/threatened species (flora and/or fauna) inventory (Red list) taken within last 5 years	■	■	■		■		■	■	■		■	■	■	■	■	■	■	■	■
Dedicated entity for monitoring species health and/or habitats named	■	■	■	■	■		■	■	■			■	■	■	■	■	■	■	■
Invasive species are monitored		■	■	■	■		■							■			■		■

■ = presence of an attribute; a blank cell signifies an attribute is not present, or that there are no data on the attribute

[1]Source: Tanzania Division of Environment. 2009. Fourth National report on Implementation of Convention on Biological Diversity. Dar es Salaam, Vice

The attributes compared among countries focus primarily on a country's attention to habitats and species. Although the presence of an attribute is important for the broad picture, details about the attribute can reveal a country's commitment to biodiversity conservation. For example, all of the countries monitored have protected areas (PAs) and almost two-thirds have more than ten percent of their territories under a PA designation[53] – a globally recognized benchmark for conservation. Closer scrutiny shows that almost a third *does not have* management plans for their PAs, an indicator of enforcement, planning capacity, and a relative degree of valuation for these resources.

High Conservation Value (HCV) areas can be a complementary and reinforcing indicator of a country's commitment to, and its capacity for monitoring threats and changes to biodiversity. HCV areas are generally outside of landscapes that have an official PA status, but are recognized for their unique habitat and/or species. These are areas that are important as migration corridors for endangered or threatened species, and/or they form important area inventories that will become PAs once resources become available and they can be officially designated as such. They can indicate a country's sophistication with biodiversity conservation, especially if these HCV areas are regularly monitored and designated as such on cover type/land use maps. In this survey, close to half of the countries reported no interest in HCV areas.

Species data and attributes linked to their measurement are more difficult to assess in the targeted countries surveyed. Basic information about plant and animal inventories, data about endangered and threatened flora and fauna, and the degree of monitoring invasive alien species showed varying degrees of reliability. Although every country surveyed is a signatory to the Convention on International Trade of Endangered Species, CITES, (see Table 154) and only three countries (Ethiopia, Sudan, Tanzania) did not cite a dedicated institution for monitoring species health and/or habitats, there was very little adherence to globally accepted standards of measurements and periodic monitoring. Collecting species data is tedious and, to be accurate, it requires a continuous effort. This demands resources that are beyond the means of most of the countries targeted for this report.

The attributes compared in the summary provided in Table 43 do not illustrate the quantity or quality of data, but merely its presence in a particular country. The details about these data, as revealed in the discussion above, does show (in relative terms) which countries have a commitment to biodiversity conservation, understand that monitoring is important and have a certain rigor and sophistication about the management of the resource. These attributes can best serve as a starting point for more specific and detailed assessments with specific development objectives.

[53] The US percentage figure is low because it includes only lands within the National Park Service jurisdiction. Other reserves and state protected areas were not included in this rapid overview of environmental attributes.

Biodiversity Data Results

First and foremost, each country must recognize the value of its biological resources to the extent that they will be measured and regularly monitored. These resources cannot be managed if they are not measured first.

There is broad awareness about biodiversity and that in the majority of cases legislation, policies and institutions do exist to address fundamental concerns about threats to biodiversity from economic development. However, enforcement of established laws and policies related to biodiversity conservation was not determined from this investigation, nor was the accuracy or overall quality of the data verified – attributes that were beyond the scope of this report. But similar to the EU and the US, the collection of biodiversity data for specific objectives needs to be carefully defined, collected rigorously and monitored/assessed carefully if it is to be of value to a country and investors in its economic development. Some countries do have data that is of immediate value because they have developed the capacity to collect and monitor it.

It was noted in the discussions on indicators and assessments that biodiversity assessments vary by stakeholder interests and values, site to site threats and management activities. The data responses obtained from the targeted countries indicate (aside from the higher risk exceptions already noted) that baseline information and the institutional framework is usually available to establish baseline assessments and conduct biodiversity monitoring necessary for economic development.

Country specific remarks

In addition to sophisticated and systematic efforts in the EU and the US, Brazil, Bolivia, and Guatemala in Central/South America already monitor data linked to biodiversity conservation on a regular basis. Among the African countries surveyed, only Malawi and Mozambique appear to have a systematic approach to data collection. Tanzania and Uganda do have focused data collection and monitoring linked mainly to their wildlife populations which provide environmental services that are important to their tourism industry. In Asia, India, Indonesia and Malaysia are becoming more sophisticated about their data collection and each country seems to recognize the value of periodic monitoring and reporting information linked to biodiversity conservation.

The EU and the US have notable systems for monitoring HCV areas in place, while Malawi, Mozambique, Indonesia and Malaysia do have notional plans for monitoring. Brazil recognizes HCV areas as a priority for action as does Guatemala. The latter has an active mapping program and strategy for these lands that could add as much as an additional nine percent to its PA territory.

Countries with active environmental NGOs and civil society organizations were often the ones that had the most up-to-date and most rigorous data about biodiversity. Countries like Malawi, Bolivia, Guatemala, Brazil, India and Indonesia had an environmental governance structure that allowed and encouraged partnerships with civil society organizations. And it was these same countries that also have a better capacity to collect and manage these types of data and use them as well in transparent reporting mechanisms. Targeted countries stressed by conflict, corruption, drought and other hardships (Pakistan, Ethiopia, Nigeria, Sudan, Ukraine) did not have the richness of biodiversity data.

Outside of the US and Europe, several countries like Indonesia, Malawi, Mozambique, Bolivia and Guatemala show significant capabilities in documenting data and indicators related to biodiversity. Others (Ethiopia, Nigeria, Sudan and Pakistan) have weak data sets and responsible entities will need to be prepared to do extensive baseline work prior to any development activity that may impact biodiversity.

In the Central/South America countries surveyed only the Bolivia data showed a strong commitment to management (with 77 percent of the Protected Areas (PAs) with current and active management plans) while others noted that plans were mandatory under existing laws but knowledge of their existence and/or use was often unavailable (Peru, Brazil). Guatemala has almost a third of its territory designated as protected areas, but less than a quarter of the PAs have active management plans. Data collected for Asia and African countries is similar. India, Mozambique and Malawi stand out because they reported close to 100 percent of their PAs have active management plans in use.

Outside of the EU and the US, Mozambique, Indonesia, India, Brazil, Guatemala and Peru do have species monitoring systems in place that show dedication and sophistication. Many times this is the result of international NGO efforts that have provided frameworks for species monitoring related to the presence of globally significant charismatic species in the country. But most countries rely on periodic outside assistance linked to the IUCN's iconic Red List efforts and on narrowly focused research by local universities and NGOs.

Biodiversity-linked data collected in four of the countries outside Europe (Ethiopia, Nigeria, Sudan and Pakistan) was often lacking in detail or was of obvious poor/unreliable quality. These countries will require more time (and probably changes in budgeting and policy priorities as well) before data can be collected and managed effectively. Other countries like Argentina, Peru, Tanzania, Uganda and Ukraine will mostly likely require targeted assistance to gain the experience necessary to collect and monitor biodiversity information that meets global standards.

Only one quarter of the analysed countries queried had Convention on Biological Diversity (CBD) reports that were not produced in the last five years, and even these (with the exception of the US which is not a signatory party) had completed at least one report. In addition, about 80 percent also had formulated a national environmental action plan and had environmental impact laws in place. These represent solid baselines for more sophisticated and targeted monitoring for biodiversity conservation.

Countries supplying EU biofuels & feedstock

For the countries providing the larger part of imported biofuels & feedstock (Argentina, Brazil, Indonesia, Malaysia and USA) main systems for conservation and policies, laws and institutions are in place. Brazil, Malaysia and Argentina are lacking additional areas of high conservation value. Furthermore Argentina and Malaysia do not have a monitoring system in place for invasive species. Brazil and Argentina do not have management plans set up for the protected areas in their countries. This is in place in Malaysia for at least several protected areas.

Indonesia and USA have all the identified conservation and biodiversity attributes in place. In general, for the countries providing the EU with biofuels in 2008, it can be stated that biodiversity monitoring is in place to a certain degree, but several countries could improve on specific aspects (like protected area management plans or additional monitoring and collecting of specific information).

4.8 Social impacts

The Renewable Energy Directive requires monitoring and reporting on the impacts on social sustainability in the EU and main third countries of supply of increased demand for biofuels.

In this section, several indicators for social sustainability as in 2008 are analysed. In the Appendix L more extensive information is provided on the various social impacts. This section is divided in the following elements:

- Local socio-economic impacts:
    - Compliance with International Labour Organisation Conventions;
    - Job creation;
    - Small farmers and land rights;
    - Farmer support in opportunities to produce biofuel feedstock;
- Macro modelling (this section is presented in Chapter 5 and deals among others with food security).

Compliance with Conventions of the International Labour Organisation [54]

Regional findings EU: All relevant Conventions of the International Labour Organisation (ILO) as listed in the Renewable Energy Directvie (regarding forced labour, child labour or discrimination)[55] have been signed and ratified by EU countries.

[54] For more information see Appendix L

[55] Convention concerning Forced or Compulsory Labour (No 29), Convention concerning Freedom of Association and Protection of the Right to Organise (No 87), Convention concerning the Application of the Principles of the Right to Organise and to Bargain Collectively (No 98), Convention concerning Equal Remuneration of Men and Women Workers for Work of Equal Value (No 100), Convention concerning the Abolition of Forced Labour (No 105), Convention concerning Discrimination in Respect of Employment and Occupation (No 111), Convention concerning Minimum Age for Admission to Employment (No 138),

Regional findings in Latin America: Most ILO Conventions are signed and ratified for each country surveyed (Argentina, Bolivia, Brazil, Guatemala and Peru). The consultant's data indicates enforcement is weak throughout the case-study countries with the exception of Brazil that has policies and education programs to eradicate child labour – especially in the informal market [ILO (OIT), Brazil]. In all cases, verification data was not available at the country level for smallholder farms. Child labour and forced labour is prevalent for landless groups in Brazil, Guatemala, and Bolivia, harvesting sugar for ethanol.

Findings relevant others: For both USA and Ukraine all ILO conventions are ratified but they have not been signed (or it is unknown if they have been signed). For the USA, weak child labour inspection/monitoring at the farm level and cumbersome policies make it difficult to track labour practices, especially at the port level [Human Rights Center, University of California, Berkeley]. Of the biofuel crops listed (sugar cane for ethanol, palm oil and soybean oil), sugar cane for ethanol was categorized with a low risk for forced/child labour [ILO-IPEC/USDOL]. Worker contracts and OSH standards were in place, however there was no data on any certifications for biofuel production in the US. Ukraine adheres to the EU legislations on working conditions and other social aspects however, there was no data listed for any other categories.

Regional findings Asia: According to the ILO and International Trade Union Confederation (ITUC) websites, most ILO Conventions are signed and ratified for India, Indonesia, Pakistan and Malaysia. Most labour laws are recorded but not enforced, especially contract labour laws and child labour prevention in agriculture [ILO (Pakistan) 1995, National Human Rights Commission Annual Report (India) 2001-02]. Specific data on levels of forced and child labour in the countries in biofuel crops or feedstocks could not be found by the consultants. However, information did exist on the approximate amount of estimated child labour and more specifically child labour in agriculture. For countries where there was data (India and Indonesia), more than half of the child labour population (68% and 57%, respectively) were engaged in work in agriculture.

Regional findings in Africa: Most ILO Conventions have been signed and ratified for each country surveyed (Ethiopia, Malawi, Mozambique, Nigeria, Sudan, Tanzania and Uganda). Data indicates that only three of the eight study countries have mechanisms in place to gauge the amount of child labour in agriculture [ILO (Mozambique), ILO, Nigeria Daily-Tribune (Nigeria) and ILO-IPEC/USDOL (Tanzania)]. Other than in Tanzania and Mozambique [ILO-IPEC/USDOL] data on the level of risk associated with ILO issues by biofuel were not available at the country

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Convention concerning the Prohibition and Immediate Action for the Elimination of the Worst Forms of Child Labour (No 182).

level since most occurrences were noted to occur at the community and smallholder level[56].

Conclusions/Recommendations:

Since it may be unlikely that the countries studied will "sign" the ratified conventions, it may be more useful and meaningful to identify other indicators that demonstrate a country's commitment to improved labour laws and enforcement of legal ages and non-hazardous working conditions for employees.

Creating an effective inspection agency and empowering its workers would highlight increased government transparency and consequently lead to the reduction of child labour and forced labour incidences

Finally, the sometimes weak enforcement and monitoring of labour practices in the US collected from the consultant, suggests that a developed nation does not necessarily indicate that developed systems or enforcing measures are in place. Developing countries have developed community awareness and certification schemes that the developed countries could benefit from and use. Particularly with respect to migrant labour and adult forced labour.

Job Creation[57]

Several studies indicate estimates of global employment related to biofuel production. For EU, the EmployRES[58] study indicates a total (direct & indirect) of about 100,000 people employed in 2005 through biofuel deployment. REN21[59] indicates global employment related to biofuel use is over 1.5 million jobs of which 730,000 in Brazilian sugar cane & related ethanol production.

The APEC[60] study on employment opportunities related to biofuel production indicates an estimate of 242,000 people employed in APEC countries related to the production of 43,401 million litres of biofuel. These estimates indicate that a large range on job creation related to biofuel production exists.

Regional findings in Latin America: Data collected from the targeted countries (Argentina, Bolivia, Brazil, Guatemala and Peru) indicates job creation from biofuels having increased or expecting to increase. Of the biofuels reviewed (sugar cane for ethanol, palm oil and jatropha), jatropha and sugar cane were the most prevalent biofuel crops. In Brazil, some 200,000 – 300,000 migrant workers are engaged in

[56] The data received indicated that ILO Convention labor issues were not disaggregated at the national evel, not separated out between feedstock for fuel and feedstock for food. There was more information at the local level in terms of available data.

[57] For more information see Appendix L

[58] EmployRES 2009 http://ec.europa.eu/energy/renewables/studies/doc/renewables/2009_employ_res_report.pdf

[59] REN21 Global Status report http://www.ren21.net/Portals/97/documents/GSR/REN21_GSR_2010_full_revised%20Sept2010.pdf

[60] APEC 2010 http://zunia.org/uploads/media/knowledge/210_ewg_Biofuels-Employ%5B1%5D1269935661.pdf

sugar cane production, part of which relates to biofuel production (for more details see the country factsheet in Chapter 6). In Argentina, about 5,000 people work in the biofuels industry.

Findings relevant others: For both USA and Ukraine, no data on amount of jobs created by biofuel production/feedstock was available. The most recent figures found on the US Department of Agriculture site state that in 2000/02, 1.9 percent of employed labour force worked in agriculture (2000) representing agricultural GDP (0.7 percent) as a share of total GDP (2002). In the Ukraine, fifteen percent of the total work force (22.3 million) is engaged in agriculture, [DOS, Ukraine].

Regional findings Asia: For most of the Asian countries studied, no information was available on exact jobs created/related to biofuel production. Only in India, it was indicated that areas producing biofuel feedstock generates 311 workdays/hectares (Planning Commission Document[61]).

In Malaysia, nearly 68,000 local and 212,000 migrant workers were employed on oil palm plantations. It should be noted that only a small part of the palm oil is used for (EU) biofuels (see the country factsheet in Chapter 6).

Regional findings in Africa: In the African countries surveyed (Ethiopia, Malawi, Mozambique, Nigeria, Sudan, Tanzania and Uganda) statistics related to job creation are still nascent. None of the consultants reported on the number of jobs created by the biofuel industry. However, in nearly all of the targeted countries, more than 50% of the population is engaged in agriculture. In Tanzania, between 200,000 and 300,000 migrant workers are engaged in sugar cane production, of which only a small part is used for biofuel production (see the country factsheet in Chapter 6).

Conclusion/recommendations

Based on lack of information retrieved, it could be surmised that biofuels currently play a nominal role as a source of labour production. In places like Malaysia, job creation at the plantation level could be an entry point for human production of biofuels and feedstock. The example of sound standards by large scale corporations has the potential to attract EU (and other foreign investment) and create a model for smallholders and cooperatives to mirror[62]. Aggregating information received on the status of forced/child labour by employer (e.g. plantation, small holder, domestic) would be helpful in determining if there is a relationship between earnings and working conditions. Based on this information, governments could intervene in situations where most prevalent cases of worst cases of child labour take place. Policies initiated at the national level can be replicated at the regional and local levels.

[61] Mainly including information on jatropha

[62] Some data collectors noted that private investments had set examples for corporate engagement and follow good labou practices. It was noted that several companies (e.g. in Mozambique) which plan to export to the EU are aware of the EU legislation and sustainability criteria.

Gender issues, small farmers and land rights[63]

Regional findings in Latin America: Civil society is highly engaged and citizens possess labour rights in Latin America. In most countries men and women have equal land rights.

Findings relevant others: While the consultant did not provide information on land rights or gender related impacts in the US, the US has very well defined and legally enforced land rights that protect its rural communities. Over the last 100 years, the US has reduced gender inequalities in agricultural communities significantly. While applicants are currently less limited by education or job opportunities than in previous decades, questions of equal pay remain, with some arguing that more could be done to increase job opportunities for women.

For the Ukraine, the consultant's report contained no information on gender impacts, small farmer's biofuels use or land/inheritance rights for men and women.

Regional findings in Asia: Much of the crops irrespective of their use, are cultivated by women but without proper inputs, technologies or output markets. Awareness of women's rights and land tenure is low across the region. Despite serving as household managers, women have limited access to 1) land/land titles and in turn 2) credit as inheritance rights tend to align with men. Inheritance rights are governed by the agricultural reform acts, land ceiling acts, tenancy acts, as well as region specific religious norms. Land tenure issues exist throughout the region. Women are key producers and were identified to need improved cook stoves and work with biofuels at the household level. The significance of this is that women may be highly encouraged to create income generation from biofuels for export as well as for domestic use if they can gain business and market skills. Closely linked to land tenure issues are challenges that women continue to face in their roles as agriculturalists and primary domestic producers of food. Four decades of research demonstrate the varied and crucial responsibilities that women hold in agriculture and the value of their contributions, both economic and social. Rural women produce half of the world's food and, in developing countries, between 60 percent and 80 percent of food crops. New directions in development assistance and agricultural investments must recognize and support women's involvement in the full agricultural value chain from production to processing to marketing [Rekha Mehra and Mary Rojas, 2010].

Regional findings in Africa: There is a high prevalence of women working in feedstock such as sugar and palm oil, and production of biofuels is predominately for household use, especially improved cook stoves. Land titles/inheritance rights in Africa are tied to credit and predominately favour men though even very few men utilize their land rights and ownership to access credit or generate capital to meet their productive (Guest, 2004). While inheritance laws have traditionally favoured men, there are many laws in place that are more equitable for women but cultural

[63] For more information see Appendix L

barriers continue to dominate and access remains limited which also means access to credit and inputs is not sufficient to produce for export standards or volume. This is an opportunity that taken could encourage women in the production and marketing of biofuels for export and increasing employment and incomes along the value chain. While Liberia is not one of the selected countries, transformation of palm oil through simple technologies such as the Freedom Mill used to extract locally processed palm oil and transitioning to mechanization for the small holder (Winrock, 2007). Women's legal rights to land can be fostered through awareness raising campaigns, finding champions in local settings to promote and train communities in accessing titles; and public private partnerships to support women's small to medium enterprises and expert businesses.

Farmer support in opportunities to produce biofuel feedstock[64]

Regional findings in Latin America: The major source of biofuels is sugar cane, soy and jatropha. Small farmers, including women farmers, can be encouraged to change from sugar cane production to jatropha which typically does not reflect a high incidence of child labour and can be more environmentally sensitive. In Latin America, large sugar producers that export to the EU (Brazil and Bolivia) are both identified as using heavily child labour and forced labour which is harmful to the producers and farmers and violates their codes of conduct codes of conduct. Efforts are being made to encourage biofuels from jatropha and work in partnership with the governments to invest private funds in inspections, awareness-raising, and good labour practices in sugarcane and jatropha.

Findings relevant others: In the United States, small farmers receive federal incentives (via tax credit and grants) to produce biofuels. Improved Energy Tech loans are given to projects that reduce air pollution and green house gases and support early commercial use of advanced technology like biofuels and alternative fuels. Animal farms generate energy which supports operations and contributes to the national grid.

The Ukrain consultant's report contained no information on farmer encouragement of biofuel feedstock/production. Nevertheless, some incentives are provided for bioenergy crops production.

Regional findings in Asia: Throughout the region, jatropha is attractive to farmers as it is less labour intensive than traditional cash crops. Jatropha, castor, sugarcane, palm oil are also viable feedstock options. Land and encouragement of farmers in terms of employment is with contract farming or agricultural subsidies.

Regional findings in Africa: Companies and organizations are investing in feedstock such as jatropha, palm oil, sugarcane and cassava for farmer encouragement. This approach could potentially lead to decentralization and democracy for developing rural economies. In a study on Mapping Food and Bioenergy in Africa (Diaz-Chavez,

[64] For more information see Appendix L

et al, 2010) it is noted that by 2004, 400 million *Jatropha curcas* L. trees were planted on 45,000 ha in North West Province of the Republic of South Africa. The South African Government then called for a moratorium on further commercial planting until it was convinced that (a) the plant was not at risk of becoming an invasive alien species, and; (b) its toxicity does not pose an environmental and health risk. Commercial plantings were given the go-ahead in 2007. Some companies have invested in jatropha in Africa." Additional opportunities for African countries may lie in jatropha as a replacement of sugarcane and palm oil.

Conclusions/recommendation

In the majority of the studied countries, biofuel production is an emerging market and has not yet gained traction as a viable stand-alone economic driver.

There is also little reference to certification or supply chain issues which indicates two important opportunities to positively impact practices in biofuel supply chains.

Conclusion local socio-economic impacts

- A trend to monitor would be the transition of traditional food crops to all biofuel crops whether being used for biofuels or in place of another crop, (sugar/starch and oil, inclusive of jatropha and castor) and what, if any, improvements in health and increased income levels can be attributed to increased biofuel production/use. While by themselves, the yields of most biofuel are not competitive as a crude oil replacement, the combined yields of all biofuels could represent a more sustainable energy alternative than continued dependence on a limited natural resource with inherent negative externalities. In Indonesia for example, additional data on what percentage feedstock crops and biofuel production comprise of the overall economy could suggest which endeavor is more lucrative. Perhaps with more transparent laws and better enforced/monitored labour practices (especially as it relates to child labour and forced labour) coupled with incentives to the private domestic sector; biofuel production would gain a stronghold in the case-study countries. Similarly in Uganda, in an effort to diversify the economy and engage in the global market, government could devote a portion of its allocated food crop land to biofuels production. Revenue from biofuel production could reduce the burden of burgeoning food prices.
- Government driven incentives of biofuel industry can have a socio-economic impact if the aim is increase biofuels production. The data from the studies indicate that farmers will likely be more willing to engage if the enabling environment (via tax incentives, land titles, subsidies, and land right policies) is profitable, equitable and there are built in measures to diversify.
- Strengthening and increasing transparency of government policies on forced/child labour is an essential ingredient in ensuring a sustainable biofuel industry. Providing incentives (e.g. seeds and tax breaks) and expanding existing infrastructure (e.g. irrigation to reach the 85% of farmers whose crops are rain-fed dependent) in Mozambique could create opportunities for agents along the

value chain. Already in Ethiopia, there is an interest and engagement by both the commercial and small holder farmers to engage in/expand their involvement in biofuel production. Biofuel production in Malawi has the potential to replace environmentally disruptive extractive industries like oil drilling (for petrol creation) as an approach which leaves less of an environmental footprint.

- Extending incentives to small holders and increasing female engagement (especially to women who are already involved in production, manage household finances and stay in school as long as or longer than males), via micro lending opportunities has the potential to strengthen the country's biofuel market and reduce risks to farmers and food security. Follow up studies may track characteristics such as equalized gender land rights, wage earnings, and practices that ensure safe and legal working conditions as socio-economic measures that would result in a sustainable impact.

5 Macro economic impacts of expanding biofuel production on food prices and land use in 2008

5.1 Major Findings

- Increased EU biofuel consumption is estimated to have contributed only little to the historical cereal price increases in 2007 and 2008. The impact of EU biofuel consumption is estimated as more substantial for price increases of non-cereal food commodities, notably through its demand for vegetable oil in the production of biodiesel;
- Global biofuel production expansion and weather related crop production distortions in 2006/07 and 2007/08, have contributed to widening the demand-supply gap in 2008 and can explain a significant part of the observed historical price increases;
- The combination of the two factors caused a combined impact that was larger than the sum of the two individual impacts, i.e. there was a non-linear and mutually reinforcing interaction of the two stress factors;
- The increase in biofuel production in the EU between 2000 and 2008 has led to an increased global agricultural land use of 1.3 Mha. This estimate obtained in modelling[65] is substantially smaller than the estimated 3.6 Mha total net land use for biofuels production as mentioned in Chapter 4. A part of the land used for biofuels feedstock production became available through yield improvements of other crops, or at the cost of decreasing production of other crops.

5.2 Background

A prime challenge of the agricultural sector today is to provide for future demand of food, feed, fibre and bio-energy crops, while responding to environmental and nature protection concerns to achieve long-term sustainability of land and water resources. To better understand the energy-food security-environment nexus a spatially detailed understanding of alternative land use and rural development options and strategies is essential.

The rapid rise in food prices of 2007 and 2008 coincided with an unprecedented expansion of maize-based ethanol production in the USA and fast biodiesel production expansion in Europe. At the same time various biofuel consumption mandates and targets were established and the industry received substantial subsidies.

There have been many speculations and accusations as to what the main causes of the food price surges in 2007 and 2008 were. Demand-supply gaps in the global food markets due to the rapid expansion of biofuel production was one of the explanations offered. Other contributing factors brought up in the discussion were

[65] Within the analysis an ecological-economic modelling framework is applied. It includes two major components, the FAO/IIASA Agro-ecological Zone (AEZ) model and the IIASA world food system (WFS) model.

poor harvests due to weather related factors, strong demand increases in economically fast growing and population rich developing countries, low levels of food stocks, and financial speculations affecting agricultural commodity markets.

While it is impossible to rerun real world history in all its complexity to see what food prices would have been without biofuel expansion and the specific policy measures supporting it, we can simulate history in a simplified way with the help of a computer model to quantify the impacts of demand growth for biofuel feedstocks on prices and conventional demand for food and feed uses of crops. The outcome can be compared to a historical simulation where biofuel expansion is suppressed and the difference in results can be interpreted as an estimate of the market impacts of historical biofuel development and policies. A similar approach can be used to quantify the impact of weather related factors by comparing simulation results for a model calculation with 'smooth' average weather (with and without biofuel expansion) to simulation results where historical production distortions due to specific historical weather events are included.

For the analysis of the global agricultural system a state-of-the-art ecological-economic modelling framework is applied. It includes two major components, the FAO/IIASA Agro-ecological Zone (AEZ) model and the IIASA world food system (WFS) model. The two model systems, adapted and expanded for resource use and by-product generation of biofuel production, form the basis of scenario evaluation of the impacts of alternative biofuel development pathways on food and agriculture at the national, regional and global levels. The modelling framework also includes a rule-based downscaling methodology to allocate the results of the world food system simulations to the spatial grid of the resource database for the analysis and quantification of environmental implications. A historical baseline assessment serves as point of departure to which alternative biofuel scenarios are compared for their impact. This scenario calculation imposes historical biofuel development throughout 2008. In addition, a scenario variant assumes weather related production shocks derived from an analysis of historical crop production trends of the period 2000 to 2008. The alternative biofuel scenarios then simulate the historical period assuming that either only EU-27 or all countries excluding the EU-27 would follow historical biofuel expansion, or alternatively that biofuel expansion would stop in year 2000. Outcomes are compared also for simulations where historical weather related deviations from regional production trends are ignored, i.e. a smooth growth of crop production without major shocks is assumed. A number of issues were clarified in this analysis, in particular the impact of biofuel expansion on price increases in the critical years 2007 and 2008, and the possible role of weather distortions in aggravating price developments in this period.

5.3 Scenario approach

The IIASA modelling framework has been applied to study the impacts of historical biofuel production expansion on food and feed markets and on the environment. Table 1 provides a summary of the scenarios simulated for the present analysis.

To assess agricultural development over the last decade, with and without biofuel expansion, several scenario simulation were carried out varying the imposed levels of biofuel production, from (i) levels recorded in the available historical records and estimates, to assuming that (ii) only EU-27 or (iii) only countries except EU-27 would follow the historical path, and to assuming that (iv) no biofuel production expansion would occur after year 2000. See Table 44 below. Note that the difference between H0-Global and H1-ROW shows the impact of the marginal increase of EU biofuels consumption on top of the rest-of-world already consuming biofuels. Similarly, but at the other end of the slope, the difference between H3-Fix and H2-EU shows the impact of the marginal increase of EU biofuels consumption compared to the year 2000, thus not putting the EU consumption as the last to enter the market.

Table 44. List of scenario experiments used in historical biofuel impact analysis

Scenario acronym	Scenario description
1. H0-Global	Simulation for period 2000 to 2008 with country/region specific biofuel production levels and feedstock mix imposed as available from historical data records.
2. H1-ROW	Simulation for period 2000 to 2008 with country/region specific biofuel production levels and feedstock mix imposed in all countries except EU-27. For EU-27, biofuel production is kept at the level of year 2000.
3. H2-EU	Simulation for period 2000 to 2008 with country/region specific biofuel production levels and feedstock mix imposed in EU-27 only. For countries other than EU-27, biofuel production is kept at the level of year 2000.
4. H3-Fix	Simulation for period 2000 to 2008 with country/region specific biofuel production and feedstock mix fixed at level of year 2000.
5. W0	As in H0 above, simulation for period 2000 to 2008 with country/region specific biofuel production levels and feedstock mix imposed as available from historical data records. In addition to assumptions for scenario H0, the scenario W0 imposes annual production shocks, which were calculated from historical FAOSTAT production data as percent deviations of annual production from the respective 2000-2008 production trend line value.
6. W1	Same as scenario H1 but with production shocks imposed as in scenario W0
7. W2	Same as scenario H2 but with production shocks imposed as in scenario W0
8. W3	Same as scenario H3 but with production shocks imposed as in scenario W0

Another external input to the model system is production fluctuation due to weather factors, which may affect region-specific crop production. For the analysis, historical production trends were calculated for each country/region and every agricultural commodity represented in the simulation model. Deviations from the trend line (in percentage terms) were then interpreted as production shocks and imposed in the historical simulations. Simulation runs for different biofuel expansion scenarios were done with and without weather related production shocks.

Biofuel production

The specification of biofuel scenarios included two steps: first, based on the data collection from different sources carried out in this project, biofuel production was specified for each country and region in the model for the years 2005 to 2008, separately for bioethanol and for biodiesel. Second, biofuel production in 2005 to 2008 is primarily based on conventional agricultural crops (maize and other cereals, sugar cane, cassava, oilseeds, palm oil, etc.). A feedstock mix is imposed for each country/region as derived from the compiled historical data.

Table 45. Production of transport biofuels by region imposed in back-casting simulations

	Biodiesel transport fuel production Million tons oil equivalent (Mtoe)					Bioethanol transport fuel production Million tons oil equivalent (Mtoe)				
	2005	2006	2007	2008	2009	2005	2006	2007	2008	2009
North America	0.3	0.8	1.5	2.1	1.7	8.2	10.3	13.8	19.7	22.8
Europe & Russia	2.8	4.3	5.0	6.8	7.9	0.5	0.9	1.0	1.6	2.0
Pacific OECD	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.1	0.1
Sub-saharan Africa	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Asia, East	0.0	0.0	0.1	0.2	0.3	0.7	0.8	0.9	1.1	1.1
Asia, South & Southeast	0.1	0.3	0.7	1.3	1.3	0.2	0.2	0.3	0.3	0.4
Middle East & N. Africa	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Latin America	0.0	0.1	0.5	1.6	2.5	7.7	9.6	11.4	13.8	13.8
World*	3.2	5.5	7.9	12.0	13.8	17.3	21.7	27.5	36.6	40.4

Source: various data sources, as collected by project members in 2010 and 2011.

Table 45 gives a regional summary of the biofuel production data used in the backcasting model simulations. For biodiesel, the global production in 2008 is estimated at 12 Mtoe of which 6.8 Mtoe (i.e. 56 percent of total production) were produced in the EU-27. Estimated global production of biodiesel in 2000 was less than 0.5 Mtoe.

Bioethanol production in 2008 was dominated by USA and Brazil, which respectively produced 19.2 Mtoe and 13.3 Mtoe of fuel ethanol, i.e. together 32.5 Mtoe out of a global production total of 36.6 Mtoe fuel ethanol. The EU-27 share in 2008 global fuel ethanol production was only less than 5 percent. Estimated global fuel ethanol production in 2000 was 9.3 Mtoe.

According to these data, global biofuel production increased from 9.8 Mtoe in year 2000 to 48.6 Mtoe in 2008, a nearly 5-fold increase. For 2005, biofuel production is estimated at 20.5 Mtoe, which highlights the very substantial production increases achieved during the period of 2006-2008.

Biofuel feedstocks

In the simulations differentiatation is made between different sources of feedstocks for transport biofuel production, based respectively on biochemical conversion of sugar crops or crops with high starch content for bioethanol or based on vegetable oil for biodiesel production.

The use of feedstocks depends on the type of biofuel (bioethanol or biodiesel) and the country or region. In the project data were collected and compiled to provide inputs into the backcasting model simulations with regard to country/region specific feedstock uses for biofuel production in 2000-2008.

Table 46 provides a summary of biofuel feedstock use in 2008 by scenario as simulated in the backcasting model experiments. Note that the level shown for scenario H3 also represents the biofuel feedstock use in 2000. It was estimated that about 60 million tons of cereals were used for fuel ethanol production in 2007, and about 85 million tons in 2008. Of these amounts respectively only 3 and 4 million tons were used in the EU-27 in 2007 and 2008. For vegetable oils and fats, the estimate comes to 9.3 million tons in 2007 and 14.3 million tons in 2008. The EU-27 use of vegetable oils and fats in biodiesel production amounted to 6 million tons and 8.1 million tons respectively in 2007 and 2008.

Table 46. Feedstock use for biofuel production in 2007 and 2008

	Biofuel feedstock use in 2007 (million tons)				**Biofuel feedstock use in 2008 (million tons)**			
Scenario	***H0***	***H1***	***H2***	***H3***	***H0***	***H1***	***H2***	***H3***
Wheat	4	2	2	0	5	3	3	0
Maize & other cereals	56	55	13	12	80	78	14	12
Sugar crops & other[66]	347	337	177	164	435	420	182	164
Vegetable oils & fats	9.3	3.8	6.1	0.5	14.3	6.6	8.3	0.5

Source: IIASA World Food System backcasting scenario simulations, June 2011.
Note: The technical conversion coefficients used in the backcasting simulations were 5.2 million tons of wheat per 1 Mtoe ethanol, 4.5 million tons maize per 1 Mtoe ethanol, 24.4 million tons sugarcane per 1 Mtoe ethanol, 10.1 million tons cassava per 1 Mtoe ethanol, and 1.2 million tons vegetable oil per 1 Mtoe biodiesel.

Biofuel feedstocks produce not only the ingredients required for biofuel production but often generate by-products. Depending on type of feedstock, conversion technology as well as which parts of the plants are used in biofuel production, substantial amounts of by-products may be produced. By-products include valuable animal feed. They may either substitute imports of feed or compete with conventional domestic feed sources. In such case both trade and domestic feed markets may be strongly affected.

[66] All feedstock use in this category is expressed in sugarcane equivalent. Consists mainly of sugar crops and sugar processing by-products; includes feedstock use from some other sources, e.g. cassava, potatoes.

The animal feed industry has productively utilized the by-products associated with the refining of oilseeds into higher value food material as well as more recently into biodiesel. In fact, in the case of soybean, the soymeal by-product is usually the prime reason for soybean production.

The alcohol-free solids and liquids remaining after fermentation and distillation of starchy crops to ethanol are generally recombined for sale as high-protein animal feed. In its wet form they are known as wet distiller's grains with solubles (WDGS) and can be sold to nearby markets. When they are dried their shelf life is extended and they are sold on domestic markets or exported as dried distiller's grains with solubles (DDGS).

For every ton of ethanol produced from grain crops, about one ton of DDGS is produced. As actual data on the rate of utilization of these by-products were not available, some additional sensitivity analysis and simulations were carried out in this respect. It is assumed in the simulations that a certain fraction of DDGS produced in the bioethanol conversion process has entered commodity markets and was available as animal feed. For 2008, utilization rates of DDGS for feeding of 0 to 30 percent were used in the sensitivity analysis.

Production distortions

Adverse weather related distortions of crop production have frequently been stipulated as an important factor contributing to international food price developments in 2007 and 2008.

For considering such distortions in the backcasting simulation experiments, the production deviations in each year from an estimated linear trend line for each crop commodity during 2000-2008 were imposed as exogenous shocks in the simulations of scenarios W0 to W3, i.e. in scenarios with and without biofuel expansion. The results were then compared to the outcomes obtained in scenarios H0 to H3 where no weather related distortions were imposed.

As an illustration, Figure 35 shows global cereal production for 2001 to 2008. As can be seen, production fell below the trend line in 2002/03 and 2003/04, exceeded trend production in 2004/05, but was short of the trend level especially in 2006/07 and 2007/08, with an implied shortfall of respectively 86 million tons and 27 million tons below the calculated trend line.

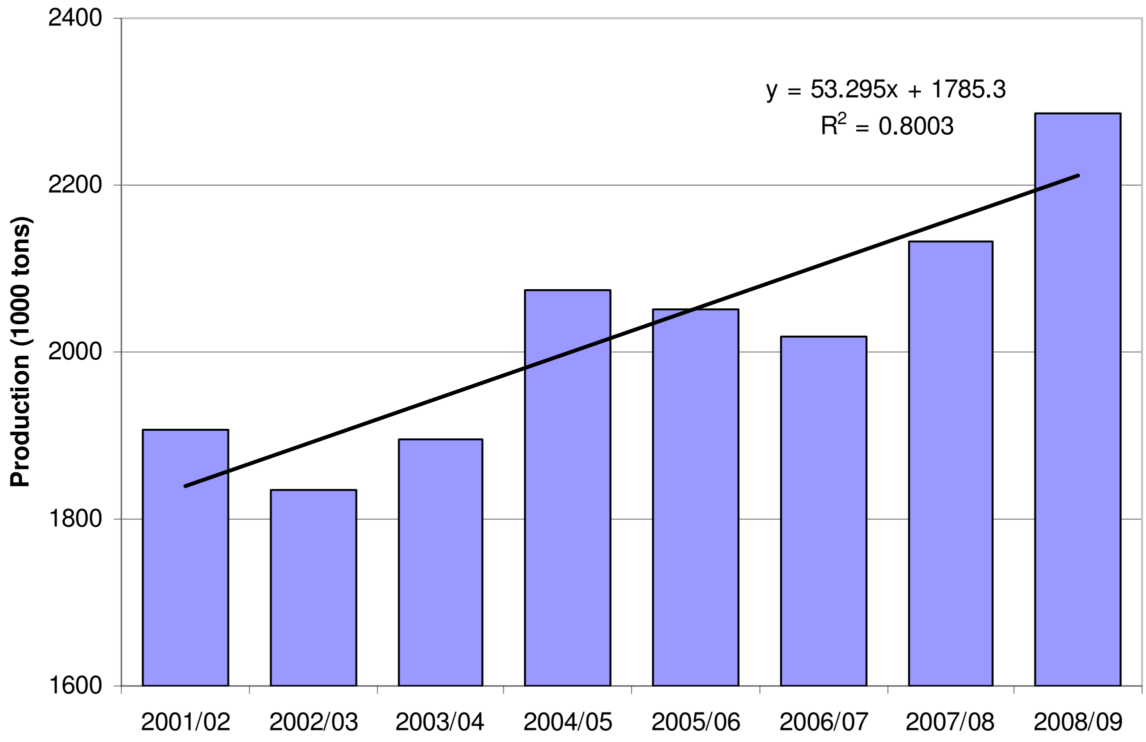


Figure 35. Global cereal production, 2001-2008. Source: FAOSTAT, online at www.fao.org

The production of cereals was well above the trend in 2008/09, which in conjunction with other important demand factors has led to at least a short term recovery of agricultural markets, as was reflected in the decrease of international agricultural prices in 2009. As international stock levels of cereal crops where already low when production shortfalls occurred in 2006 and 2007, a consequent price increase in 2007 and 2008 induced by these shortfalls in production is plausible due to creating a temporary demand-supply gap.

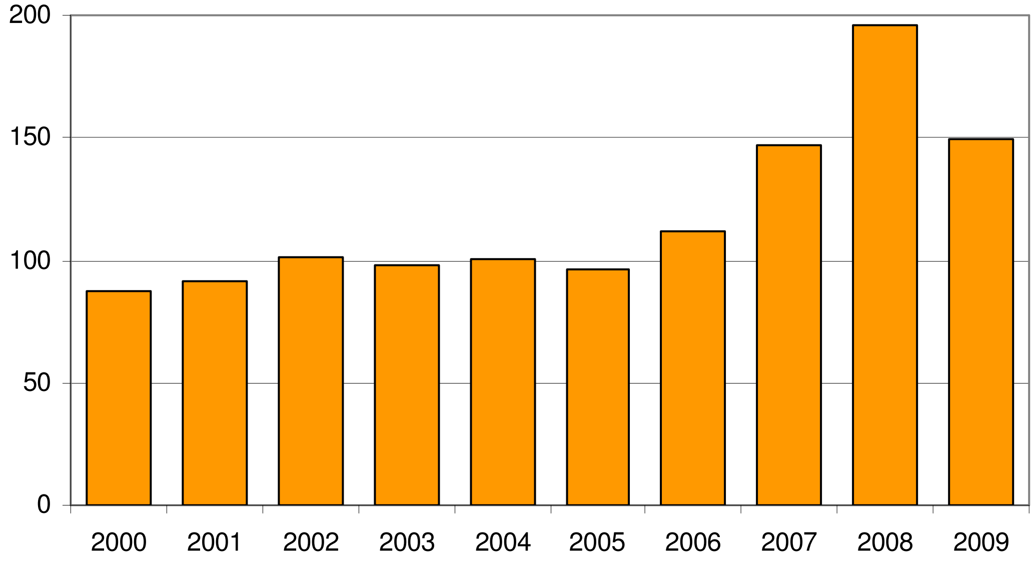


Figure 36. Annual real cereal price index (2002-2004=100), 2000-2008. Source: FAOSTAT, online at www.fao.org

As shown in Figure 37, large distortions with production levels below the trend line occurred for both wheat and maize in 2006/07 and to lesser extent in 2007/08.

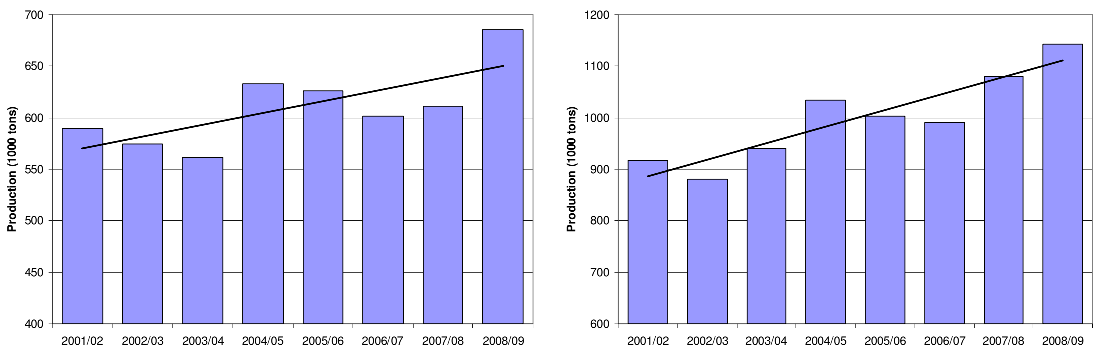


Figure 37. Global production wheat (left) and maize (right), 2001-2008. Source: FAOSTAT, online at www.fao.org

5.4 Impacts of biofuel expansion on the food system

To indicate the impacts of biofuel production expansion on main agricultural commodity and factor markets, the results are presented relative to a (hypothetical) simulation where no biofuel expansion occurs after 2000 (i.e., scenario H3). The differences between this scenario H3 and alternative biofuel scenarios (H0 = historical biofuel production levels in all countries according to historical data; H1 = historical biofuel production in all countries except in the EU-27; H2 = historical biofuel production only in EU-27) were computed with regards to impacts on international prices, impacts for food/feed markets, and land use (i.e. use of cultivated land, harvested area).

All policy settings and demand system components were kept the same for all backcasting simulation runs (except, of course, the biofuel production levels and associated feedstock demand) and no specific adjustment measures to counteract altered performance of agriculture have been assumed beyond the farm-level adaptations resulting from economic adjustments of the individual actors in the national models.

Agricultural prices

When simulating scenarios with increased demand for food staples due to the production of first-generation biofuels, the resulting market imbalances push commodity prices upwards (see Table 47). The exception is commodity 'protein feed' where increased biofuel production can result in lower prices (see scenario H2, when on EU-27 is expanding biofuels in the simulation) due to large amounts of co-products generated when crushing oilseeds or converting grains to bioethanol, i.e. livestock feeds from starch-based ethanol production and protein meals and cakes from crushing of oilseeds for biodiesel production). Having access to cheap feed sources also resulted in only very modest increases of livestock product prices.

Table 47. Impacts of biofuel expansion on agricultural prices

	Change of price index relative to reference scenario H3 (percent change)								
Scenario	*Scenario H0*			*Scenario H1*			*Scenario H2*		
	2006	2007	2008	2006	2007	2008	2006	2007	2008
Crops	7.6	9.5	16.1	5.8	7.5	13.0	1.7	1.8	2.8
Cereals	9.2	12.6	21.4	8.2	11.5	19.2	0.9	1.0	1.7
Other crops	6.7	7.8	13.3	4.5	5.5	9.6	2.1	2.1	3.4
Livestock	1.8	2.1	3.3	1.5	1.8	2.7	0.3	0.4	0.5
Wheat	7.6	9.7	16.4	6.6	8.4	14.0	1.1	1.4	2.0
Rice	3.5	4.0	6.4	3.0	3.5	5.5	0.5	0.4	0.8
Coarse grains	15.1	21.7	36.9	13.8	20.2	34.0	1.1	1.3	2.1
Protein feed	4.8	6.7	12.1	4.9	6.9	12.0	-0.1	-0.2	-0.0
Other food	7.1	8.2	13.8	4.7	5.6	9.8	2.3	2.3	3.8
Non-food crops	1.9	2.2	3.6	1.6	1.8	3.0	0.3	0.2	0.4

Source: IIASA World Food System backcasting scenario simulations, June 2011.

Table 47 indicates the magnitude of price differences occurring in the backcasting scenarios when all countries (scenario H0), all countries except EU-27 (scenario H1), and only EU-27 (scenario H2) follow the historical biofuel production path. Results are expressed relative to a scenario where no biofuel expansion is assumed during this historical period (scenario H3).

When all countries follow the historical path, then cereal prices are up in 2008 by 21 percent in scenario H0 relative to prices simulated in scenario H3. Due to the quite low production of bioethanol in EU-27, the price effect on cereals is only 2 percent in 2008 for scenario H2. Under the H0 scenario, the simulated impact on coarse grain prices (mostly maize) is 37 percent, more than twice the increase simulated for wheat. When only EU-27 historical biofuel production is simulated (scenario H2), wheat and coarse grain prices increase by about 2 percent. This suggests that EU-27 biofuel production played only a very modest role in the dramatic cereal price increases observed in 2008. For other food crops, including oil crops, the price increases simulated in 2008 due to biofuel production were 14 percent when all countries were considered (scenario H0) and respectively 10 percent and 4 percent when countries except EU-27 (scenario H1) or only EU-27 biofuel production was included (scenario H2). Thus, the role of EU-27 biodiesel production has been quite significant in pushing up other food prices, notably prices of oilseeds and vegetable oils.

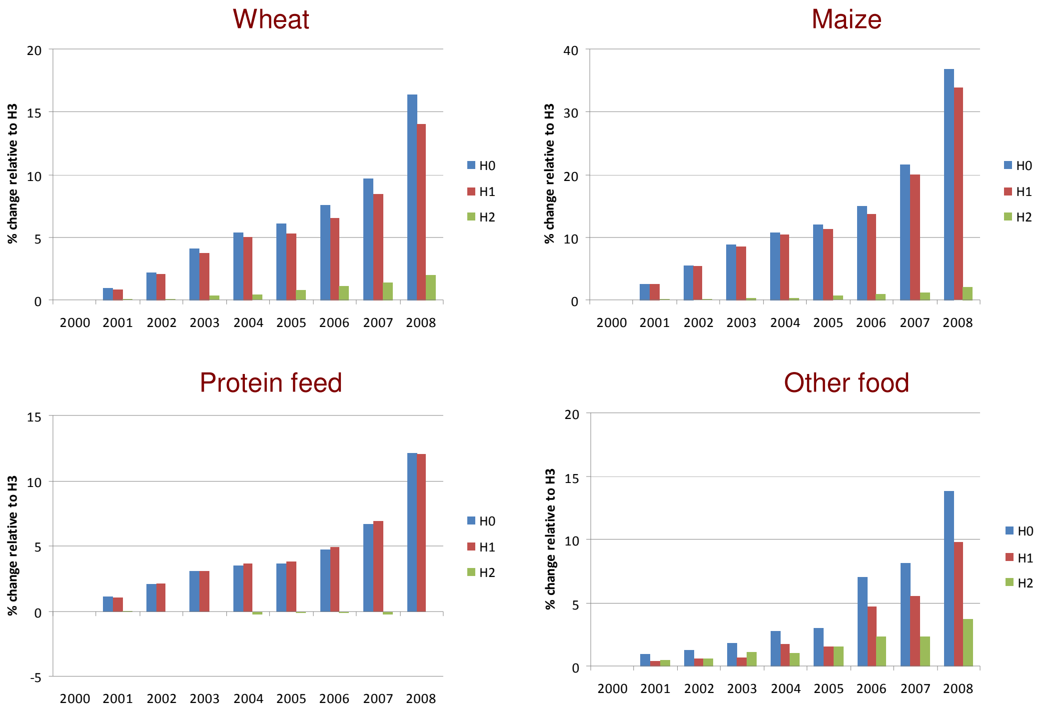


Figure 38. Impact of biofuel production on food prices (% changes relative to scenario H3). Source: IIASA World Food System backcasting scenario simulations, June 2011.

Table 48. Combined impacts of biofuel expansion and production disturbances on agricultural prices in 2008 (% change relative to prices in scenario H3)

	Change of simulated price index in 2008 relative to prices of scenario H3 (percent change)			
Scenario	***W0***	***W1***	***W2***	***W3***
Crops	35.7	31.4	19.0	14.5
Cereals	47.9	44.0	18.3	14.4
Other crops	29.2	24.6	19.3	14.5
Wheat	50.1	46.0	42.9	37.6
Rice	16.6	14.6	8.3	7.1
Coarse grains	71.6	66.4	9.1	4.1
Protein feed	47.0	46.5	24.6	23.8
Other food	29.2	24.3	19.6	14.5
Non-food crops	11.7	10.0	9.2	7.2

Source: IIASA World Food System backcasting scenario simulations, June 2011.

Table 48 presents the simulated outcomes when both historical biofuel expansion and (commodity specific) production deviations from the respective trend line were imposed. The results are expressed as percentage changes relative to scenario H3, i.e. a model simulation without biofuel production expansion after 2000 and without (weather related) production shocks. The comparison of scenario W3 to H3 indicates the effect of production distortions alone whereas comparison of scenarios W0, W1 and W2 to H3 shows the combined effect of alternative biofuel production levels and historical production shocks. The simulation suggests that the price impacts in 2008 induced by production shortfalls in 2006/07 and 2007/08 overall would have been in the order of 15 percent. Note that the production shortfall of 2006/07 compares quite well to the amount of cereals used as fuel ethanol feedstock in 2008. Combined with the additional demand for crops as biofuel feedstocks, the simulated price impact in 2008 is 36 percent for all crops and almost 50 percent for cereal crops. Note that the combined impact on simulated coarse grain prices exceeds 70 percent. Note also that the combined effect of both biofuel feedstock demand and production distortions is larger than the sum of respective impacts in simulations where only one of the two factors was imposed.

5.5 Scenario impacts on arable land use

The discussion of the extent and kind of land required for biofuel production and of the impacts on cultivated land caused by expanding biofuel production, distinguishes two elements: first, direct land use changes, i.e. estimating the extent of additional land that is used for producing actual biofuel feedstocks (i.e. feedstock that can be linked to biofuels production within a supply chain); secondly, the estimation of indirect land use effects, which can result from bioenergy production displacing services or commodities (food, fodder, fibre products) on arable land currently in production.

The approach pursued was to apply a general equilibrium framework that can capture both direct and indirect land use changes by modelling responses of consumers and producers to price changes induced by introducing competition with biofuel feedstock production. This approach accounts for land use changes but where relevant also considers production intensification on existing agricultural land as well as consumer responses to changing availability and prices of agricultural commodities.

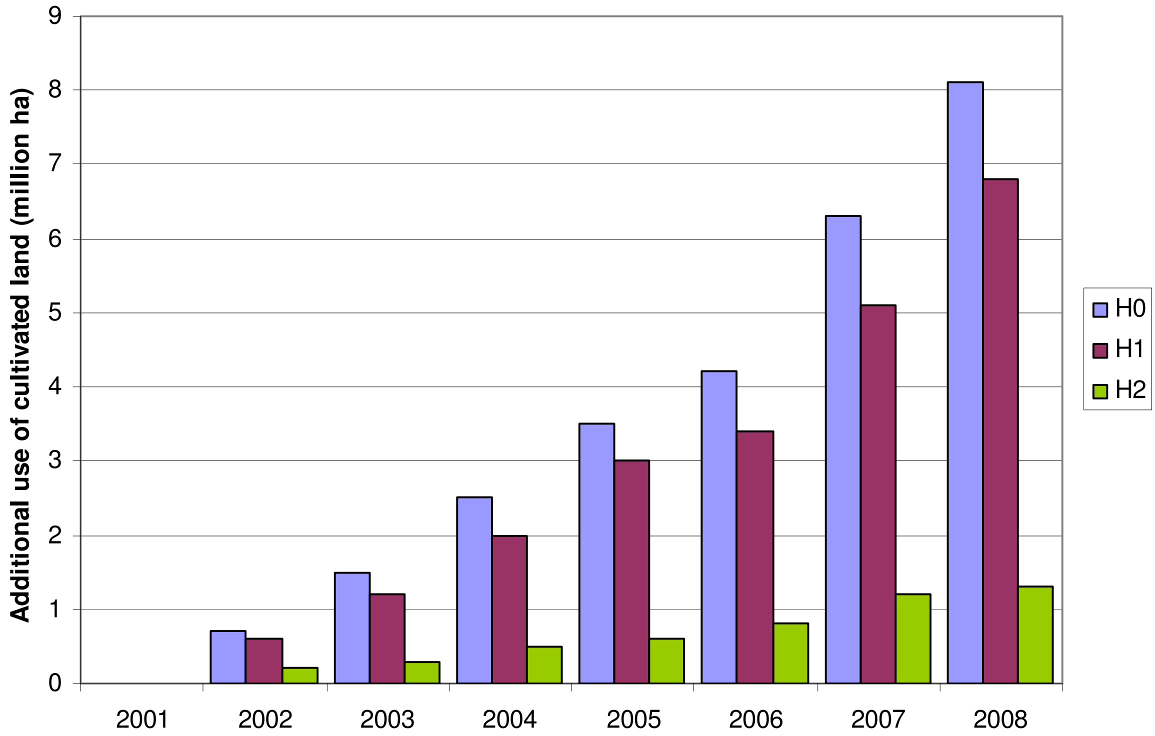


Figure 39. Additional arable land in use due to biofuel production relative to *H3.* Source: IIASA World Food System backcasting scenario simulations, June 2011.

Figure 39 shows the simulated additional use of cultivated land in the alternative backcasting biofuel scenarios relative to a simulation run without biofuel production expansion after 2000, i.e. scenario H3. According to these simulations, an additional use of cultivated land in 2008 of about 8.1 million hectares is attributed to biofuel feedstock demand when historical biofuel production figures are used for all countries (scenario H0), about 6.8 million hectares when biofuel production is simulated for countries excluding EU-27, and 1.3 million hectares when simulating for EU-27 alone.

Comparing for each scenario the additional use of cultivated land in 2008 to the respective additional production of transport biofuels (increment since 2000) gives an indication of the associated resource use per additional unit of biofuels produced. A summary for 2008 is shown in Table 49. Note that the figures shown are for a relatively short simulation period and a fast expansion of biofuel production especially after 2005 resulting in significant increases of agricultural prices. As use and conversion of cultivated land may be affected with some lag only, the figures shown in Table 49 may underestimate the full resource implications of rapidly expanding biofuel production.

The intensity of land-use is higher in H1-ROW than in H0-Global. This means that when including the EU biofuels consumption, going from H1 to H0, the average land-use efficiency is higher (land use intensity decreases). Apparently, the EU biofuels consumption leads to more efficient land use. This is also shown in H2-EU, where the 1.3 Mha additional land for EU biofuels (assuming a rest of world "without" biofuels) is much more efficiently used than in H1-ROW. The cause can be in more optimal agricultural practices and more fertile land use for the EU consumed biofuels.

Table 49. Additional use of cultivated land per additional unit of biofuel produced in 2008.

Scenario	Additional transport biofuel production (Mtoe)	Additional use of cultivated land (Mha)	Additional land used per additional unit of biofuel (Mha/Mtoe)
H0	38.8	8.1	0.209
H1	30.8	6.8	0.221
H2	8.2	1.3	0.160

Source: IIASA World Food System backcasting scenario simulations, June 2011.

5.6 Conclusions

Backcasting scenario analysis with a world food system model has been used to quantify the impact of demand growth for biofuel feedstocks in recent years on prices and conventional demand for food and feed uses of crops. The outcomes of scenarios with historical biofuel production levels were compared to a simulation for 2000 to 2008 where biofuel expansion was suppressed. The difference in results was interpreted as an estimate of the market impacts of historical biofuel development and policies. This approach was also used to quantify the impact of recent weather related factors by comparing simulation results for a model calculation with 'smooth' average weather (with and without biofuel expansion) to simulation results where historical production distortions due to specific historical weather events were included.

The results indicate that both factors, global biofuel production expansion and weather related crop production distortions in 2006/07 and 2007/08, have contributed to widening the demand-supply gap in 2008 and can explain a significant part of the observed historical price increases. The two factors are found to be of similar importance, but since the EU biofuel consumption is only a fraction (about 20%] of the increased global biofuel consumption, the EU plays only a limited part of the overall increase. The analysis suggests that the combination of the two factors caused a combined impact that was larger than the sum of the two individual impacts, i.e. there was a non-linear and mutually reinforcing interaction of the two stress factors.

The backcasting scenario analysis clearly shows that EU-27 biofuel production expansion has contributed only little to the historical cereal price increases in 2007 and 2008. The impact of EU-27 was more substantial for price increases of non-cereal food commodities, notably through its demand for vegetable oil in the production of biodiesel.

6 Country Factsheets

In the following sections a set of country factsheets for the main producing regions that export biofuels or their feedstocks to the EU market are presented for:

- EU;
- Brazil;
- USA;
- Indonesia;
- Malaysia;
- Argentina;
- Mozambique;
- Tanzania.

The following country profiles present summaries on land use and main crops (for all uses domestic and exports), land cover, biodiversity and socio-economic aspects.

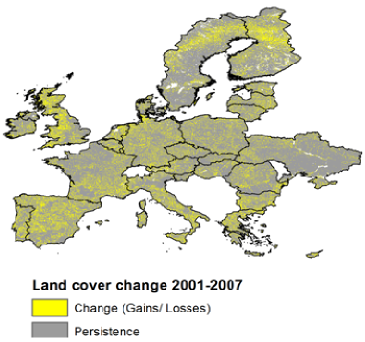
FACT SHEET
EU

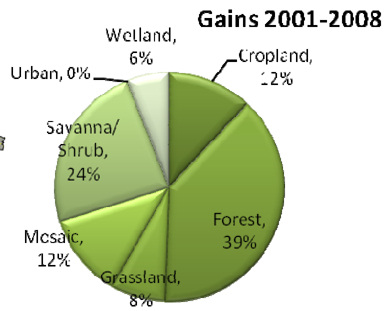
LOCATION AND GENERAL CHARACTERISTICS

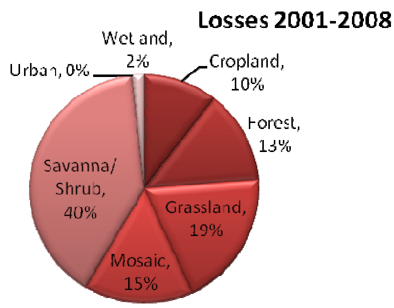
Total area 4,324,782 km2
Population 2010 estimate 501,064,211
GDP (PPP) 2010 (IMF) estimate $15.170 trillion
GINI 2009 30.7 (EU25)
The EU is the main exporter in the world and the second biggest importer.
In 2005, the EU accounted for 18.1% of world exports and 18.9% of global imports.
In 2004, more than two thirds of jobs in the 25-nation EU were in the services sector. The figure for agriculture was 5.0% and for industry 27.9%.

LAND USE

LAND PATTERN AND LAND COVER CHANGE







According to MODIS land cover datasets for 2001 and 2007, land cover change is observed on only 21% of total area of EU countries, while persistence is observed on 79% of total area of EU countries. Land cover changes are expressed as losses, when a land cover category looses area to other land cover categories, and as gains, when a land cover category gains area from other land cover categories.

BIOENERGY CROPS

Description of Agriculture

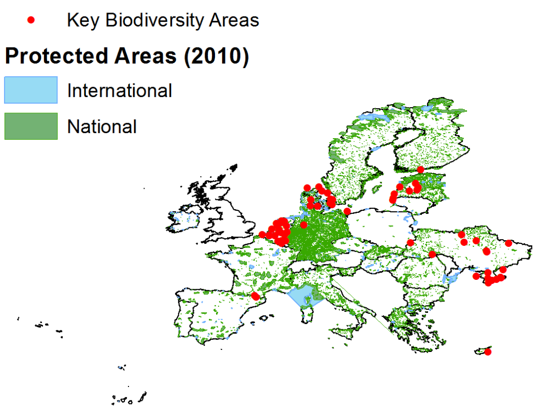
Land Used to Grow Feedstock (Hectares)	Total Area Harvested (Hectares)	Total Land Area (Hectares)
172 million		445 million

Main biofuel (related) crops (tonnes)

Wheat	Sugar Beet	Rapeseed
150,301,458	101,792,845	18,928,239

ENVIRONMENTAL ASPECTS

Biodiversity and conservation areas



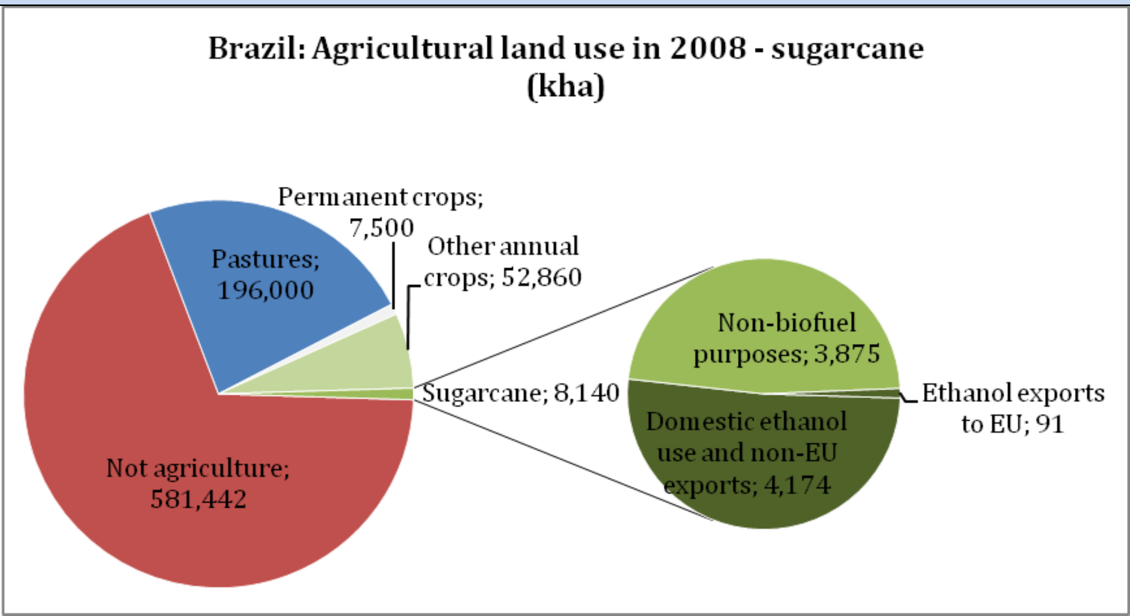
Sustainability standards.

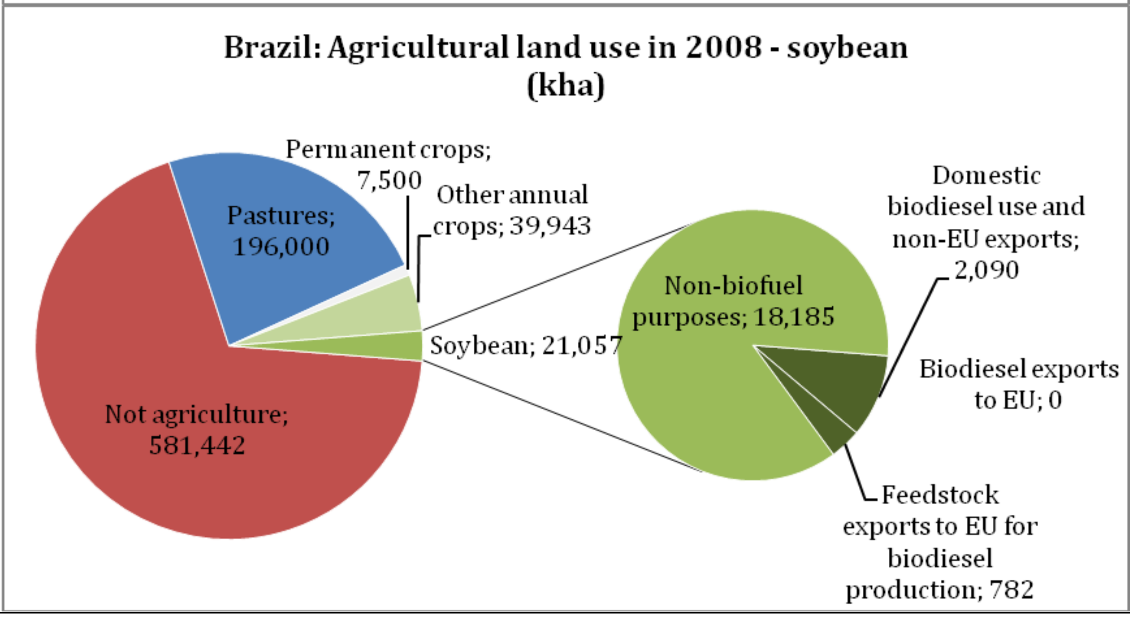
Bonsucro	FSC	PEFC	RTRS
-Belgium – AIM Progress -Denmark – Neltec Denmark -France – Ethical Sugar -Luxemburg – Ferrero -Netherlands – North Sea Group, Rabobank, Solidaridad, Suiker Unie -United Kingdom – BP, British Sugar, ED&F Man, Greenergy, Kraft Foods, Shell, Tate & Lyle	Certified forest: 22,902,571 hectares 318 certificates Chain of custody certificates: 8,727	-PEFC Belgium -PEFC Czech Republic -PEFC Denmark -Estonian Forest Certification Council -PEFC Finland -PEFC France -PEFC Germany -PEFC Italy -PEFC Luxembourg -PEFC Poland -Slovak Forest Certification Association -Institute for Forest Certification in Slovenia -PEFC Spain -PEFC Sweden -PEFC UK	
SA8000	**ISCC**	**RSPO**	**SAN/RA**
1034 facilities 344,177 employees	42 biodiesel plants 1 ethanol plant 76 first gathering points 36 oil mills 3 other plants 38 refineries 6 sugar mills 44 traders 11 warehouses certified	Members: Austria – 1 Belgium – 13 Cyprus – 2 Denmark – 3 Finland – 2 France – 29 Germany – 32 Greece – 1 Ireland – 2 Italy – 7 Latvia – 1 Luxembourg – 1 Netherlands – 37 Norway – 1 Spain – 7 Sweden – 12 Switzerland – 17 United Kingdom – 70	

FACT SHEET
BRAZIL

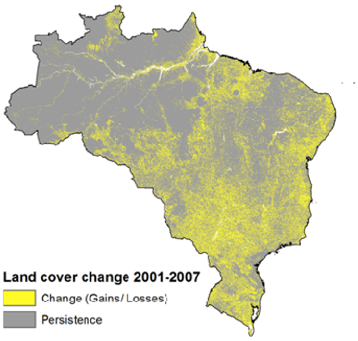
LOCATION AND GENERAL CHARACTERISTICS
Area: 8,511,965 sq. km. (3,290,000 sq. mi.) Population (2010): 190 million. Annual population growth rate: 1.02%. GDP (nominal exchange rate): $ 2.1 trillion Agriculture is a major sector of the Brazilian economy, and is key for economic growth and foreign exchange. Agriculture accounts for about 6% of GDP (25% when including agribusiness) and 36% of Brazilian exports Brazil has one of the most advanced industrial sectors in Latin America. http://www.state.gov/r/pa/ei/bgn/35640.htm

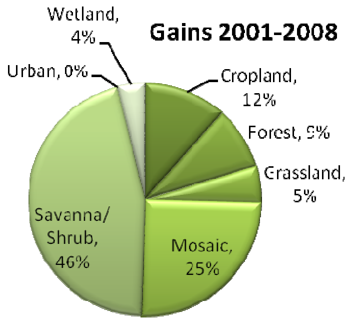
LAND USE

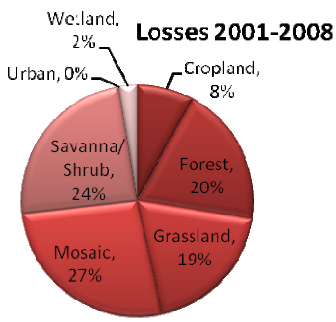




LAND PATTERN AND LAND COVER CHANGE







According to MODIS land cover datasets for 2001 and 2007, land cover change is observed on only 22% of total area of Brazil, while persistence is observed on 78% of total area of Brazil. Land cover changes are expressed as losses, when a land cover category looses area to other land cover categories, and as gains, when a land cover category gains area from other land cover categories.

BIOENERGY CROPS

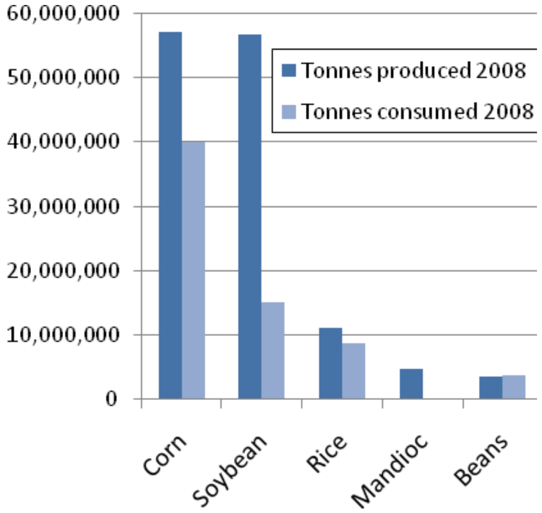
Description of Agriculture

Land Used to Grow Feedstock (Hectares)	Total Land Area (Hectares)
31,384,250.00	851400000

Main biofuel (related) crops (tonnes)

Soybean	Sugarcane	Sun Flower
56,960,732.00	648,850,000.00	109,000.00
Palm Oil	**Cotton Seed**	
1,165,100.00	1,890,600.00	

Main food crops (ha & volume)



ENVIRONMENTAL ASPECTS

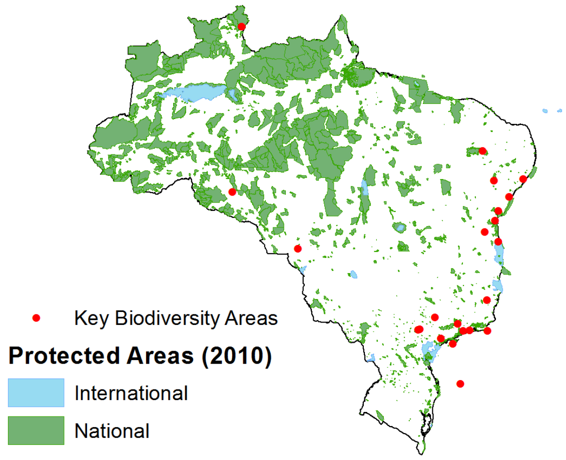
Water governance

Water Governance Institutions	Relevant Laws and Governance Documents
• National System for the Management of Hydraulic Resources (SINGREH) - formed by reps of different public bodies, including federal, state, district, municipal • Committee of Hydrographic Basin	• Federal Constitution (distinguishes ownership and responsibility for water resources between the Federation and the States).

Soil

Characteristics	Source (attach or provide weblink)	Metric	Data Collection technique	Data collection scale
IBGE/Brazilian Institute of Geography and Statistics	http://mapas.ibge.gov.br/solos/viewer.htm	IS	Satellite; manual	State

Biodiversity and conservation areas



Sustainability standards.

Bonsucro	FSC	ISCC	PEFC	SAN/RA
-Bayer Crop Science -Cevasa -Cosan -Unica	Certified forest: 6,340,866 hectares 72 certificates Chain of custody certificates: 674	1 first gathering point certified	Brazilian Forest Certification Programme (CERFLOR)	43 chain of custody certified farms 2 farms certified for sugar cane

RTRS	RSPO	SA8000
Has a the National Technical Group comprised of ICV(Civil Society), APDC (Producer), Bayer Crop Science (Industry), Monsanto (Industry), WWF (NGO), Business Social Development (BSD), Grupo André Maggi (Producer), IEGS (Civil Society).	5 members	93 facilities 82,068 employees

SOCIO-ECONOMIC CHARACTERISTICS

Employment

Biofuel feedstock production for ethanol and biodiesel largely employs men. Roughly 200,000 to 300,000 migrant workers are engaged in sugarcane production. While no numbers were available, the consultant noted that migrant farm workers are mostly relegated to sugarcane harvesting. For soy and cotton production, highly mechanized activities require less migrant workers.

ILO

2002 data records estimate 3 million children are engaged in labour, with 1.65 million working in agriculture; 35% of which are paid, [ILO (OIT), 2004]. Considering that 60% of the children work in agriculture, it can be estimated that 42% of the child labour is forced labour (1.26 million).

Land tenure

While the constitution guarantees men and women inheritance rights, equal land title ownership, and land use rights, according to the consultant's report, implementation of the law is slow and as the father is usually head of household, he normally inherits an estate and transmits his patrimony to the next generation. The majority of land is concentrated amongst a few large land holders who generally do not recognize the land distribution laws in place as the demand for biofuel generation has raised land values.

Smallholders

Large soy and cotton producers rent land from small holders as increased use of machinery and fertilizers have resulted in low margins from soy and cotton production. Incomes per hectare have been gradually decreasing (without considering the 2007/08 peak) for small holders.

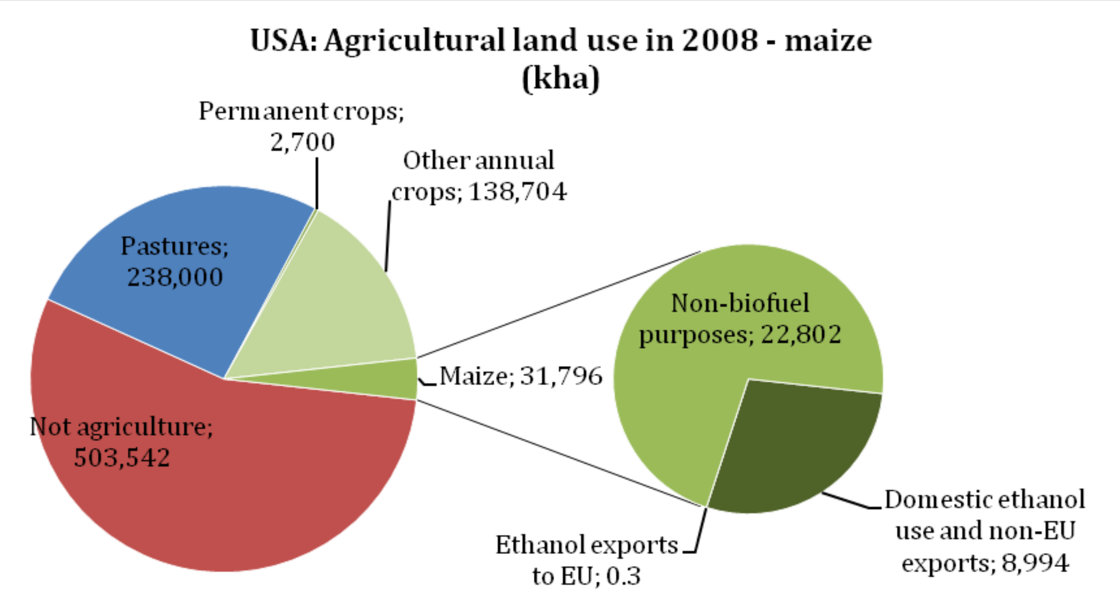
Gender

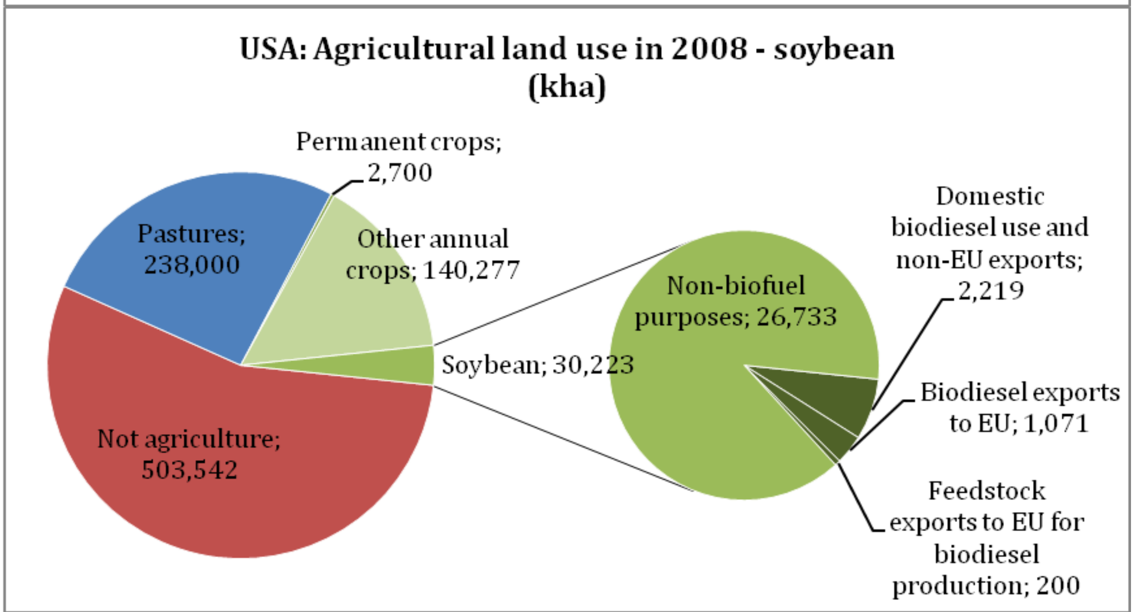
FACT SHEET
USA

LOCATION AND GENERAL CHARACTERISTICS

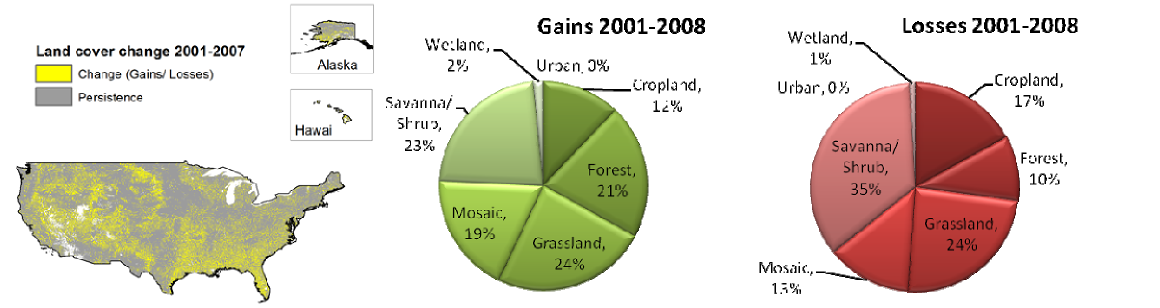
Area: 3.79 million square miles (9.83 million km^2)
Population: over 308 million people
GDP 2010 $14.7 trillion (23% of nominal global GDP)
The United States is the largest importer of goods and third largest exporter, though exports per capita are relatively low.
While agriculture accounts for just under 1% of GDP,http://en.wikipedia.org/wiki/USA - cite_note-Econ-72 the United States is the world's top producer of corn and soybeans.

LAND USE





LAND PATTERN AND LAND COVER CHANGE



According to MODIS land cover datasets for 2001 and 2007, land cover change is observed on only 23% of total area of USA, while persistence is observed on 77% of total area of USA. Land cover changes are expressed as losses, when a land cover category looses area to other land cover categories, and as gains, when a land cover category gains area from other land cover categories.

BIOENERGY CROPS

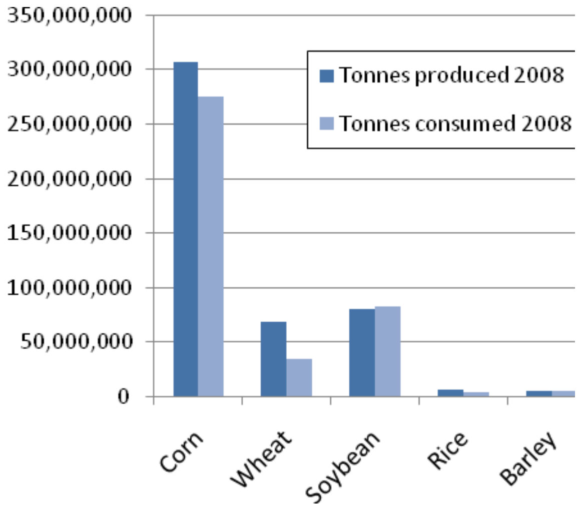
Description of Agriculture

Land Used to Grow Feedstock (Hectares)	Total Area Harvested (Hectares)	Total Land Area (Hectares)
68,791,663	65,313,719	916,192,298

Main biofuel crops (ha & volume)

Corn	Soybean	Sugarcane
307,141,735	80,748,726	30,418,506
Rapeseed	**Sorghum Grain**	
136.08	11,998,028	

Main food crops



ENVIRONMENTAL ASPECTS

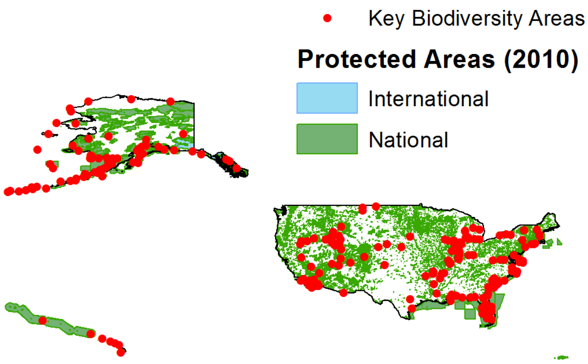
Water governance

Water Governance Institutions	Relevant Laws and Governance Documents
• Environmental Protection Agency • Army Corps of Engineers • Bureau of Reclamation • Department of Agriculture • State Environmental Agencies	• Clean Water Act (1977) • Presidential Executive Orders

Soil

Characteristics	Source (attach or provide weblink)	Metric
USDA-NRCS	http://soils.usda.gov/sqi/	Soil organic matter (SOM); Physical: soil structure, depth of soil, infiltration and bulk density; water holding capacity; Chemical: pH; electrical conductivity; Biological: microbial biomass C and N; potentially mineralizable N; soil respiration. extractable N-P-K;

Biodiversity and conservation areas



Sustainability standards

Bonsucro	FSC	ISCC
-Bacardi Limited -Cargill -Coca Cola Company -WWF	Certified forest: 13,689,849 hectares 113 certificates Chain of custody certificates: 3,742	3 ethanol plants 4 first gathering points 1 sugar mill 3 traders 2 warehouses certified

PEFC	RSPO
PEFC United States	26 members

SOCIO-ECONOMIC CHARACTERISTICS

Employment

The most recent figures found on the US Department of Agriculture site state that in 2000/02, 1.9 percent of employed labour force worked in agriculture (2000) and; representing agricultural GDP (0.7 percent) as a share of total GDP (2002). No data is available on employment related to biofuel feedstock production.

ILO

All Conventions are ratified but none have been signed. Weak child labour inspection/monitoring at the farm level and cumbersome policies make it difficult to track labour practices, especially at the port level, [Human Rights Center, University of California, Berkeley] Of the biofuel crops listed (sugar cane for ethanol, palm oil and soybean oil), sugar cane for ethanol was categorized with a low risk for forced/child labour, [ILO-IPEC/USDOL] Worker contracts and OSH standards were in place, however there was no data on any certifications for biofuel production in the US

Land tenure

No data reported.

Smallholders

Small farmers receive federal incentives (via tax credit and grants) to produce biofuels. Improved Energy Tech loans are given to projects that reduce air pollution and green house gases and support early commercial use of advanced technology like biofuels and alternative fuels.

Gender

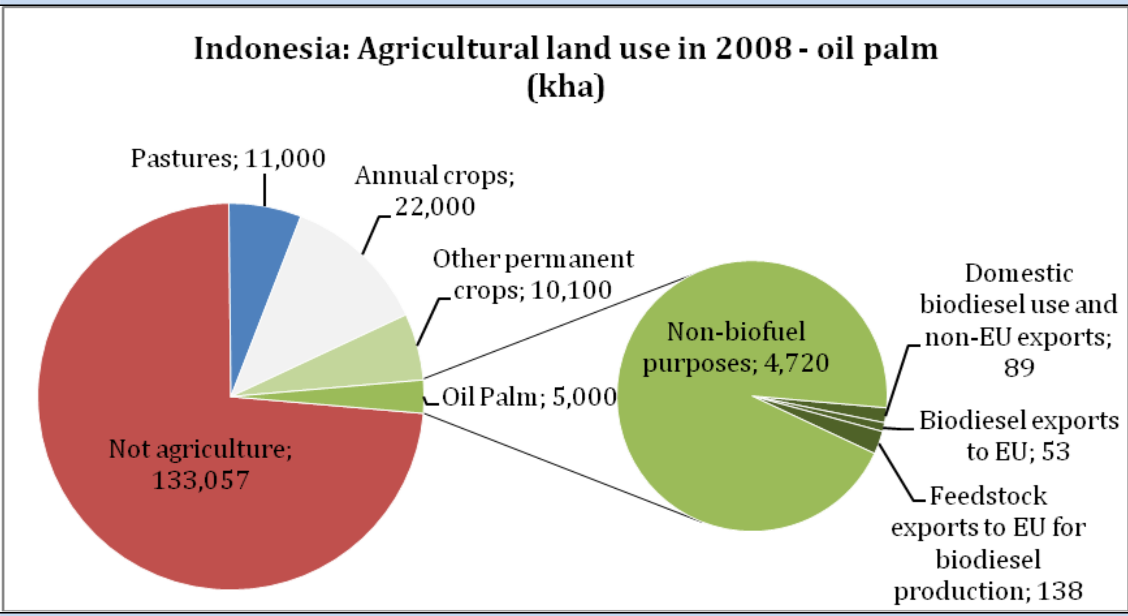
No data was reported.

FACT SHEET
INDONESIA

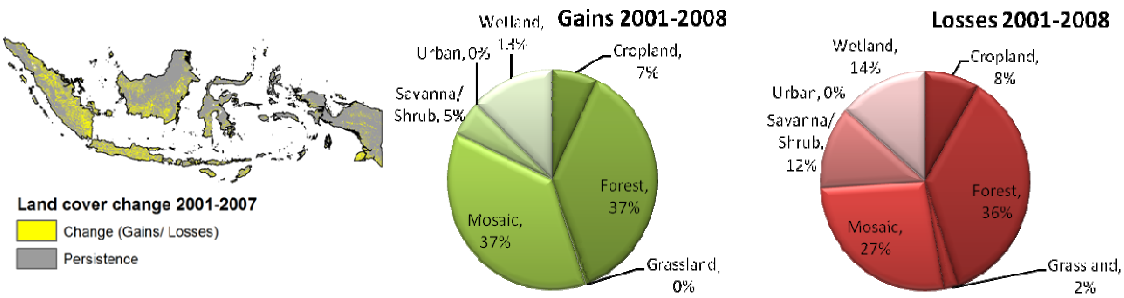
LOCATION AND GENERAL CHARACTERISTICS

Area: 2 million sq. km. (736,000 sq. mi.); maritime area: 7,900,000 sq. km
Population (July 2009 est.): 240.3 million.
Annual population growth rate (2009 est.): 1.136%.
GDP (2007): $433 billion; (2008): $511 billion; (2009): $542 billion.
Per capita income (2009 est., PPP): $4,149.
Natural resources (10.5% of GDP, 2009): Oil and gas, bauxite, silver, tin, copper, gold, coal.
Agriculture (15.3% of GDP, 2009): *Products*--timber, rubber, rice, palm oil, coffee. *Land*--17% cultivated

LAND USE



LAND PATTERN AND LAND COVER CHANGE



According to MODIS land cover datasets for 2001 and 2007, land cover change is observed on only 22% of total area of Indonesia, while persistence is observed on 78% of total area of Indonesia. Land cover changes are expressed as losses, when a land cover category looses area to other land cover categories, and as gains, when a land cover category gains area from other land cover categories.It should be mentioned that palm oil plantations are often included in the category of forests, thus possible conversion of forest to palm oil plantations is not visible from this data.

BIOENERGY CROPS

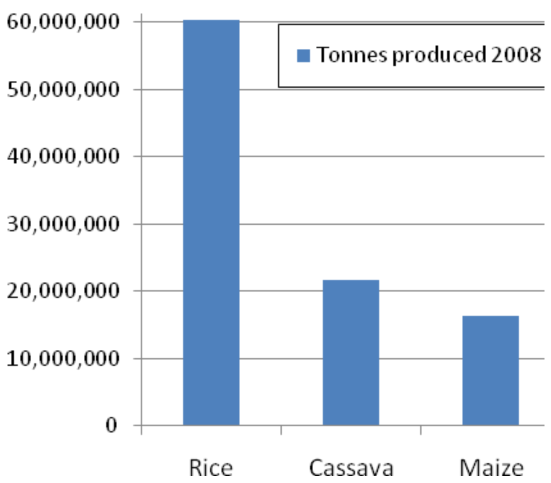
Description of Agriculture

Land Used to Grow Feedstock (Hectares)	Total Area Harvested (Hectares)	Total Land Area (Hectares)
7,824,253	5,558,780	189,075,400

Main biofuel (related) crops (tonnes)

Palm Oil	Molasses
17,539,788	2,668,428

Main food crops (ha & volume)



ENVIRONMENTAL ASPECTS

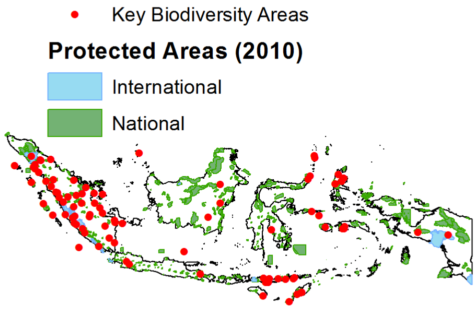
Water governance

Water Governance Institutions	Relevant Laws and Governance Documents
• President • Water Resources Council • Ministry of Public Works • Ministry of Agriculture • Ministry of Environment • Provincial Local Government • Local Government and Village Government	Indonesia river basins are grouped into river territories called Satuan Wilayah Sungai (SWS). Thus, the country has been divided into 90 SWS or river territories

Soil

Did not report any soil quality data sets.

Biodiversity and conservation areas



Sustainability standards.

FSC	ISCC	SAN/RA
Certified forest: 850,569 hectares 9 certificates Chain of custody certificates: 155	2 farms/ plantations 6 first gathering points 6 oil mills 3 warehouses certified	1 chain of custody certified farm
RSPO	**SA8000**	
77 members 13 certified growers, covering 24 mills	9 facilities 15,098 employees	

SOCIO-ECONOMIC CHARACTERISTICS

Employment
While the data did not specify amounts of jobs created by biofuels, re-harvesting and harvesting jobs exist for both bioethanol, (derived from cassava) and biodiesel (from jatropha). The consultant's data did not include the number of jobs attributable to specific biofuels, however, information did exist on the approximate amount of estimated child labour and more specifically child labour in agriculture.

ILO
An estimated six percent (3. 5 million) of the 58.8 million children between the ages of 5-17 are engaged in child labour; an estimated 57.2 percent (2.02 million) of the 3. 5 million work in agriculture. There is no data to determine whether the percentage of child labour for biofuels feedstocks is higher or lower than for agriculture as a whole. Jatropha is the only biofuel crop, with no data for its level of risk associated with ILO issues, or those pertaining to palm oil or sugar cane as biofuel crops or biofuel production. Workers receive contracts, have access to sanitation facilities, and medical access, [Labour Law No. 25; Indonesia, 2007].

Land tenure
Indonesian men are more likely to inherit land than women, twice as likely, if they are Muslim.

Smallholders
The consultant reported no information on impacts of biofuel production or small farmers' engagement in biofuel feedstocks/production.

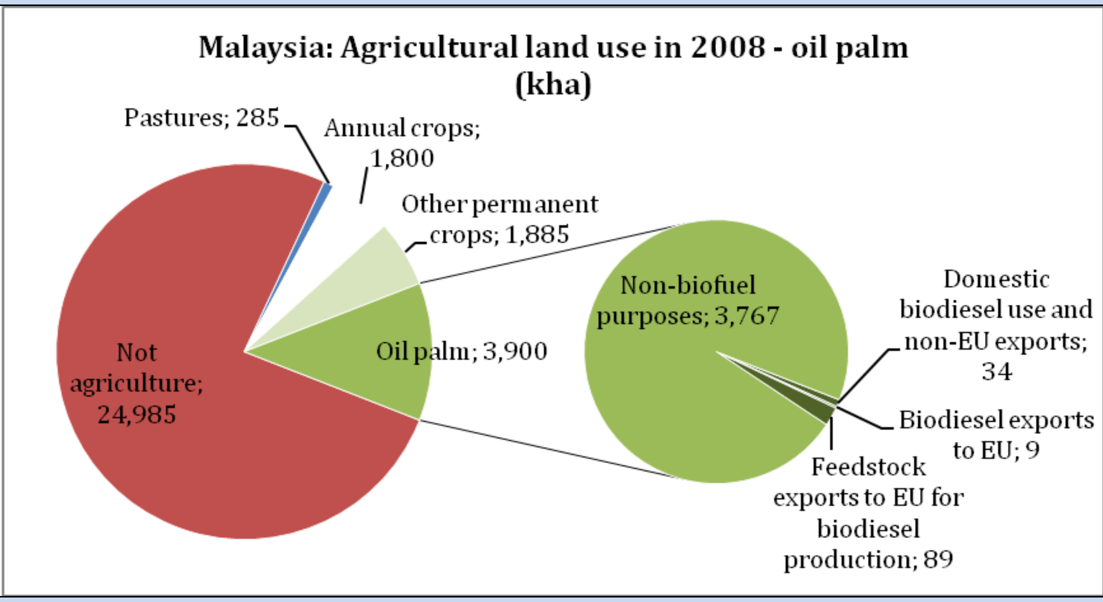
Gender
The report did not indicate any information on gender issues for biofuel crops or household benefits from use of feedstock/biofuel production.

FACT SHEET
MALAYSIA

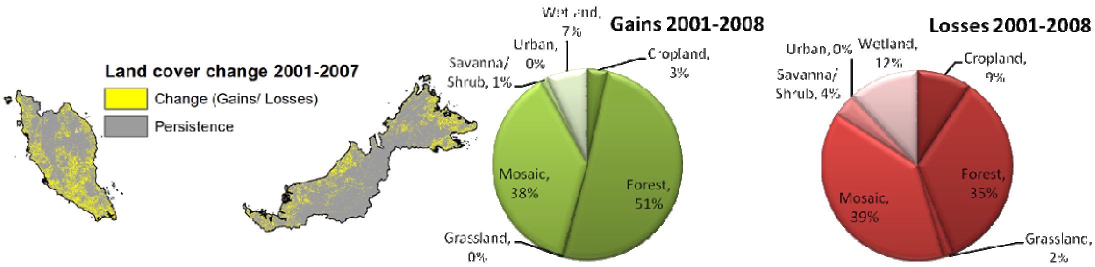
LOCATION AND GENERAL CHARACTERISTICS

Area: 329,847 sq. km. (127,315 sq. mi.)
Population (2010): 28.3 million
Nominal GDP: $191.5 billion.
Nominal per capita income (GNI): $6,897.
Natural resources: Petroleum, liquefied natural gas (LNG), tin, minerals.
Agricultural products: Palm oil, rubber, timber, cocoa, rice, tropical fruit, fish, coconut.

LAND USE



LAND PATTERN AND LAND COVER CHANGE



According to MODIS land cover datasets for 2001 and 2007, land cover change is observed on only 18% of total area of Malaysia, while persistence is observed on 82% of total area of Malaysia. Land cover changes are expressed as losses, when a land cover category looses area to other land cover categories, and as gains, when a land cover category gains area from other land cover categories.
It should be mentioned that Palm oil plantations are often included in the category of Forests, thus possible conversion of forest to palm oil plantations can not be seen from this data.

BIOENERGY CROPS

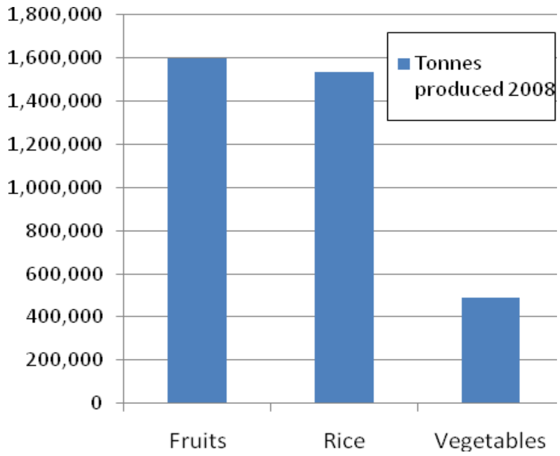
Description of Agriculture

Land Used to Grow Feedstock (Hectares)	Total Area Harvested (Hectares)	Total Land Area (Hectares)
4,487,957	3,915,924	33,080,300

Main biofuel crops (tonnes)

Palm Oil
17,734,441

Main food crops



ENVIRONMENTAL ASPECTS

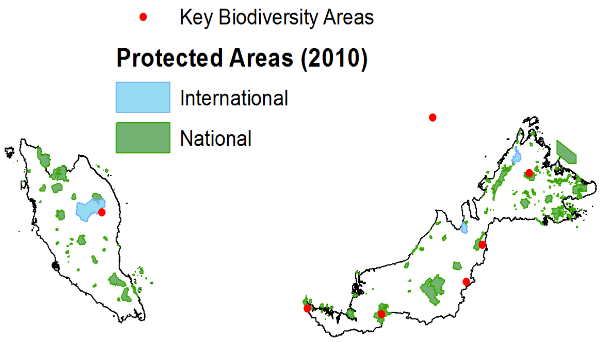
Water governance

Water Governance Institutions
• Department of Water Supply and National Water Services Commission • Department of Environment • Department of Irrigation and Drainage

Soil

Characteristics	Years Available
Ministry of Agriculture	soil suitability maps available for the 1960s and 1970s

Biodiversity and conservation areas



Sustainability standards.

FSC	ISCC	PEFC
Certified forest: 203,840 hectares 5 certificates Chain of custody certificates: 125	2 biodiesel plants 4 first gathering points 4 oil mills 2 refineries 1 trader certified	Malaysian Timber Certification Council

RSPO	SA8000
89 members 10 certified growers, covering 53 mills	1 facility 474 employees

SOCIO-ECONOMIC CHARACTERISTICS

Employment
The consultant’s baseline survey data from June 2010 indicates a 20+ hectare palm oil plantation employed nearly 68,000 local and 212,000 foreign migrant workers. Employees hired through contractors, numbered 8,400 and approximately 23,000, respectively. The majority of workers are hired to plant palm oil solely for vegetable oil and oleochemical production.

ILO
There was a low risk of forced/child labour related to palm oil cultivation and processing and no reported data for other potential biofuel crops such as sugar cane. Information gathered from the consultant states that plantation unions negotiate contracts with companies on behalf of seasonal harvesters and while plantations provide medical services, workers are usually exposed to pesticides with inconsistent access to safety precautions/materials. (Subsequent USDOL 2010 reports indicate that there is incidence of forced labour in oil palm in Malaysia.)

Land tenure
No information on land rights other than inheritance lies with men for Muslim women.

Smallholders
The consultant’s data indicated small farmer engagement in biofuel feedstocks/production as not applicable. at the household.

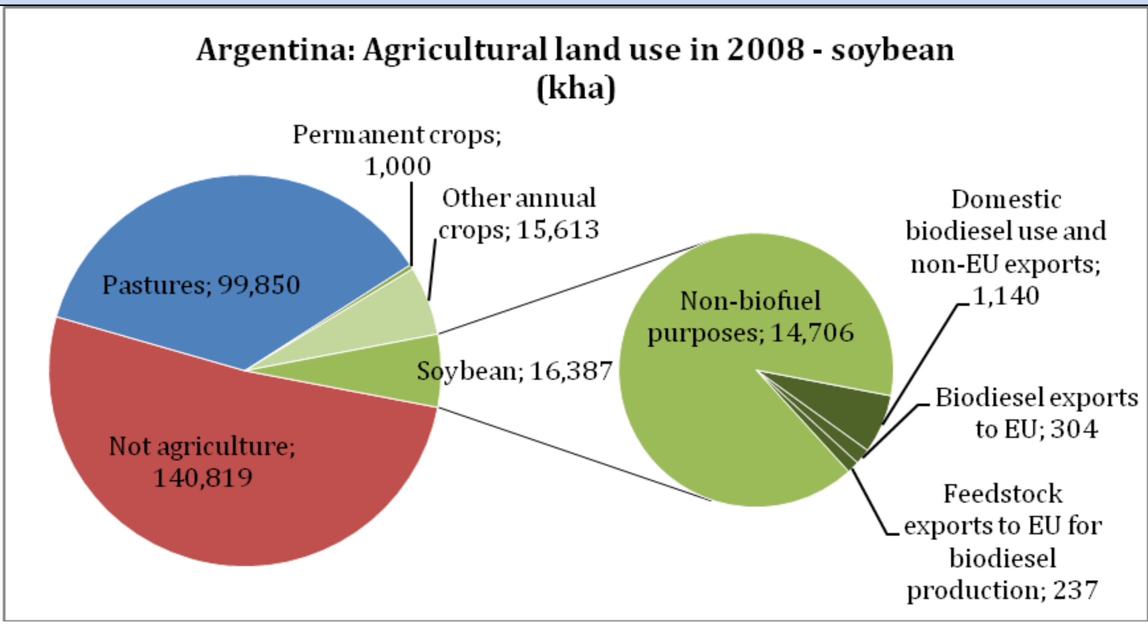
Gender: The consultant’s data indicated gender issues for biofuel crops/production as not applicable

FACT SHEET
ARGENTINA

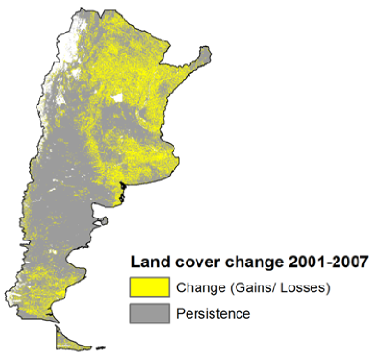
LOCATION AND GENERAL CHARACTERISTICS

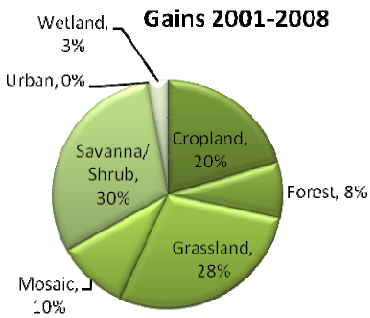
Argentina benefits from rich natural resources, a highly educated population, a globally competitive agricultural sector, and a diversified industrial base
Population (2010 est.): 41.029 million.
Annual population growth rate (2010 est.): 1.053%.
GDP 2009 U.S. $306.7 billion

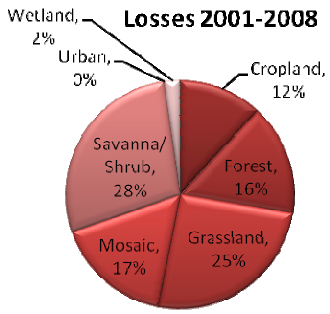
LAND USE



LAND PATTERN AND LAND COVER CHANGE







According to MODIS land cover datasets for 2001 and 2007, land cover change is observed on only 28% of total area of Argentina, while persistence is observed on 72% of total area of Argentina. Land cover changes are expressed as losses, when a land cover category looses area to other land cover categories, and as gains, when a land cover category gains area from other land cover categories.

BIOENERGY CROPS

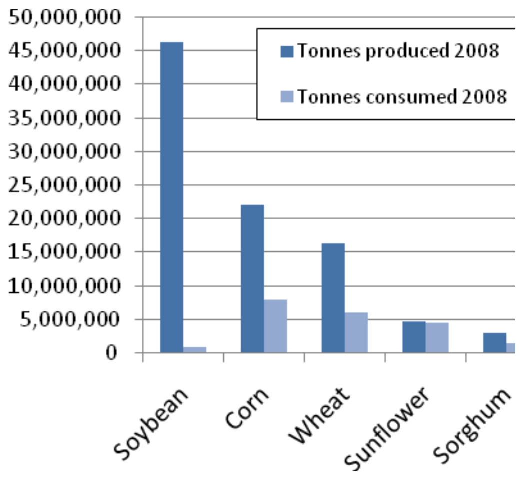
Description of Agriculture

Land Used to Grow Feedstock (Hectares)	Total Area Harvested (Hectares)
18,032,805	16,767,548

Main biofuel (related) crops (tonnes)

Soybean
30,993,379

Main food crops (ha & volume)



ENVIRONMENTAL ASPECTS

Water governance

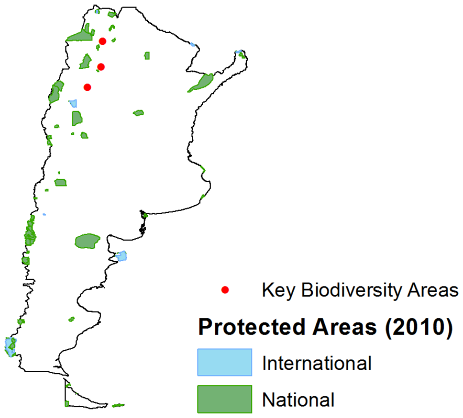
Water Governance Institutions	Relevant Laws and Governance Documents
• Secretary of public works • Deputy Minister of Water Resources • National Bureau of Conservation and Protection of Water Resources • Bureau of Control and Regulation of Water Resources	• Federal National Plan for Water Resources

Soil Quality Data sets

No national data set available, but should be soon as a program is under development

Biodiversity and conservation areas	**Sustainability standards**

Biodiversity and conservation areas



Sustainability standards

FSC	SAN/RA	RTRS	SA8000
Certified forest: 229,210 hectares 18 certificates Chain of custody certificates: 50	14 chain of custody certified farms	Has a National Technical Group comprised of AAPRESID (Producer Association), Los Grobo (Producer), Grupo Lucci (Producer), UBA University (Academic area), Fundación Vida Silvestre (NGO), Cargil (Industry), Asaga (Industry).	3 Facilities 5,710 employees

SOCIO-ECONOMIC CHARACTERISTICS

Employment
The biofuel industry created an average of 5,000 jobs, the most of which were indirect labour positions versus direct operation jobs [Hilbert]. Over the next 15 years, it is estimated that the industry will generate 60-70,000 new jobs. Most industry job creation will be driven by demand for animal meal derived from increased soybean production and not necessarily for soybean oil.

ILO
While the legal working age is 18 years, the Ministry of Labour (MOL) cites 20% of overall child labour instances affecting those 14-17 years of age, with 14-17 year olds representing 14% of child labour in agriculture.[67] With respect to monitoring child labour laws, the MOL provides a public website[68] where violations of child labour can be reported.[69]

Land tenure
Men and women were reported by the consultant's data to have equal inheritance rights and are reported to earn equal wages.

Smallholders
The most significant actors engaged in biofuel production are large companies whose product is destined to foreign market. Most agriculture production is done on land rented by farmers.

Gender
Peak income earning period for labourers is age 35-49 with no information as it relates to gender.

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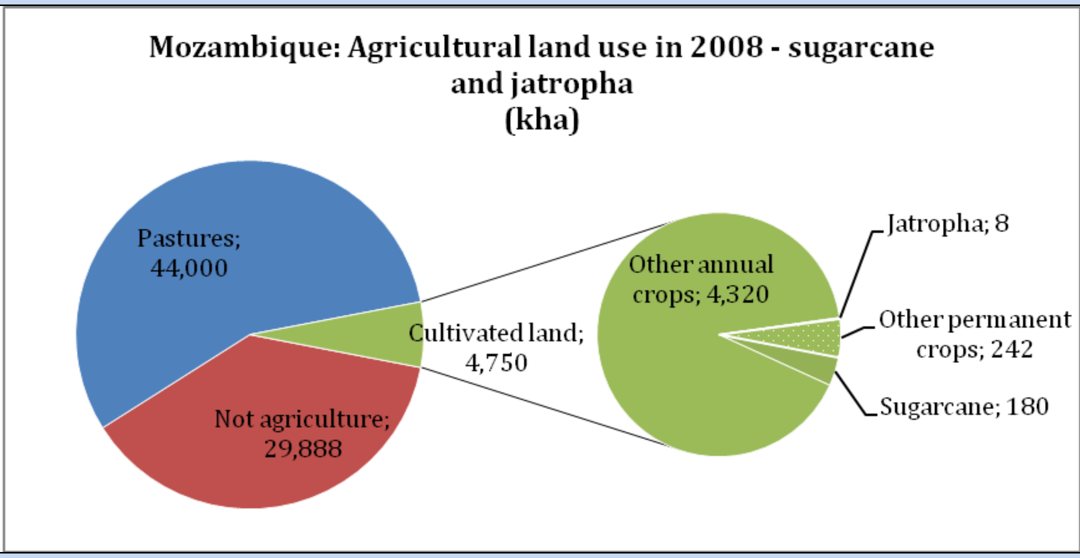
[67] http://www.oit.org.ar/documentos/ti_en_argentina.pdf, http://www.dol.gov/ilab/regs/eo13126/main.htm
[68] http://www.trabajo.gob.ar/left/estadisticas/bel/belDisplay.asp?idSeccion=1&idSubseccion=2
[69] http://www.trabajo.gov.ar/left/estadisticas/otia/index.asp?pregunta=2

FACT SHEET
MOZAMBIQUE

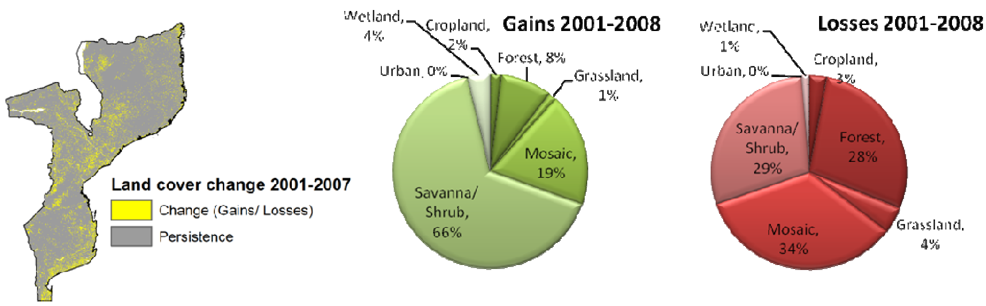
LOCATION AND GENERAL CHARACTERISTICS

Area: 308,642 sq. miles
Population (2009 est.): 20.226 million; 48.2% male and 51.8% female
GDP: $17.64 billion.
Annual economic (GDP) growth rate (2009): 4.5%.
Per capita gross domestic product (2009): $465.
Natural resources: Hydroelectric power, coal, natural gas, titanium ore, tantalite, graphite, iron ore, semi-precious stones, and arable land.
Agriculture (21% of GDP; annual growth 7.9%): *Exports*--cotton, cashew nuts, sugarcane, tea, cassava (tapioca), corn, coconuts, sisal, citrus and tropical fruits, potatoes, sunflowers, beef and poultry. *Domestically consumed food crops*--corn, pigeon peas, cassava, rice, beef, pork, chicken, and goat.

LAND USE



LAND PATTERN AND LAND COVER CHANGE



According to MODIS land cover datasets for 2001 and 2007, land cover change is observed on only 11% of total area of Mozambique, while persistence is observed on 89% of total area of Mozambique. Land cover changes are expressed as losses, when a land cover category looses area to other land cover categories, and as gains, when a land cover category gains area from other land cover categories.

BIOENERGY CROPS

Description of Agriculture

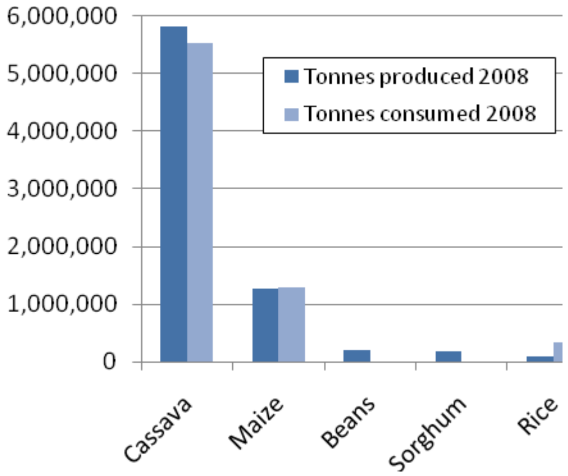
Land Used to Grow Feedstock (Hectares)	Total Area Harvested (Hectares)	Total Land Area (Hectares)
1,000	3,600,000	79,938,000

Main biofuel (related) crops (tonnes)

Jatropha: 554.5

Sugar cane: 113.3

Main food crops



ENVIRONMENTAL ASPECTS

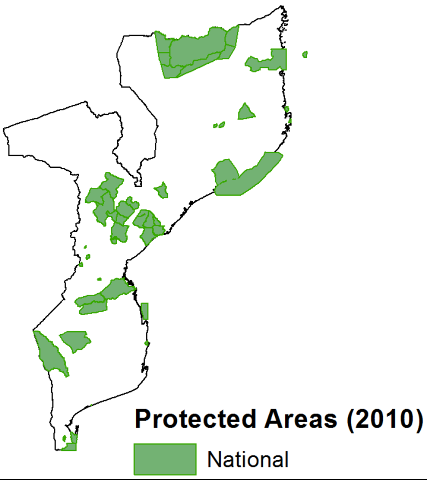
Water governance

Water Governance Institutions	Relevant Laws and Governance Documents
• National Council of Water • Regional (South, Centre, Zambezi and North) Water Administration Authorities • Scientific Council of Water presided by the Ministry of Science and Technology • Ministry of Fisheries • Ministry of mineral resources • Ministry for the coordination of Environmental Affairs • Ministry of Housing and Public Works	• Water Law (No 16/91)

Soil

Characteristics	Source (attach or provide weblink)	Years Available
Recent soil quality analysis has been carried out by the Institute for Agricultural Research (IIAM)	http://library.wur.nl/isric/fulltext/ISRIC_940.pdf	1949

Biodiversity and conservation areas



Sustainability standards.

FSC
Certified forest: 46,240 hectares 1 certificate

SOCIO-ECONOMIC CHARACTERISTICS

Employment
No data reported on the number of families working for wage labour on biofuel farms, but report states that more families are engaged in the practice as they lack the capital to comply with biofuel certification guidelines to establish their own farm. Overall, 81 % of the work force (9.4 million est. 2006) is engaged in agriculture [DOS, Mozambique].

ILO
The labour law has structures in place for monitoring forced labour and child labour but it is noted as being unclear. Private sector compliance to labuor laws is monitored only for an organization's first two years of existence. Mozambique has a National Policy and Strategy for Biofuels with structures in place that provide for fair trade and Corporate Social Responsibility (CSR) and companies engaging in biofuel production or feedstock trade (export or import) are aware of the EU legislation and sustainability requirements. There were no reports on the level of risk associated with ILO issues of sugar cane for ethanol, palm oil or other fuels.

Land tenure
While there are matrilineal and patrilineal inheritance rights, the constitution states that all land and inclusive natural resources belong to the state.

Smallholders
While farmers lack capital to comply with certification guidelines, microfinance institutions (MFIs) are providing credit to small farmers. The high level of public participation and established SME presence already providing agricultural inputs (pesticides) and services (machinery) are two important components for scaling up biofuel production, [Interview with Center for Promotion of Agriculture (CEPAGRI)].

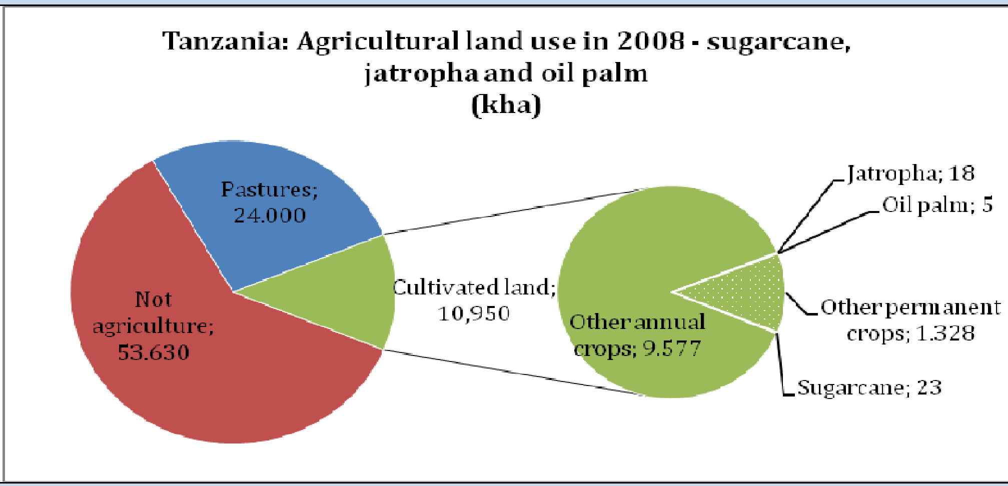
Gender: Men and women both work on plantations, but women at the farm level work longer, resulting in less leisure time. The increased income women receive (especially from plantation work) allows them to purchase and plant their own biofuel seeds and later sell for cash. Traditionally only engaged in subsistence farming, more women, and their families are working for wage labour on biofuel farms.

FACT SHEET
TANZANIA

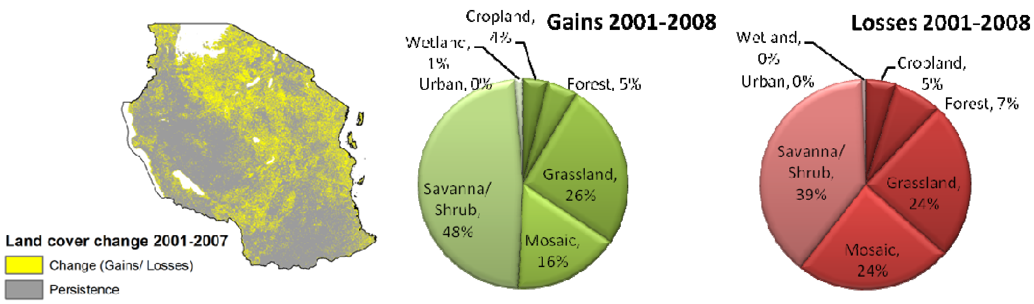
LOCATION AND GENERAL CHARACTERISTICS

Area: *Mainland*--945,000 sq. km. (378,000 sq. mi.)
Population: *Mainland*--41.8 million (2010 est.). *Zanzibar*--1.3 million (est.).
GDP (2010 est.): $23.2 billion.
GDP per capita (2009): $509.
Natural resources: Hydroelectric potential, coal, iron, gemstones, gold, natural gas, nickel, diamonds, crude oil potential, forest products, wildlife, fisheries.
Agriculture (2009 est.): 26.6% of GDP. *Products*--coffee, cotton, tea, tobacco, cloves, sisal, cashew nuts, maize, livestock, sugar cane, paddy, wheat, pyrethrum.

LAND USE



LAND PATTERN AND LAND COVER CHANGE



According to MODIS land cover datasets for 2001 and 2007, land cover change is observed on only 26% of total area of Tanzania, while persistence is observed on 74% of total area of Tanzania. Land cover changes are expressed as losses, when a land cover category looses area to other land cover categories, and as gains, when a land cover category gains area from other land cover categories.

BIOENERGY CROPS

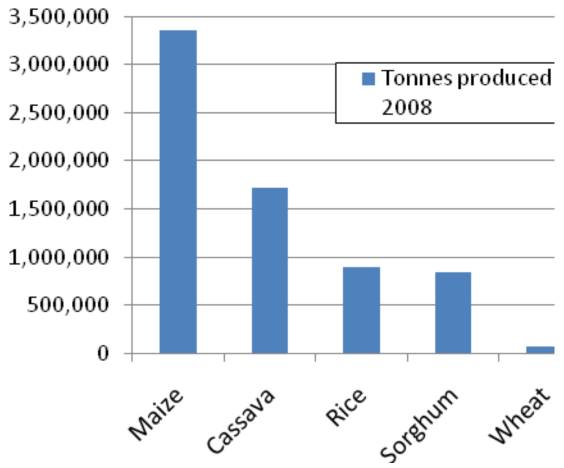
Description of Agriculture

Land Used to Grow Feedstock (Hectares)	Total Area Harvested (Hectares)	Total Land Area (Hectares)
282,936	44,000,000	94,500,000

Main biofuel (related) crops (has)

Sugarcane	Sweet sorghum	Oil palm
22,500	25,000	30,436
Jatropha	***Croton megalocapus***	
185,000	20,000	

Main food crops



ENVIRONMENTAL ASPECTS

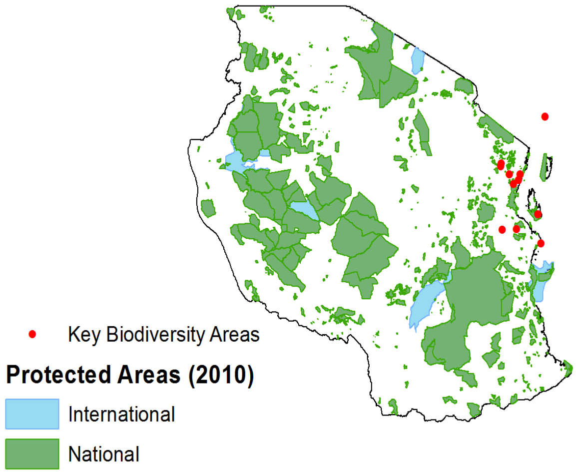
Water governance;

Water Governance Institutions	Relevant Laws and Governance Documents
• President • Minister • Director of Water Resources • National Water Boards • Water Basin Boards • Catchment and Sub-Catchment Water Committees • Water User Associations	• Water Resource Management Act (1999)

Soil

No data was reported

Biodiversity and conservation areas



Sustainability standards.

FSC
Certified forest: 32,462 hectares 2 certificates Chain of custody certificates: 1

SOCIO-ECONOMIC CHARACTERISTICS

Employment
Biofuel feedstock production for ethanol and biodiesel largely employs men. Roughly 200,000 to 300,000 migrant workers are engaged in sugarcane production. While no numbers were available, the consultant noted that migrant farm workers are mostly relegated to sugarcane harvesting. For soy and cotton production, highly mechanized activities require less migrant workers.

ILO
2002 data records estimate 3 million children are engaged in labour, with 1.65 million working in agriculture; 35% of which are paid, [ILO (OIT), 2004]. Considering that 60% of the children work in agriculture, it can be estimated that 42% of the child labour is forced labour (1.26 million).

Land tenure
While the constitution guarantees men and women inheritance rights, equal land title ownership, and land use rights, according to the consultant's report, implementation of the law is slow and as the father is usually head of household, he normally inherits an estate and transmits his patrimony to the next generation. The majority of land is concentrated amongst a few large land holders who generally do not recognize the land distribution laws in place as the demand for biofuel generation has raised land values.

Smallholders: Large soy and cotton producers rent land from small holders as increased use of machinery and fertilizers have resulted in low margins from soy and cotton production. Incomes per hectare have been gradually decreasing (without considering the 2007/08 peak) for small holders.

Gender: Women are relegated to harvesting wood for household heating and cooking.

7 Literature sources[70]

ACSS, 2011, Assured Combinable Crops Standards. Red Tractor Farm Assurance Combinable Crops & Sugar Beet Scheme (formerly ACCS). URL: http://assurance.redtractor.org.uk/rtassurance/farm/crops/cr_about.eb. Accessed March 2011.

Ariati, Ratna, 2010, Personal Communication, Director for New Renewable Energy and Energy Conservation, Ministry of Energy and Mineral Resources, Indonesia.

BioNachV, 2007, Regulation regarding requirements for the sustainable production of biomass for use as biofuels (Biomass Sustainability Regulation – BioNachV).

Bonsucro, 2011, Bonsucro or Better Sugar Cane Initiative Production Standard - July 2010, Better Sugarcane Initiative Ltd. URL: http://www.bettersugarcane.org/. Accessed December 2011.

Bonsucro, 2011b, Our Members, Bonsucro. URL: http://www.bonsucro.com/members.html. Accessed 11 March 2011.

BV, 2011, Biomass and Biofuels Sustainability Certification. URL: http://www.bureauveritas.fr/wps/wcm/connect/bv_fr/Local/Home/bv_com_serviceSheetDetails?serviceSheetId=14670&serviceSheetName=Biomass+and+Biofuels+Sustainability+Verification. Accessed February 2011.

Colchester, M., Jiwan, N., Andiko, Sirait, M., Firdaus, A., Surambo, et al., 2006, Promised Land. Palm oil and land aquisition in Indonesia: implications for local communities and indigenous peoples. Gloucester: Forest Peoples Programme, Perkumpulan Sawit Watch, HuMA & World Agroforestry Centre.

COM, 2006, Biofuels Progress Report. Report on the progress made in the use of biofuels and other renewable fuels in the Member States of the European Union. Accompanying document to the biofuel report. COM(2006) 845 final. SEC(2006) 1721/2. Brussels.

CSBP, 2010, Draft Provisional Standard for Sustainable Production of Agricultural Biomass, Council on Sustainable Biomass Production.

Dam et. al., 2010, From the global efforts on certification of bioenergy towards an integrated approach based on sustainable land use planning.

[70] The literature sources presented in this chapter connect to literature references made in the main section of this report. For literature references made in the annexes, sources are presented in the same annex.

Diaz-Chavez, 2007. Comparison of Draft Standards- Contribution to ECCM, 2006. Environmental Standards for Biofuels. A report commissioned by the Low Carbon Vewhicle Partnership. URL: http://www.lowcvp.org.uk/resources-library/reports-and-studies.asp?pg=11. Accessed January 2011.

Diaz-Chavez R and Rosillo-Calle F, 2009, Biofuels for Transport – Sustainability and Certification, Where are we now and where are we going, Department for Transport, UK.

Dillon, HS, Laan, T, Dillon HS, Government support for ethanol and biodiesel in Indonesia, Geneva, Switzerland, Global Subsidies Initiative of the International Institute for Sustainable Development, 2008.

DfT, 2006, International resource costs of biodiesel and bioethanol, UK Department for Transport.

EC, 2003, Directive 2003/30/EC of the European Parliament and the Council on the promotion of the use of biofuels or other renewable fuels for transport. Official Journal of the European Union. Brussels.

EC, 2009, SEC(2009)503, Commission staff working document, Accompanying document to The Renewable Energy Progress Report.

EC, 2009, 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.

EC CAP, 2011, Objectives and instruments for a European Common Agricultural Policy after 2013. URL: http://ec.europa.eu/agriculture/cap-post-2013/debate/documents/contributions/sh/sh-20100521-0001_en.pdf. Accessed February 2011.

Eurostat, 2010, European Commission - Eurostat database, http://epp.eurostat.ec.europa.eu, 10 May 2010

Eurobserv'er, 2009, Biofuels Barometer.

Farell, A. E. and D. Sperling, 2007a, A Low-Carbon Fuel Standard for California - Part 1:Technical Analysis, Regents of the University of California.

Farell, A. E. and D. Sperling, 2007b, A Low-Carbon Fuel Standard for California - Part 2: Policy Analysis, Regents of the University of California.

FSC, 2011, The Forest Stewardship Council (FSC), Standards. URL: http://www.fsc.org/. Accessed January 2011.

FSC, 2011b, Global FSC certificates: Type and Distribution. URL: http://www.fsc.org/fileadmin/web-data/public/document_center/powerpoints_graphs/facts_figures/2011-02-15-Global-FSC-Certificates-EN.pdf. Accessed March 2011.

F.O. Licht, 2011, personal communication of C Biggs with F.O. Licht.

Gallardo ALCF and Bond A, 2010, Capturing the implications of land use change in Brazil through environmental assessment: Time for a strategic approach? Environmental Impact Assessment Review 31(3):261-270.

GBEP, 2011, Task Force on Sustainability, Global Bioenergy Partnership. URL: http://www.globalbioenergy.org/fileadmin/user_upload/gbep/docs/2008_events/6th_Steering_Committee/TF_Sustainability-Report_to_6th_SC1.pdf. Accessed February 2011.

Genesis Quality, 2011, Genesis Quality Assurance. URL: http://www.genesisqa.com/. Accessed March 2011.

Greenergy. 2008. Full Sustainability Criteria. URL: http://www.greenergy.co.uk/Biofuel_sustainability/PDFs/Standard_Brazilian_sugarcane.pdf. Accessed June 2010.

HCV Network, 2005, HCV Overview, High Conservation Value Network. URL: http://www.hcvnetwork.org/about-hcvf. Accessed June 2010.

IADB 2011. Inter-American Development Bank IDB Sustainable Energy and Climate Initiative (SECCI) and Biofuels Sustainability Scorecard.

IIASA, World Food System backcasting scenario simulations performed for the EC Biofuel Baseline project, June 2011.

ILO, 2011, Labour Standards.International Labour Organisation. URL: http://www.ilo.org/global/standards/lang--en/index.htm. Accessed January 2011.

IPIECA, 2008, Workshop: Biofuel Sustainability and Chain of Custody. London, UK, 29 September 2008. IPIECA/ISEE/GBC. URL: http://www.ipieca.org/activities/fuels/workshops/sept_08.php. Accessed January 2011.

ISCC, 2011, Sustainability Requirements for the Production of Biomass. International Sustainability & Carbon Certification.URL: http://www.iscc-system.org/e865/e890/e1491/e1496/ISCC202SustainabilityRequirements-RequirementsfortheProductionofBiomass_eng.pdf. Accessed January 2011.

ISEAL, 2010, Impacts Code of Good Practice, ISEAL Alliance. URL: http://www.isealalliance.org/content/impacts-code. Accessed February 2011.

ISO, 2011,International Standard Organisation catalogue of available and in process standards. URL: http://www.iso.org/iso/catalogue_detail.htm?csnumber=52528. Accessed February 2011.

Lamers, P., McCormick, K., Hilbert, J., 2008, The emerging liquid biofuel market in Argentina: Implications for domestic demand and international trade. Energy Policy 2008;36:1479-90.

Lamers, P., Hamelinck, C., Junginger, M., Faaij, A., International Bioenergy Trade – a review of past developments in the liquid biofuels market, Berlin, Germany, 2011.

Lopez, Gregore Pio and Laan, Tara, 2008, Biofuels – At What Cost? Government Support for Biodiesel in Malaysia. Prepared for the Global Subsidies Initiative and the International Institute for Sustainable Development.

LEAF, 2011, Leaf Marque Standard. URL: http://www.leafuk.org/leaf/farmers/LEAFmarquecertification/standard.eb. Accessed March 2011.

Mekonnen MM and Hoekstra AY, 2010, The green, blue and grey water footprint of crops and derived crop products, Value of Water Research Report Series No.47, UNESCO-IHE, Delft, the Netherlands.

PEFC, 2010, Program for Endorsement of Forest Certification. URL: http://www.pefc.org/. Accessed June 2010.

REN21, 2011, Renewables 2011 Global Status Report, Paris, REN21 Secretariat.

RFA, 2008, Quarterly Report 2: 15 April - 14 October 2008. Renewable Fuel Agency UK. http://www.renewablefuelsagency.org/reportsandpublications/rtforeports.cfm. Accessed January 2009.

RFA, 2011, Carbon and Sustainability Guidance, Renewable Fuels Agency. URL: http://www.dft.gov.uk/rfa/reportsandpublications/carbonandsustainabilityguidance.cfm. Accessed September 2010.

Rhee, S., Kitchener, D., Brown, T., Merrill, R.,Dilts, R & Tighe, S, 2004, Report on Biodiversity and Tropical Forests in Indonesia. Jakarta: USAID.

Rosillo- Calle, F, Walter, A., Pelkmans L., A global review of the vegeteable oils, with respect to biodiesel, IEA Bioenergy Task 40, 2009

RSB, 2010, The Roundtable on Sustainable Biofuels: Version 1. URL: http://energycenter.epfl.ch/. Accessed January 2011.

RSPO, 2010, RSPO Principles and Criteria for Sustainable Palm Oil Production, Roundtable on Sustainable Palm Oil. Public Release Version.

RSPO, 2011, RSPO Members, Roundtable on Sustainable Palm Oil. URL: http://www.rspo.org/?q=countrystat. Accessed January 2011.

RTRS, 2011, Principles and criteria, Round Table on Responsible Soy Association. URL: http://www.responsiblesoy.org/principles_criteria.php. Accessed January 2011.

RTRS, 2011, Certification: National Interpretations, Round Table on Responsible Soy Association.

SAI, 2011, Social Accountability International. URL: http://www.ac.org.ar/nota_e.asp?did=13768. Accessed January 2011.

SAN, 2011, Rainforest Alliance: Sustainable Agriculture Network. URL: http://sanstandards.org/sitio/subsections/display/7. Accessed January 2011.

Schott, Christina, 2009, Socio-Economic Dynamics of Biofuel Development in Asia Pacific*,* Friedrich, Ebert, Stiftung (FES) Indonesia Office.

SEKAB, 2008, Verified Sustainable Ethanol Initiative. URL:http://www.sustainableethanolinitiative.com/default.asp?id=1062. Accessed: September 2008.

SMA, 2007, Queima de Cana de Açucar. URL: http://www.ambiente.sp.gov.br/cana/default.asp. Accessed December 2007.

Soepardjo, Tuti, 2010, Personal Communication, Consultant, Winrock International, Indonesia.

Sustainable Food News, 2010, Is Sustainable Agriculture Standard Effort Dead?, Sustainable Food News. URL: http://www.sustainablefoodnews.com/story.php?news_id=10794. Accessed March 2011.

TNT, 2010, TNT at a Glance. URL: http://group.tnt.com/aboutus/tntataglance/index.aspx. Accessed January 2011.

Unica, 2011, Quotes and Statistics, http://english.unica.com.br/dadosCotacao/estatistica/

Yale University, 2010 Environmental Performance Index, epi.yale.edu

Appendices to Chapter 2 (Biofuel Market Place)

Appendix A Production and consumption statistics

Use of biofuels in road transport in Europe (in tonne oil equivalent - toe).

Eurostat nrg_1073a 2011 dataset

	2007	2007	2007	2007
	Bioethanol	Biodiesel	Other	Total
Austria	13,000	250,000	45,000	308,000
Belgium	0	87,000	0	87,000
Bulgaria	0	0	2,000	2,000
Cyprus	0	1,000	0	1,000
Czech Republic	0	30,000	0	30,000
Denmark	6,000	0	0	6,000
Estonia	0	0	0	0
Finland	1,000	0	0	1,000
France	279,000	1,168,000	0	1,447,000
Germany	292,000	1,245,000	1,185,000	2,722,000
Greece	0	85,000	0	85,000
Hungary	27,000	2,000	0	29,000
Ireland	3,000	17,000	2,000	22,000
Italy	0	141,000	0	141,000
Latvia	0	2,000	0	2,000
Lithuania	12,000	42,000	0	54,000
Luxembourg	1,000	33,000	0	34,000
Malta	0	0	0	0
Netherlands	88,000	189,000	0	277,000
Poland	80,000	23,000	2,000	105,000
Portugal	0	133,000	0	133,000
Romania	0	40,000	0	40,000
Slovakia	12,000	78,000	0	90,000
Slovenia	1,000	13,000	0	14,000
Spain	113,000	272,000	0	385,000
Sweden	182,000	102,000	0	284,000
United Kingdom	77,000	268,000	0	345,000
	1,187,000	4,221,000	1,236,000	

	2008	2008	2008	2008
	Bioethanol	Biodiesel	Other	Total
Austria	54,000	245,000	86,000	385,000
Belgium	12,000	89,000	0	101,000
Bulgaria	0	2,000	2,000	4,000
Cyprus	0	14,000	0	14,000
Czech Republic	35,000	75,000	0	110,000
Denmark	5,000	0	0	5,000
Estonia	0	0	0	0
Finland	73,000	11,000	0	84,000
France	411,000	1,861,000	0	2,272,000
Germany	392,000	1,370,000	744,000	2,506,000
Greece	0	69,000	0	69,000
Hungary	46,000	118,000	0	164,000
Ireland	16,000	35,000	3,000	54,000
Italy	89,000	665,000	0	754,000
Latvia	0	2,000	0	2,000
Lithuania	15,000	46,000	0	61,000
Luxembourg	1,000	36,000	1,000	38,000
Malta	0	0	0	0
Netherlands	108,000	179,000	0	287,000
Poland	126,000	310,000	5,000	441,000
Portugal	0	128,000	0	128,000
Romania	0	49,000	58,000	107,000
Slovakia	26,000	101,000	0	127,000
Slovenia	3,000	22,000	0	25,000
Spain	92,000	527,000	0	619,000
Sweden	214,000	130,000	0	344,000
United Kingdom	104,000	686,000	0	790,000
	1,822,000	6,770,000	899,000	

	2009	2009	2009	2009
	Bioethanol	Biodiesel	Other	Total
Austria	64,000	314,000	106,000	484,000
Belgium	47,000	238,000	0	285,000
Bulgaria	0	3,000	0	3,000
Cyprus	0	15,000	0	15,000
Czech Republic	59,000	136,000	0	195,000
Denmark	5,000	4,000	0	9,000
Estonia	0	0	0	0
Finland	90,000	0	0	90,000
France	392,000	2,062,000	0	2,454,000
Germany	571,000	2,017,000	194,000	2,782,000
Greece	0	78,000	0	78,000
Hungary	0	123,000	0	123,000
Ireland	21,000	53,000	1,000	75,000
Italy	117,000	1,063,000	0	1,180,000
Latvia	3,000	2,000	0	5,000
Lithuania	14,000	38,000	0	52,000
Luxembourg	1,000	40,000	1,000	42,000
Malta	0	0	0	0
Netherlands	138,000	235,000	0	373,000
Poland	195,000	387,000	80,000	662,000
Portugal	0	201,000	0	201,000
Romania	3,000	38,000	122,000	163,000
Slovakia	34,000	134,000	0	168,000
Slovenia	2,000	28,000	0	30,000
Spain	151,000	921,000	0	1,072,000
Sweden	198,000	162,000	0	360,000
United Kingdom	160,000	808,000	0	968,000
	2,265,000	9,100,000	504,000	

Production of biofuels in Europe (in tonne oil equivalent - toe). Eurostat nrg_1073a 2011 dataset

	Bioethanol	Biodiesel	Other	Total
Austria	6,000	167,000	87,000	260,000
Belgium	0	128,000	34,000	162,000
Bulgaria	0	0	2,000	2,000
Cyprus	0	0	0	0
Czech Republic	17,000	72,000	0	89,000
Denmark	0	63,000	0	63,000
Estonia	0	0	0	0
Finland	0	0	0	0
France	264,000	863,000	0	1,127,000
Germany	290,000	1,263,000	2,435,000	3,988,000
Greece	0	83,000	0	83,000
Hungary	9,000	8,000	0	17,000
Ireland	1,000	13,000	2,000	16,000
Italy	0	180,000	0	180,000
Latvia	7,000	8,000	0	15,000
Lithuania	10,000	22,000	0	32,000
Luxembourg	0	0	0	0
Malta	0	0	0	0
Netherlands	7,000	75,000	38,000	120,000
Poland	67,000	41,000	2,000	110,000
Portugal	0	160,000	3,000	163,000
Romania	0	20,000	0	20,000
Slovakia	14,000	45,000	0	59,000
Slovenia	0	4,000	0	4,000
Spain	219,000	161,000	0	380,000
Sweden	182,000	103,000	146,000	431,000
United Kingdom	9,000	375,000	0	384,000
	1,102,000	3,854,000	2,749,000	

	Bioethanol	Biodiesel	Other	Total
Austria	45,000	122,000	111,000	278,000
Belgium	10,000	252,000	26,000	288,000
Bulgaria	0	9,000	2,000	11,000
Cyprus	0	6,000	0	6,000
Czech Republic	39,000	67,000	0	106,000
Denmark	0	88,000	1,000	89,000
Estonia	0	0	0	0
Finland	0	12,000	0	12,000
France	377,000	1,574,000	0	1,951,000
Germany	395,000	1,492,000	1,992,000	3,879,000
Greece	0	63,000	0	63,000
Hungary	39,000	123,000	0	162,000
Ireland	0	19,000	3,000	22,000
Italy	89,000	597,000	17,000	703,000
Latvia	7,000	25,000	0	32,000
Lithuania	11,000	57,000	0	68,000
Luxembourg	0	0	0	0
Malta	0	0	0	0
Netherlands	4,000	73,000	44,000	121,000
Poland	59,000	232,000	5,000	296,000
Portugal	0	149,000	4,000	153,000
Romania	0	24,000	58,000	82,000
Slovakia	38,000	101,000	0	139,000
Slovenia	0	7,000	0	7,000
Spain	174,000	198,000	0	372,000
Sweden	214,000	130,000	112,000	456,000
United Kingdom	35,000	248,000	0	283,000
	1,536,000	5,668,000	2,375,000	

	Bioethanol	Biodiesel	Other	Total
Austria	56,000	117,000	132,000	305,000
Belgium	38,000	225,000	90,000	353,000
Bulgaria	0	11,000	0	11,000
Cyprus	0	6,000	0	6,000
Czech Republic	58,000	137,000	0	195,000
Denmark	0	77,000	1,000	78,000
Estonia	0	0	0	0
Finland	0	69,000	0	69,000
France	348,000	1,866,000	0	2,214,000
Germany	569,000	2,017,000	1,257,000	3,843,000
Greece	0	71,000	0	71,000
Hungary	41,000	112,000	0	153,000
Ireland	0	56,000	1,000	57,000
Italy	117,000	713,000	289,000	1,119,000
Latvia	9,000	40,000	0	49,000
Lithuania	16,000	93,000	0	109,000
Luxembourg	0	0	0	0
Malta	0	0	0	0
Netherlands	0	242,000	48,000	290,000
Poland	94,000	253,000	81,000	428,000
Portugal	0	226,000	4,000	230,000
Romania	3,000	20,000	53,000	76,000
Slovakia	51,000	100,000	0	151,000
Slovenia	0	6,000	0	6,000
Spain	235,000	652,000	0	887,000
Sweden	198,000	162,000	197,000	557,000
United Kingdom	38,000	172,000	0	210,000
	1,871,000	7,443,000	2,153,000	

Appendix B Global production and direct trade of biofuels and selected feedstock

Statistics on global production and direct trade have been collected for:

- Biodiesel;
- Bioethanol;
- Rapeseed & oil;
- Soybean & oil;
- Palm oil;
- Wheat;
- Maize.

The resulting data-sheets can be found as digital annex to this report.

B 1 Method for data collection

The statistics are collected in tables with format as given in Figure 40

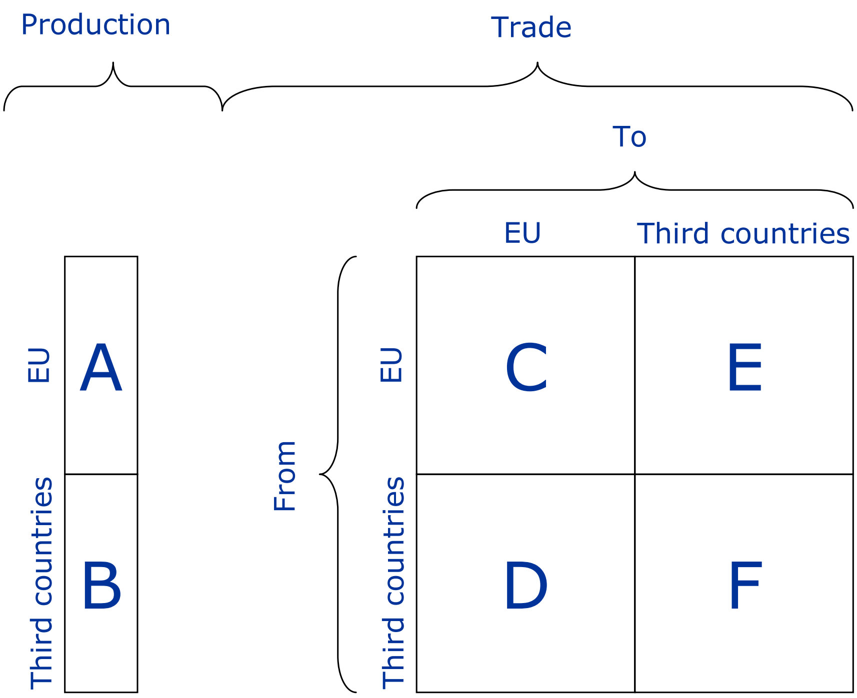


Figure 40. Format of the data tables for production and trade statistics.

The following sources of information have been used:

- Production ranges A and B: FAOSTAT;
- Trade ranges C (intra EU) and D (from third countries to EU): EU import matrices from Eurostat DS-016890-EU27 Trade Since 1995 By CN8 (*select import*). The following sets were extracted:
    - Biodiesel: HS 3824.90.91
    - Bioethanol: HS 2207.20 (denatured, of any strength) + HS 2207.10 (undenatured, at least 80 %) + HS 2208.90.91 (undenatured, less

    - than 80 %) + HS 2208.90.99 (undenatured, less than 80 %) + HS 2909.19.10 (in blends or in ETBE)
    - Soybeans (HS 1201.00.90) + Soybean oil (HS 1507.10.10, 1507.90.10). The oil volumes were converted to bean equivalent
    - Rapeseed (HS 1205.10.90, 1205.90.00) + Rapeseed oil (HS 1514.10.10, 1514.11.10, 1514.19.10, 1514.90.10, 1514.91.10, 1514.99.10). The oil volumes were converted to bean equivalent
    - Sunflower seed (HS 1206.00.91, HS 1206.00.99) + Sunflower oil (HS 1512.11.10, 1512.19.10)
    - Palm oil (HS 1511.10.10, 1511.90.91)
    - Wheat (HS 1001.90.99)
    - Maize (HS 1005.90.00)
    - Barley (HS 1003.00.90)
- Trade range D (from EU to third countries): EU export matrices Eurostat from Eurostat DS-016890-EU27 Trade Since 1995 By CN8 (*select export*). Same sets used as above.
- Trade range F (between third countries): Comtrade.

Appendix C Triangular trade

C 1 Method

Introduction

For all the biofuels on the EU market, insight is needed in the original feedstock and where it has been produced. This is important to amongst others determine which are the main countries of supply for EU consumed biofuels, so that the research on sustainability issues and measures can focus on those countries. A quantification of crops per country that are the feedstock for EU consumed biofuels can be used to calculate the total land use in those countries and put it into perspective with the other agricultural activities. It can also be used to understand the location of water usage around the globe, induced by EU biofuels consumption. It assists the understanding of EU security of energy supply if more is known about the origin of the biofuels feedstock.

The original feedstock and region information is derived by combining data on:

- Production of biofuels in Europe
    - Their feedstock mix
    - Ultimate origin of that feedstock
- Biofuels imported in Europe
    - Their feedstock mix
    - Ultimate origin of that feedstock

The basic route to derive the ultimate feedstock and region information is sketched in Figure 41.

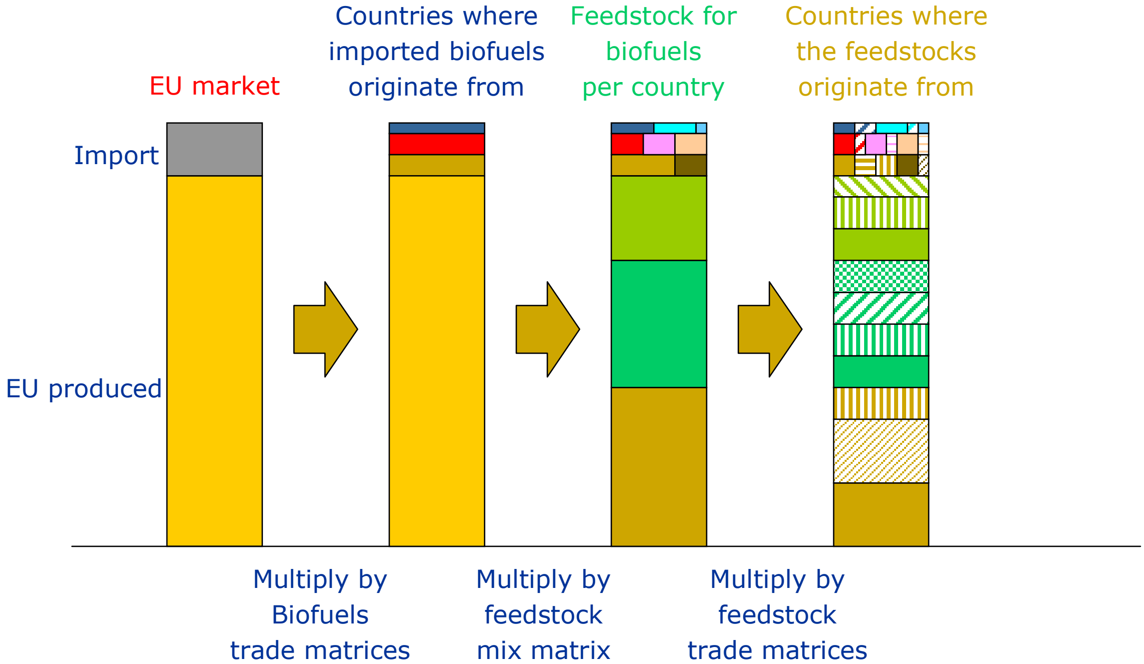


Figure 41. Schematic representation of the calculations needed to derive the ultimate feedstock and region information for EU biofuels.

Direct trade matrices for biofuels and their feedstock have been derived by Ecofys (Patrick Lamers) and Agra CEAS on basis of Comtrade, Eurostat and FAOtrade statistics. These can be found in separate digital appendices.

However, direct trade does not take into account that some goods are traded via third countries. For example, a significant share of the biodiesel that seemed to stem from the USA in 2008, actually came from Argentina, palm oil exports from Singapore actually stem from Malaysia and Indonesia. Even some swap trade occurred with a small stream of EU biodiesel to the US, to collect the blend subsidy after which it returned to the EU market. This is further explained in the main text in Section 2.5 of this report.

To understand the upstream sustainability effects, we need to know the ultimate origin, not the direct origin. A closer look at trade balances in combination with consumption/production information per country gives insight in the indirect trade.

Assumptions and method details

In Figure 42, international trade is simplified to trade of a certain commodity between four countries.

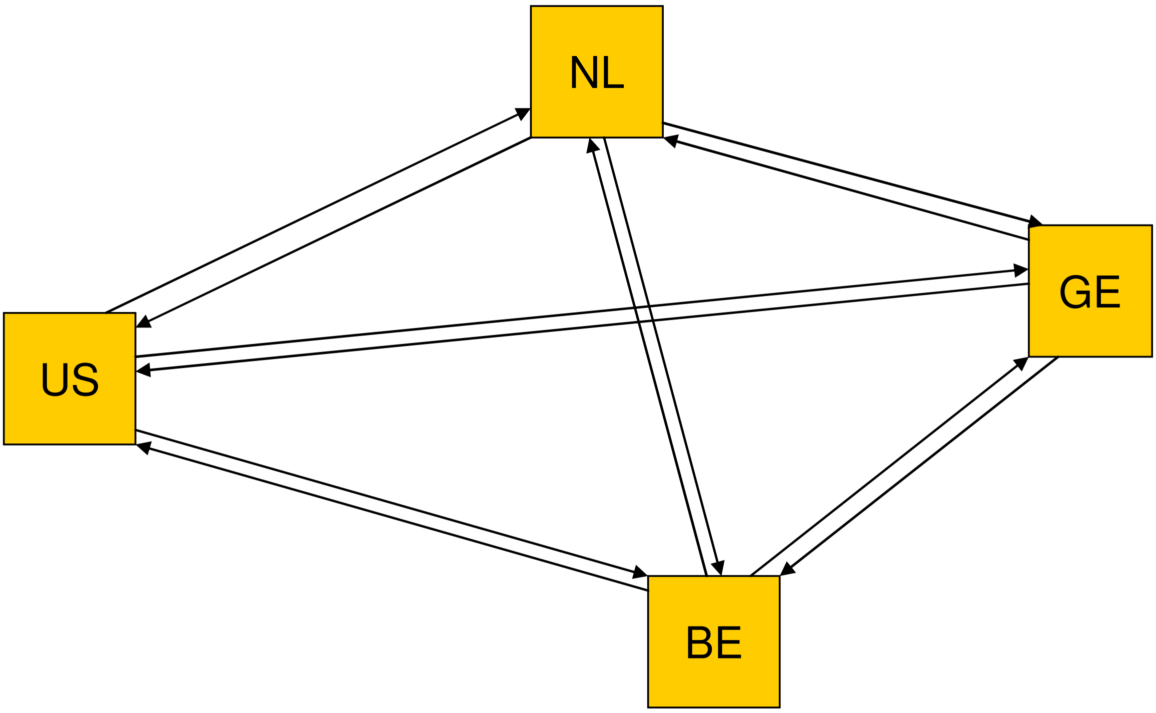


Figure 42. Schema of trade options for a commodity between four countries.

The different trade options can easily be seen:

- Direct trade: from e.g. NL to BE
- Indirect trade:
    - Either triangular trade from e.g. US via NL to BE
    - Or Swap trade from NL to BE and back to NL

The direct trade can be represented by a matrix. For a trade between the four countries only, this would look like Figure 43.

From \ To	BE	NL	GE	US
BE	-	10	8	2
NL	10	-	10	4
GE	8	10	-	10
US	4	8	8	-

Figure 43. Imaginary trade matrix for a certain commodity traded between four countries only

The net trade cannot be simply calculated from this information. For example, since NL→BE = 10 and BE→NL = 10 the net trade seems to be 0. However, this would not be correct, since part of BE export in fact originates from GE and US. For example, 4 units on the BE market originate from the US. To understand the share of this in the total BE exports, the BE indigenous production must be known.

Assumption #1: Markets are totally mixed. This implies that import and indigenous production are linearly represented in the export.

If the market would not be totally mixed, there can be two extreme situations:

- Export contains as much as possible import. Only what cannot be met by import will be assumed to stem from indigenous production;
- Export contains as much as possible the indigenous production, only what cannot be met by production is assumed to stem from imports.

Assumption #2: Only one indirect trade step occurs. This implies that we only correct the direct trade with one iteration.

For many commodities, more than one step would not represent economically viable trade. Later the results seem to indicate that most of the indirect trade is indeed captured with this correction. In few cases (negligible in the total), multiple trade steps should be accounted for. E.g. palm oil used in Austria for biodiesel production seems to be imported from Germany, who imported it from the Netherlands, who imported it from Indonesia and Malaysia. But this anomaly becomes invisible in the end result.

Let us focus on the trade between two countries X and Y (one cell in the trade matrix), for example NL and BE in the matrix above, see Figure 44.

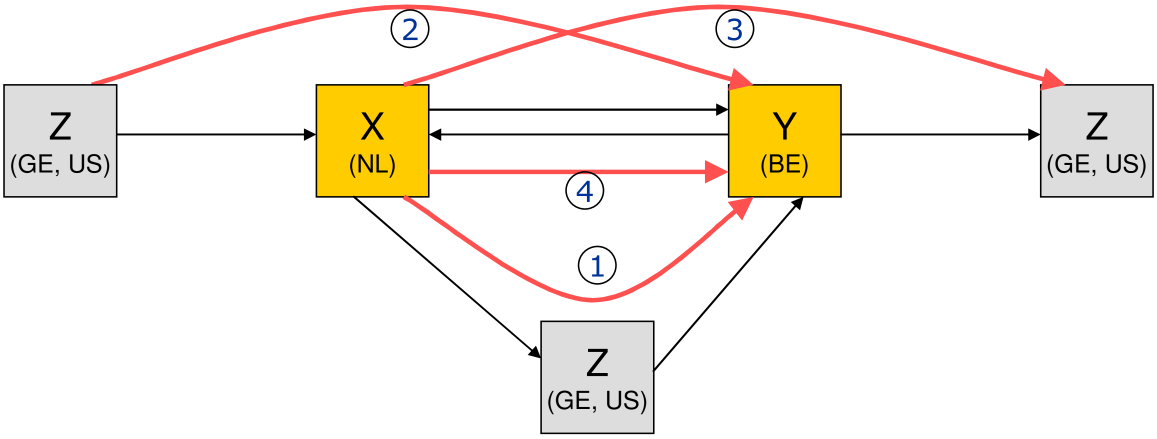


Figure 44. Four corrections to direct trade.

Four different corrections are necessary:
#1: Implicit trade from NL→BE via third countries: increase NL→BE
#2: Part of what leaves NL actually stems from third countries: decrease NL→BE
#3: Part of what arrives in BE actually goes to third countries: decrease NL→BE
#4: Eliminate swap trade: Only show net trade between each 2 countries

Correction #1
In the original trade matrix for direct trade, the indigenous production has been placed on the diagonal, see Figure 45. The sum of columns (e.g. import to BE + indigenous production in BE) is equal to the market. At the right, only the exports are totalled.

From \ To	BE	NL	GE	US	∑export
BE	6	10	8	2	20
NL	10	2	10	4	24
GE	8	10	20	10	28
US	4	8	8	20	20
∑market	28	30	46	36	

Figure 45. Focus of example corrections discussed in the text.

Let us focus on on the circled cell, NL→BE. Additional trade could go from NL→BE via the third countries US and GE (option 1 in Figure 44):

- Trade via US
    - NL→US = 4, US market = 36. This means that 4/36 = 11% of US market stems from NL;
    - US→BE = 4, of which 11% actually stems from NL
    - Therefore increase NL→BE with 11% x 4 = +0.44
- Trade via GE
    - 10/46 = 22% of GE market stems from NL
    - Increase NL→BE with 22% x 8 = +1.74
- Overall result: NL→BE increased with 2.2

For the total matrix, the correction can be done by multiplying row BE in a market normalised matrix with column BE in the direct trade matrix.

Correction #2

Correction #2 in Figure 44 concerns the fact that some of the product that is exported actually stems from a third country. Again, let us focus on NL→BE. The product partially stems from the US and GE.

- To correct the direct flow NL→BE with what actually stems from US:
    - US→NL = 8, market NL = 30
    - So, 8/30 = 27% of NL market actually stems from US
    - 27% of NL→BE does not stem from NL and should not be in NL→BE
    - Decrease NL→BE with 8/30 x 10 = - 2.7
- To correct the direct flow NL→BE with wat actually stems from GE
    - GE→NL = 10, market NL = 30
    - Decrease NL→BE with 10/30 x 10 = - 3.3
    - Overall result: NL→BE decreased with 6

Correction #3
Part of what arrives in Y actually goes to third countries. In the example NL→BE, the question is what part does not stay in BE?

The correction is as follows, similar to correction #2 above:

$\Delta NL\lozenge BE$
$= - NL\lozenge BE/\sum marketBE \times (BE\lozenge GE + BE\lozenge US)$
$= - NL\lozenge BE/\sum marketBR \times (\sum exportBE - BE\lozenge NL)$
$= - 10/28 \times (20 - 10) = - 3.6$

Interim result

The combination of corrections #1, #2 and #3 above leads to a new matrix as shown in Figure 46.

From \ To	BE	NL	GE	US
BE		3.2	4.3	2.9
NL	2.6		3.8	2.9
GE	5.9	6.9		4.7
US	3.9	3.2	7.4	

Figure 46. Result of corrections #1, #2 and #3.

For NL→BE, the original value was 10
- Correction #1: + 2.2
- Correction #2: - 6.0
- Correction #3: - 3.6
- Result: 2.6

Correction #4
The swap trade between each two countries is eliminated and only the net trade is shown.

Example NL→BE, the question is how much did come from BE in the first place. The correction is as follows:

- Since NL→BE < BE→NL we should replace NL→BE with 0
- Since BE→NL > NL→BE we should decrease BE→NL with NL→BE

This is shown in Figure 47.

Becomes 3.2-2.6 = 0.6

Becomes 0

From \ To	BE	NL	GE	US
BE		3.2	4.3	2.9
NL	2.6		3.8	2.9
GE	5.9	6.9		4.7
US	3.9	3.2	7.4	

Figure 47. Correction #4. Eliminate swap trade and only show net trade between each 2 countries.

The total result is shown in Figure 48.

From \ To	BE	NL	GE	US
BE		0.6		
NL				
GE	1.6	3.1		
US	1.0	0.3	2.7	

Figure 48. Result of the four corrections.

Appendix D Advanced biofuels

Europe's largest advanced biofuel producer, Dutch start-up **BioMCN**, has developed an innovative large-scale industrial process that converts crude glycerin via synthesis gas into bio-methanol. This means that the plant in the future could also run on gasified biomass. By March 2008, BioMCN's pilot plant started to produce 20,000 tonne of bio-methanol per year. At the end of 2009, BioMCN has finalized the construction of the first large-scale production unit with a capacity of 200,000 tonne per year (94.5 ktoe/year). Since the new unit was only taken into production halfway 2009, the 2009 production must have been less then 120 (20+0.5*200) ktonne or 57 ktoe. Capacity is expected to be increased over the next few years up to a maximum of 800,000 tons. The actual production is not public.

Borregaard Chemcell, a Norwegian company, has a production capacity of 15,800 tons of bioethanol on basis of wood as raw material.

In Denmark several cellulose-based biofuel initiatives are lead by **Inbicon** (subsidiary of DONG Energy). Already in 2003, a small-scale pilot plant in Skærbæk for research and development was constructed. In 2009, the demonstration plant located at Kalundborg was commissioned and started producing ethanol from straw, with a capacity of 4,300 tonne ethanol per year.
The plant also demonstrates energy integration with a power station. Besides bioethanol, the Kalundborg plant also produces, green chemicals, animal feed (molasses) and bio-pellets.

The **Bionic Fuel Technologies Group** (BFT), also in Denmark has a technology to convert biomass into lightoil through catalytic low temperature depolymerization of hydrocarbons through the application of microwave technology. As from 2008, the initiative produces 200 tonnes of biodiesel from straw pellets.

Sekab Group, Sweden's largest ethanol producer, is one of leaders in the developing technologies for production of ethanol from cellulose. The company's pilot plant in the north of Sweden has been in continuous operation producing 100 tons of ethanol per year from forestry waste products since 2004. The plant was designed to produce the necessary expertise for the expansion to commercial production. Besides wood chips, Sekab focuses also on the utilization of other raw materials such as bagasse from sugarcane, wheat and corn stover, energy grass and recycled waste. The intention was to start construction of a demonstration-scale cellulosic ethanol plant in early 2009, which would scale up the existing technology. The new plant would have a capacity of 5,000 tons per year[71].

In April 2008, Germany's **Choren Industries** commissioned the world's first industrial scale biomass to liquid (BtL) production plant based on gasification/FT

[71] The exact status of this initiative is at the moment of writing the report unknown, but operation is expected to start in 2011.

technology process for biofuel production. At the end of 2009, the demonstration plant started commercial production with an annual capacity of 15,000 tons of FT-diesel from wood residues. Choren contemplates to set up a second large industrial scale plant with an annual production capacity of 200,000 tons of BtL in Schwedt, Germany. If the plan succeeds, the plant could start operating in 2013 or 2014.

NSE Biofuels Oy, a joint venture between Neste Oil and Stora Enso, has launched a BtL demonstration plant at Stora Enso's Varkaus Mill in Finland. As from spring 2009, the demonstration facility produces 656 tons per year of FT-diesel by using a slipstream from a thermal gasifier which thermochemically converts forest residues into syngas.

In Austria, **CTU** demonstrates the production of synthetic natural gas (SNG) through thermo-chemical conversion of solid biomass. The demonstration unit was inaugurated in June 2009, producing 576 tons of SNG annually.

In Salamanca, Spain, **Abengoa** has a demonstration plant which started producing cellulosic ethanol in 2009 (construction completed in 2008). The feedstock used is mainly wheat straw and the capacity of the demonstration plan is 70 ton per day.

There are several other initiatives under development, which in 2008 did not have a demonstration or pilot plant in production, but which have concreted plans of setting one up in the near future. Among these are initiatives from the Mossi & Ghisolfi Group (Chemtex) in Italy in the field of cellulosic ethanol, or BTL initiatives in the region of East London (Solena group).

Appendix E Security of Supply

E 1 Methodology

This report describes the methodology applied in calculating the impact biofuels might have on the EU Security of Energy Supply for the Transport sector (SoES). The first part provides the background of the task and the chosen methodology. The second part presents the results of the approach taken. The final section reflects upon the results and provides an outlook to potential future SoES developments and options to adapt the methodology.

Background

The improvement of the security of transportation energy supply (SoES) is a strategic aspect in the European Commission's efforts to increase the share of renewable energy sources in the EU-energy matrix. While this applies to the overall energy mix, it particularly applies to the transport fuel sector due to the dependence on fossil fuel imports, mainly mineral oil.

SoES indicators have a long history in describing a nation's dependence on energy imports. Their application in analysing the effects biofuels might have, however, is a new concept. Prior to this analysis, Londo et al. [2006] investigated four potential indicators regarding the SoES for the entire energy system as well as the transport sector under the supportive activities for the impact assessment of the Biofuels Directive Review for DG TREN. The following table provides an overview of the indicators, and a rough estimate of the time required for their calculation.

In this work, SoES indicators shall measure the specific impact biofuels have on the EU SoES. Hence, the analysis only focuses on biofuels for transport and a system boundary is drawn to reflect only the effect biofuels have on the SoES in the transport sector. The analysis of the effect, biofuels might have on the entire energy system of a Member State or the EU as a whole was not deemed suitable due to the yet small share biofuels have within the overall primary energy supply. With the increase of the biofuel share, their reflection in overall security of supply indicators could become relevant in the future.

Table 50. Indicators investigated by Londo et al. [2006] adapted, interpreted

	Short description	Calculated for entire energy system	Calculated for transport sector only	Complexity, Amount of data required	Suitability/Informative value reg. biofuel SoES
Avoided fossil fuel imports	Measurement indicating the amount of fossil fuels avoided	YES	YES	Simple, Little amount	Poor (no reflection of diversity)
Shannon index	Diversity index designed to indicate a region's extent of resilience against structural threats to its energy supply system	YES	YES	Medium, Medium to large amount	Good (reflection of diversity, possibility for extension, no reflection of demand development)
Supply/ Demand index	Aim similar to Shannon index, but additional reflection of domestic market challenges	YES	NO	Simple, Little amount	Good to very good (reflection of demand side but approach not suitable for transport sector specific consideration)
Markowitz portfolio approach	Approach seeks to identify the scope of optimizing a target portfolio.	NO	YES	Very complex, Very large amount	Good (very complex approach, no optimization possible as no target portfolio exists is known)

Approach

As laid out in Table 1, the Shannon index seems well-balanced regarding complexity, data requirements, and expressiveness i.e. informative value. In addition, it allows reflecting the diversity and relative evenness of supply options. Thus it serves as an indicator of the stability of the biofuels sector. This 'system stability', in our opinion, is a very important aspect as it reflects a key difference to fossil fuel (supply) alternatives. Applied to biofuels and fossil fuels, the Shannon index seems applicable to compare the SoES in the EU27 and the development over time. A transport sector indicator combining weighted Shannon indices for bio- and fossil fuels seem appropriate to describe the transport sectors overall SoES in the EU27.

The indexes

Based on the Shannon index[72] approach, we suggest the formulation of a biofuel security of supply index (BioFI), a fossil fuel security of supply index (FosFI) and a combined security of supply index for the transport sector (TransI) in order to describe the impact of biofuels production, import and consumption on the SoES in the transport sector within the EU (aggregated):

The BioFI describes the SoES for biofuels based on the diversity of feedstock used in their production, taking into account import dependencies via the number of countries of origin and country specific import amounts:

$$BioFI_t = \frac{\sum_{it}(c_{it}^2 p_{it} \ln p_{it})}{S_2^{\max}}$$, where:

p_{it} = share of biofuel feedstock (feedstock considered see Table 2) in biofuel supply in year t

S^2_{max} = the maximum score of BioFI given a certain number of energy resources (with 12 resources S_2^{max} equal to 2.48)

c^2_{it} = correction factor c_{it}^2 for the diversity of import:

$$c_{it}^2 = 1 - m_{it}(1 - S_{it}^m / S_{it}^{m,\max})$$, where:

m_{it} = share of imports in biofuel supply of resource i in time t

S_{it}^m = Shannon Index of import flows of resource I from country j:

$$S_{it}^m = -\sum (m_{ijt} \ln m_{ijt})$$, where:

m_{ijt} = share of imports of feedstock i from country j in total import of feedstock I at tim t

j = 1…N: index for (foreign) country of origin

$S_{it}^{m,max}$ = Maximum value of Shannon index of import flows of resources i (i.e. for wheat and meslin equal to 3.52 for 34 region of origin, excluding the home region)

[72] The Shannon index, sometimes referred to as the Shannon-Weaver Index, is one of several diversity indices used to measure diversity in categorical data.

FosFI describing the SoES for the fossil fuel section. See Appendix for the inclusion of feedstock options (approach as in BioFI).

A combined index which takes the first two indexes into account and is normalized over the highest indexed fuel type at time t:

$$TransI_t = \frac{BioFI_t * S_t^{bio} + FosFI_t * S_t^{fos}}{MaxFI_t}$$, where:

S_t^{bio} = share of biofuels in transport fuels at time t, and
S_t^{fos} = respective share of fossil fuel and
$MaxFI_t$ = largest FI, either BioFI or FosFI.

All indices range zero to one. Rising indices represent higher entropies in BioFI and FosFI. A higher TransI represents a transport fuel supply situation relying on the source with the highest entropy in the feedstock system. The minimum value of TransI is given by the minimum FI either BioFI or FosFI; at maximum it can reach one. The TransI increases under the following aspects:

- In case fossil or biofuels and their feedstock are produced domestically rather than imported;
- Fossil or biofuels are produced from a wide range of feedstock (i.e. since the diversity in biofuel production is higher to that of fossil fuels, they are deemed more secure);
- Fossil or biofuels (and their feedstock) are imported from a wide range of countries thus making their supply more diverse/secure;
- Import volumes are equally distributed across trade partners (i.e. greater security than heavy dependence on specific partner countries).

The combined index (TransI) increases under a rising relative share of biofuels or an overall improvement of the biofuel mix under the same share. This way, the positive effect of a decreasing demand for transport fuels (through efficiency measures, alternative transport forms, etc.) on the security of energy supply can also be shown.

Discussion: system boundaries and limitations

The biofuel sector consists of a number of characteristics (some of which also apply to fossil fuels) which cannot be fully reflected in SoES indicators. This section outlines these characteristics and discusses their limitations regarding the indicators calculated.

Diversity of imports

Imports aimed at the supply of biofuels to the transport market can take on various forms: raw materials/feedstock (e.g. soy beans), intermediate (e.g. crude vegetable oil) or final products (e.g. biodiesel, pure or as blend). The key question is how to quantify i.e. differentiate between the impact such different types of imports have on the SoES. In addition, a differentiation within the individual categories could be realized. Intermediate products e.g. could be virgin or pre-refined vegetable oils (or else).

The type of feedstock/intermediate product can also be matched with the respective import country's infrastructure (see following paragraph on "flexibility of production systems"). In general, it appears that the import of final products should enhance the SoES compared to the import of unfinished products since no further processing is needed and the risk of production bottlenecks (in this context reserved for domestic feedstock) is avoided. A counterargument to this is the structure of the different markets: feedstock can be sourced from a variety of countries whereas compared to the global grain or oilseed market, biofuel supply and trade is still rather small. Hence, an overcapacity in biofuel production should increase the SoES.[73]

Yet again, it is unclear how and to what extent these potential benefits shall be attributed and whether the same attribution would be suitable to all MS. Concluding, imports are not differentiated into raw, intermediate or final form, in order to avoid uneven results. Nevertheless, their diversity regarding the sourcing regions is taken into account.

Flexibility of production systems

Not all biofuel production and refining plants use the same technologies/processes. Thus their requirements regarding potential feedstock are different. This might have an effect on the SoES since some plants will allow a range of input material while others only focus on specific feedstock. For the production of biodiesel, SoES should increase along the following technology diversion:

Specific oil → Multi oil → Multi oil + waste oil → HVO → FT

Increasing Security of Energy Supply

For the production of bioethanol, SoES should increase along the following technology diversion:

Specific crop (starch or sugary) → Multi crop (starch, sugary) → Lignocellulose

Increasing Security of Energy Supply

Also, plant location can indicate flexibility towards sourcing from different regions. Plants located in international ports or along main European waterways will be more

[73] Without taking the actual demand into account, bioethanol based production should rank higher in the SoES as it relies on a larger (and elastic) global grain market compared to the oilseed market for biodiesel production.

flexible in sourcing from anywhere around the world than rural located plants that focus on sourcing from the immediate surroundings of the plant.

Note that biofuels industry data is collected and analysed by this consortium. In the future, such information may be used for including the flexibility of production systems in determining the SoES. However, it is not straightforward to distinguish between the effects different production systems and their interlinked feedstock flexibility (might) have on the SoES. There is also a lot of room to rank production lines with different end products i.e. whether a portfolio of multi-crop plants for bioethanol is more "secure" than a multi-oil portfolio of biodiesel plants. We believe that a plant specific differentiation would have an effect on the SoES, but at the same time would also go beyond the aim of this assignment. Therefore, the flexibility of production systems was not taken into account in the calculations.

Political stability

Biofuels can be produced from a range of feedstock. Almost all countries of the world have the potential to produce some kind of biofuel feedstock. Hence, the supply of biofuels (or their feedstock) is not restricted to a small number of export regions/countries as e.g. compared to mineral oil. Therefore, political stability is not deemed to be a factor which could significantly influence the biofuels SoES. Hence it was not taken into account. At the same time, it is acknowledged that the international biofuel market and trade is still relatively immature with a range of dominant exporting regions (e.g. Brazil, USA, Indonesia, Malaysia) whose trade volumes to Europe are by far larger than those of other exporting countries (e.g. Bolivia, Pakistan). While some countries are most likely going to further dominate international bioenergy trade, the influence on the SoES of such concentrations in trade volume is reflected in the diversity index via the number of sourcing countries.

Crop growth and harvest risks

Crop yields and thus feedstock production for biofuels is weather dependent. While this applies to both domestic production as well as imports, its potential impact on the SoES – as measured in the indexes outlined above – is most likely higher in case domestic production declines due to bad weather patterns as the relative share of imports will increase. The potential effect of weather patterns is not directly quantified in the SoES indicator. Conclusions however could be drawn on an annual basis depending on the trade balance and crop yields of specific MS.

Trade regimes and costs

Costs for biofuel production are not directly taken into account. This also applies to trade regimes i.e. import/export taxes affecting the prices of feedstock, intermediate, or final product imports. Indirectly they are reflected in the trade balances. However, there are MS specific phenomena as e.g. the exclusion of non-drinkable ethanol for use as biofuel in Germany which cannot be reflected in a SoES indicator.

Re-Export

Trade balances for the EU are taken into account. The EU is seen as one region regarding import/export. Re-export within the EU is not taken into account as it is a signal for sufficient supply or strong market incentives in the respective importing region. Often exports are only a minor share in the production/consumption and trade balance (see Figure 49).

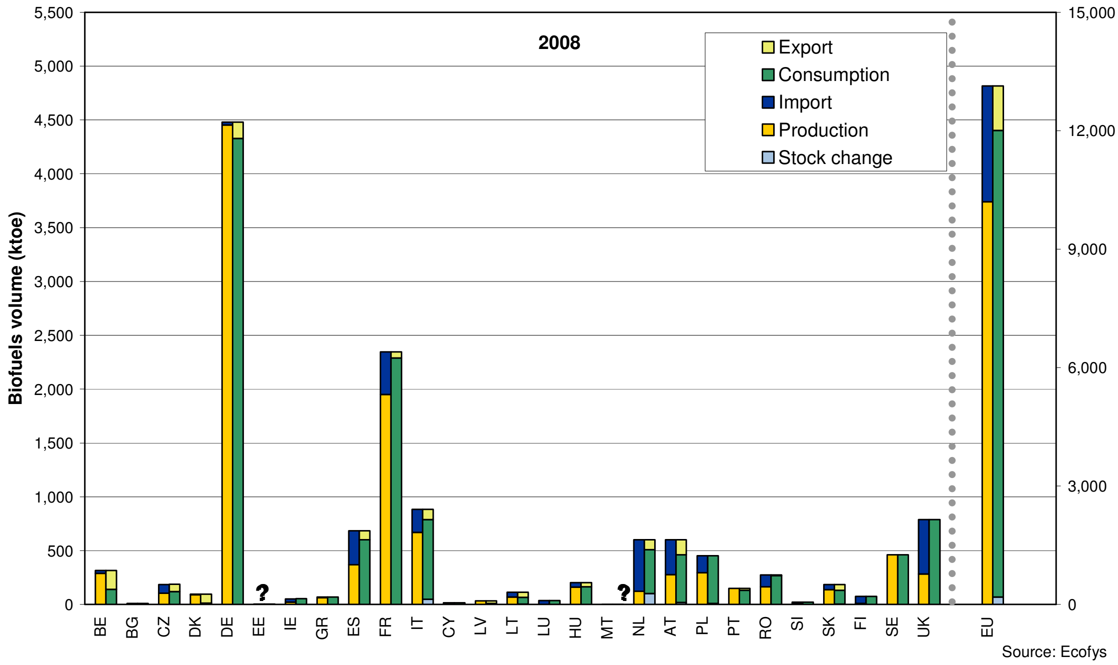


Figure 49. Biofuels trade balances 2008 for the EU and individual Member States [Eurostat 2010]. For Estonia (EE) and Malta (MT) no data is available, for several countries, data on either import or export, or both are not available.

E 2 Results

The Biofuel Indicator (BioFI)

BioFI was calculated for the EU27 in 2008 during which the supply consisted of 12 different feedstock (Wheat, Maize, Barley, Other grains, Sugar beet, Molasses, Raw alcohol, Sugar cane, Rapeseed, Soybean, Palm Oil, Waste Oils). Across these, the number of countries of origin reach up to 60 (e.g. rice, sugar cane). Import quantities and feedstock can be found and updated in the spreadsheet tool constructed for this excersise. The structure of the biofuels supply sector is given in Table 51 below.

Table 51. BioFI 2008

i - Fuel type	Feedstock	Share in supply	Feedstock share in supply
Bioethanol (Biogasoline)		17.8%	
	Wheat		35,0%
	Maize		12,0%
	Barley		9,0%
	Other grains		1,0%
	Sugar beet		14,0%
	Molasses		6,0%
	Raw alcohol		1,0%
	Sugar cane		23,0%
Biodiesel		81.3%	
	Rapeseed		46,0%
	Soybean		30,0%
	Palm Oil		14,0%
	Waste Oils		10,0%
Other liquid biofuels		0.9%	
Biofuels		100.0%	

Based on this distribution, the biofuel indicator reaches $BioFI_{2008}$ = 0.60 (on a range between 0 i.e. most insecure and to 1 i.e. most secure).

The Fossil Fuel Indicator (FosFI)

FosFI was calculated across the EU27 for the year 2008. During this time, crude oil was sourced from 24 different countries. The respective import quantities are presented in the spreadsheet tool. The indicator is calculated under the assumption that any crude oil type is a substitute of the other i.e. no differentiation was made. Diversity indices, however, cannot be calculated for one single feedstock (i.e. $ln\ 1$). Therefore, we need to assume that there is a small factor of flexibility in crude oil production (e.g. via the exploration of new sources/regions/etc.).[74] The diversity of both factors is weighed equally.

The resulting fossil fuel security of supply indicator is $FosFI_{2008}$ = 0.07 (on a range between 0 i.e. most insecure and to 1 i.e. most secure).

Table 52. FosFI 2008

i - Fuel type	Feedstock	Share in supply	Feedstock share in supply
Fossil fuel		100.0%	
	Crude Oil, Feedstock		99.0%
	Other		1.0%

Apart from crude oil imports, trade in refined products could also be taken into account. Yet, while there are significant import and export activities of petroleum

[74] The flexibility factor was kept explicitly small since its influence on the overall TransI is significant.

products within the EU27 and third countries, the net balances remain marginal [see EC 2010]. Thus, trade of these products was not taken into account within this SoES calculation.

The Transport Sector Indicator (TransI)

TransI is the combination of the above indicators i.e. in this case reflects the security of energy supply in the transport sector across the EU27 in 2008. The individual countries of origin, feedstock types, and quantities can be found and updated in the TransI spreadsheet tool. The structure of the transport sector in 2008 is given in Table 53.

Table 53. Transport fuel indicator

	Indicator	Share in Transport Sector
$FosFI_{2008}$	0.07	96.6%
$BioFI_{2008}$	0.60	3.4%
$TransI_{2008}$	0.14	100.0%
$FosFI_{2008}$	0.07	90.0%
$BioFI_{2008}$	0.60	10.0%
$TransI_{2020}$	0.20	100.0%

The resulting transport sector security of supply indicator is 0.14 (on a range between 0 i.e. most insecure and to 1 i.e. most secure). Maximum security would be reached if the fuel supply was based on biofuels only. Minimum security would apply to a situation without biofuels. Assuming a constant mix in diversity for either fuel, an increase in the share of biofuels up to 10% of total transport fuel consumption in 2020 is inevitably connected to an overall increase in the SoES.

E 3 Reflections and conclusions

There is a range of indicators available to calculate and describe the security of energy supply (SoES). For the transport sector, it appears advisable to use an approach based on the Shannon Index. The methodology suggested here calculates separate values for the fossil and biofuel part and merges it into a combined transport sector indicator. The transport sector, in particular biofuels, consists of a number of characteristics which cannot be fully reflected in SoES indicators. Examples include the flexibility of production systems or crop growth and harvest risks.

The indicators calculated clearly show the benefits of biofuels over fossil fuels in terms of their positive impact on the security of energy supply. For the year 2008, the biofuel indicator reaches 0.60 as compared to the fossil fuel indicator at 0.07 (on a range between 0 i.e. most insecure and to 1 i.e. most secure). The higher number for biofuels is directly related to the fact that already under the current market situation biofuels are based on a wide variety of feedstock and sourced from a diverse range of countries.

During 2008, the amount of biofuels in transport fuel consumption was 3.4%. Given this market distribution, the combined transport indicator reaches 0.14 (on a range between 0 i.e. most insecure and to 1 i.e. most secure). In case the 10% renewable energy target of the EU for transport in 2020 would solely be met by the same mix of biofuels, it would increase the SoES in the transport sector by 42% i.e. up to 0.2.

However, the supply side mix is bound to change over time. To reflect these changes, the methodology can be adapted accordingly. To achieve this, data by Eurostat needs to simply be integrated into the provided tools.

The methodology can also be modified to represent the supply side in more detail. (see Eurostat Guide in tool). In order to do this, the current set of feedstock codes would simply need to be replaced with data of higher level Eurostat codes.

The approach as presented here for the EU27 can also be applied to individual EU Member States (MS). However, due to the variety of biofuel feedstock and complex supply chains including multiple intra-EU border crossings, such an application requires a significant amount of additional data/information. At the same time, from the viewpoint of an integrated EU market, it appears less relevant to derive SoES differentiations between MS.

E 4 References

[1] EC (2010). European Commission Market Observatory. Available online: http://ec.europa.eu/energy/observatory/oil/import_export_en.htm [November 28th 2010]

[2] Eurostat (2010). European Commission - Eurostat database. Available online: http://epp.eurostat.ec.europa.eu [May 10th 2010]

[3]

Londo, M., Deurwaarder, E. Seebregts, A. & Jansen, J. (2006). Indicators for security of energy supply and results for indicators 1, 2 and 3. ECN, IIASA, Joanneum Research. Chapter 2 in: Supportive activities for the Impact Assessment for the Biofuels Directive Review (Tender TREN/A1/46-2005), Final report (January 2007).

Scheepers, M., Seebregts, A., de Jong, J. & Maters, J. (2006). EU standards for energy security of supply. ECN-C-06-039, ECN/CIEP, Petten/The Hague, July.

Appendices to Chapter 3 (Policy framework)

Appendix F Overview of national support schemes in the EU

Below an overview is given of the different policy measures in place in the EU-27 by 2008. More details on this overview and the data behind is provided in the the Biofuel Progress report 2010.

Table 54. Overview of biofuels policies in the EU-27 MS in place by 2008[75].

	Quota obligation/requirement**	Penalty>tax relief	Tax exemption/relief	Other policies*	Target Member States - 2010	Obligation biofuels (%) - 2010	Obligation bioethanol (%) - 2010	Obligation biodiesel (%) - 2010	Estimated level of support bioethanol (€/liter)***	Estimated level of support biodiesel (€/liter)***	Growth (%-points) 2007-2008	Share biofuels 2007	Share biofuels 2008
Austria	x	?	x		5.75%	5.75%	-	-	0.03	0.03	2.90	0.03	5.7%
Belgium			x		5.75%	0.00%	0.00%	0.00%	0.46	0.18	0.10	0.01	1.1%
Bulgaria	x	?	x		5.75%	5.75%	-	-	0.35	0.31	0.00	0.00	0.1%
Cyprus	x	?	x	x	2.50%	2.50%	-	-	0.00	0.24	1.90	0.00	2.0%
Czech Republic	x	x	x		5.75%	-	-	-	0.00	0.04	1.40	0.01	1.9%
Denmark			x	x	0.75%	-	-	-	0.03	0.03	0.00	0.00	0.1%
Estonia			x		5.00%	-	-	-	0.02	0.02	-0.10	0.00	0.6%
Finland	x	x		x	4.00%	4.00%	-	-	0.00	0.00	1.90	0.00	1.9%
France	x		x		7.00%	7.00%	-	-	0.21	0.15	2.00	0.04	5.5%
Germany	x	x	x	x	5.75%	6.25%	2.80%	4.40%	0.66	0.32	-2.20	0.08	6.1%
Greece			x		-	-	-	-	0.25	0.25	-0.20	0.01	1.0%
Hungary			x	x	5.75%	-	-	-	0.77	0.77	3.10	0.01	3.7%
Ireland			x	x	4.00%	-	-	-	0.44	0.37	1.16	0.00	1.2%
Italy	x		x		5.75%	-	-	-	0.28	0.18	1.60	0.00	1.9%
Latvia			x	x	5.75%	-	-	-	0.33	0.28	0.00	0.00	0.1%
Lithuania	x		x	x	5.75%	0.00%	5.00%	5.00%	0.33	0.28	0.10	0.04	3.7%
Luxembourg	x		x		5.75%	5.75%	-	-	0.02	0.01	0.10	0.02	1.7%
Malta			x		5.75%	-	-	-	0.00	0.06	-0.70	0.00	0.4%
Netherlands	x	x		x	4.00%	4.00%	-	-	0.00	0.00	-0.30	0.03	2.4%
Poland	x	?	x	x	5.75%	5.75%	-	-	0.45	0.30	2.10	0.01	2.9%
Portugal			x		10.00%	0.00%	0.00%	10.00%	0.39	0.11	-0.20	0.02	2.0%
Romania	x	x	x		4.00%	4.00%	-	-	0.33	0.27	1.40	0.01	2.3%
Slovakia	x		x		5.75%	5.75%	-	-	0.50	0.47	1.20	0.05	6.1%
Slovenia	x		x		3.00%	5.00%	-	-	0.46	0.40	0.40	0.01	1.1%
Spain			x		5.83%	5.83%	3.90%	3.90%	0.37	0.28	0.80	0.01	1.9%
Sweden			x	?	5.75%	-	-	-	0.72	0.56	0.60	0.04	4.5%
United Kingdom	x	x	x		3.50%	3.50%	0.00%	0.00%	0.25	0.25	1.20	0.01	2.0%

? Not clear from the MS reports
* See "Complementary policies"
** In Spain and Portugal obligations are in place since 2009

[75] In the sixth column targets as identified in MS reports are given. It should be noted that with the exception of Malta EC did not accept any other alternative targets and applies 5.75%.

Appendix G Country factsheets: Analysis of legal and voluntary mechanisms relevant to the EU biofuel sustainability scheme[76]

G 1 Introduction

Legal and voluntary mechanisms exist that will, to varying degrees, provide information on various environmental and social issues covered in the EU biofuel sustainability scheme. Analysis of these mechanisms can provide valuable insights into how countries manage sustainability challenges in areas relevant for biofuels production aimed for export to EU. Also, the analysis can indicate whether or not governments of third countries tend to develop policies in response to EU sustainability concerns.

Legal mechanisms include for example environmental legislation (this appendix) and Environmental Impact Assessments. Voluntary mechanisms include for example certification schemes, Voluntary Emissions Reductions (VER), REDD and CDM projects. These mechanisms are treated in separate reports.

In this appendix, the following items are analysed:

- **National and sub-national legislation** relevant for sustainability considerations in relation to agriculture in general and biofuels in particular, with the intention to provide insight in the target countries' general legislative readiness to produce biofuels complying with the existing sustainability requirements of the Renewable Energy Directive, as well as potential requirements that can be added to the Directive when revised;
- **Enforcement**, both juridical responsibilities to enforce biofuel related legislation and practical potential to enforce legislation in general, with the intention to discuss if biofuels are likely to be produced in compliance with national legislation.

Results from the legislation and enforcement analyses are presented on a national level for selected third countries as listed in Table 55.

[76] More extensive information is available from: Englund O, Berndes G, Franzen M, Palm A and Pestana MI, 2011, Legislative readiness for RED. Technical report for the EU Biofuel Baseline project. Gothenburg, Chalmers University of Technology. Available at: http://publications.lib.chalmers.se/records/fulltext/local_146741.pdf

Table 55. Countries analysed for legal mechanisms related to Renewable Energy Directive [2009/28/EC] sustainability requirements and enforcement potential, with reference to the section in this appendix where the country is discussed.

	country	Section
South America		
	Brazil	G 3
	Argentina	G 4
	Guatemala	G 5
Asia		
	Indonesia	G 6
	Malaysia	G 7
	Pakistan	G 8
	India	G 9
Africa		
	Tanzania	G 10
	Malawi	G 11
	Mozambique	G 12
	Uganda	G 13
	Ethiopia	G 14
	Nigeria	G 15

In this chapter, results are presented on a country level. Each country profile is intended to provide an overview of the legislative situation in the different countries, from a biofuels perspective. For each country, results from the legislation analysis and enforcement analysis are presented separately.

G 2 Limitations

The ECOLEX database (FAO et al. 2011) has been used to identify environmental legislation in the selected countries (for further methodology description see Appendix G 17). The developers FAO, UNEP and IUCN claim that ECOLEX "provides the most comprehensive possible global source of information on environmental law", although it is assumed that the database is not perfectly comprehensive. Therefore, it is unlikely that all laws relevant for biofuels have been analysed for all the countries.

Only legislation was included in the main analysis. Regulation was excluded due to time constraints. Since regulation can be relevant for biofuels, a complementary analysis for regulations was performed in cases where no laws were identified covering certain aspects. However, an identical analysis for regulation as for legislation would provide the most comprehensive and reliable results.

G 3 Brazil

Brazil is a major producer of Sugarcane ethanol and part of the *America* region.

Biofuel legislation

Available environmental legislation in Brazil includes 257 laws, written in Portuguese (FAO et al. 2011). As seen in Figure 50, 150 laws are relevant for biofuels and about 54% of the relevant laws have a national coverage.

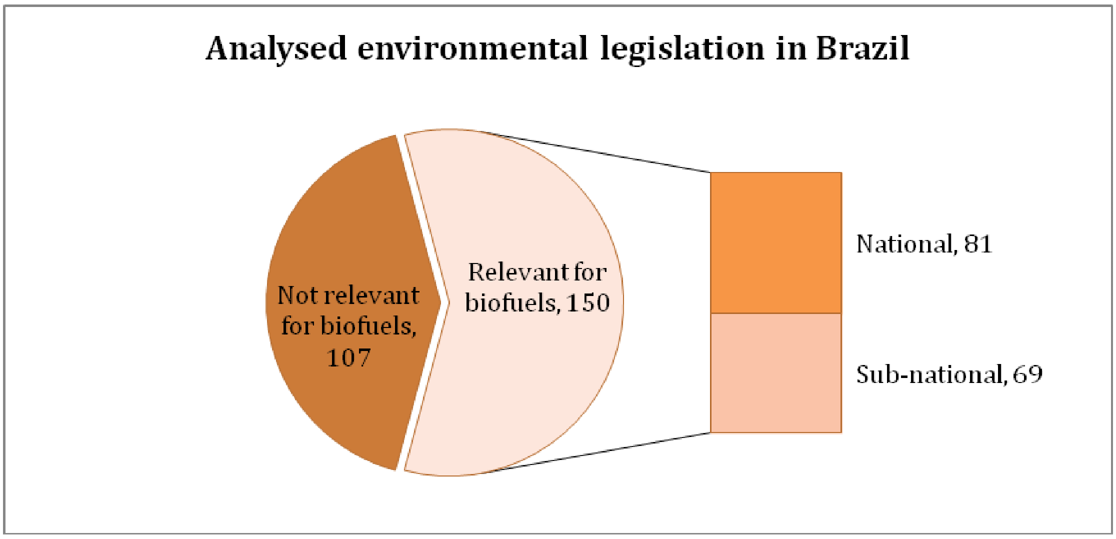


Figure 50. Overview of the analysed environmental legislation in Brazil, including number of laws relevant for biofuels and their national coverage.

Connections to biofuels

As seen in Figure 51, most of the biofuel related laws have connections to the feedstock production phase and particularly agriculture in general. Three laws are specifically connected to biofuel feedstock production, "Law No. 11.116 ruling on the Special Registry of biodiesel producers and importers and other provisions" (national), "Law No. 11.097 ruling on Biodiesel introduction among Brazil national energy sources" (national) and "Law No. 3135 instituting State Policy on climate change, environment conservation and sustainable development" (sub-national).

Almost one third of the relevant laws have connections to industrial activities. Four laws are specifically connected to biofuel processing, "Law No. 11.116 ruling on the Special Registry of biodiesel producers and importers and other provisions" (national), "Law No. 11.097 ruling on Biodiesel introduction among Brazil national energy sources" (national), "Law No. 3135 instituting State Policy on climate change, environment conservation and sustainable development" (sub-national) and "Law No. 9.478 on the National Energy Policy" (national).

About 40% of the relevant laws have connections to biofuels in other ways than feedstock production or processing. Most common are laws on environmental education and land-rights.

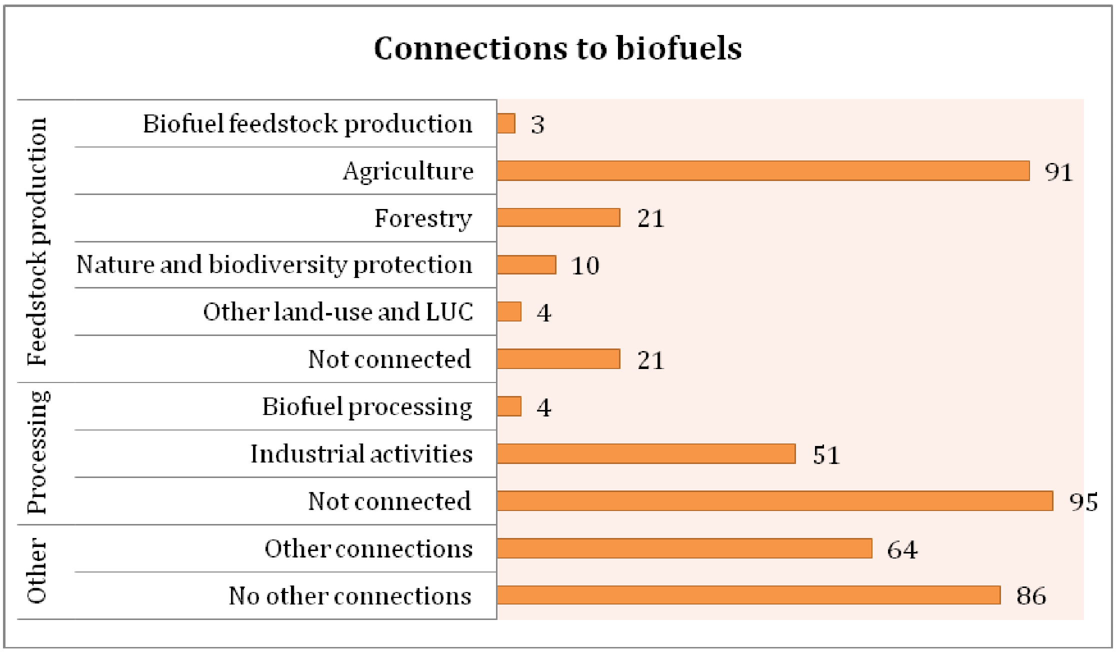


Figure 51. Connections between environmental legislation and biofuels in Brazil.

Relations to RED sustainability topics

As seen in Figure 52, *Social sustainability*, *Water* and *Land-use* seem to be the most considered RED-topic in Brazil's biofuel related legislation. The least considered topic seem to be *GHG emissions*.

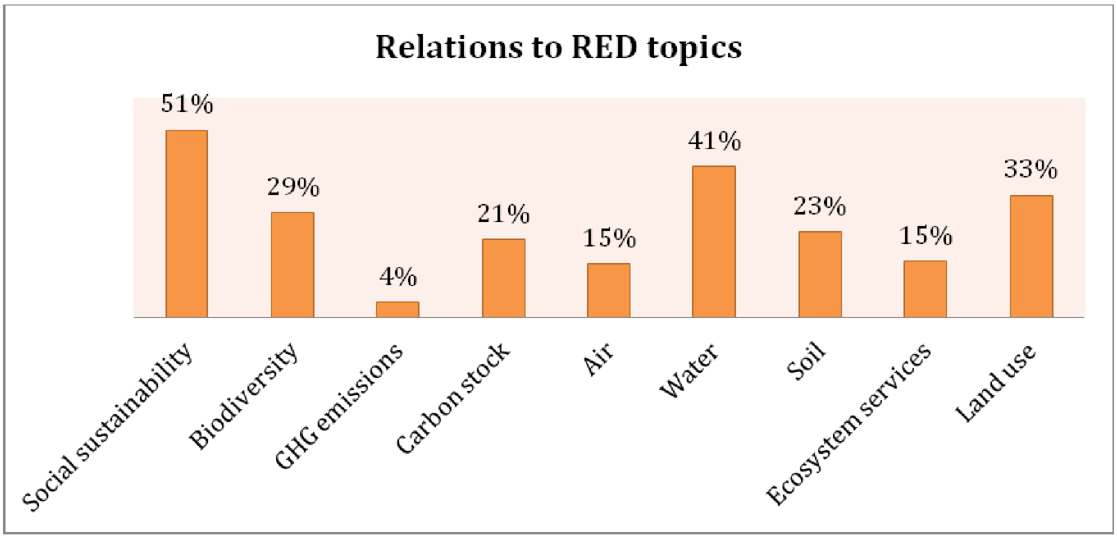


Figure 52. Share of Brazil's biofuel related legislation that consider each RED topic.

Relations to RED sustainability criteria

As seen in Figure 53, most relations were found for *Impacts on areas designated for nature protection purposes* and *Clearing of forests*. Few relations were found for *Conversion of wetlands* and *Conversion of grasslands*. No relations were found for *Drainage of peatlands.*

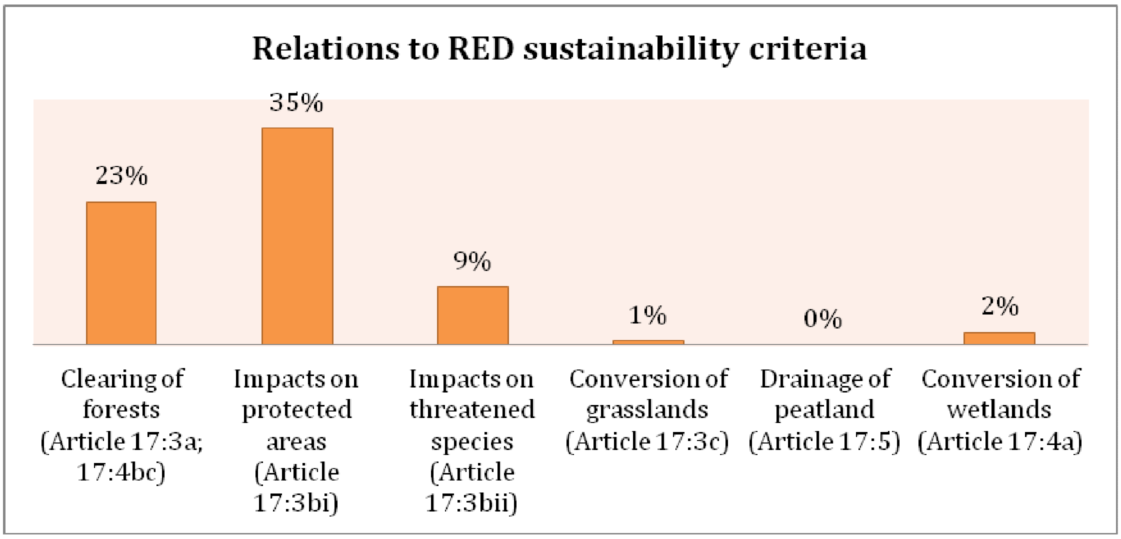


Figure 53. Share of Brazil's biofuel related legislation that consider each RED criterion.

Complementary analysis of regulations

Due to capacity constraints, no complementary analysis of regulations was made for Brazil. It should be noted though that the number of Brazilian regulations in ECOLEX (922) is far greater than the number of legislations (269). It is therefore likely that a complementary analysis of regulations could be very useful to better understand the Brazilian case.

Enforcement

Enforcement is analysed both from the perspective of juridical responsibilities to enforce biofuel related legislation and practical potential to enforce legislation in general.

Enforcement of biofuel legislation in the juridical sense

Almost all 150 laws relevant for biofuels specify that "the government" is responsible for enforcement. No laws specify more specific responsible institutions.

Enforcement potential of legislation

Table 56 presents the results for Brazil on the CPI, GII, ID and EI indexes, with the purpose to provide for a discussion on how compliance with legislation in Brazil is managed in the practical sense. Note that this chapter does not focus specifically on how compliance is managed with biofuel legislation, but rather on Brazil's potential to enforce legislation in general.

Table 56. Indices for enforcement potential of legislation in Brazil.

Indicator	Score	Description
CPI - Corruption Perception Index	3.7 / 10	Corruption is perceived medium
GII – Global Integrity Index	76 / 100	Anti corruption framework is moderate
ID – Index of Democracy	7.1 / 10	Classified as "flawed democracy".
EI - Enforcement Index	6.1 / 10	Potential to enforce legislation is intermediate
RLI – Rule of Law Index		Not reported

Brazil is regarded to be a "flawed democracy". Public sector corruption is perceived to exist to a medium extent and the anti-corruption framework is considered to be moderate. Brazil's potential to enforce legislation is classified as "intermediate".

G 4 Argentina

Argentina is a major producer of Soybean biodiesel and part of the *America* region.

Biofuel legislation

Available environmental legislation in Argentina includes 454 laws, written in Spanish (FAO et al. 2011). As seen in Figure 54, 237 laws are relevant for biofuels and about 85% of the relevant laws have a sub-national coverage.

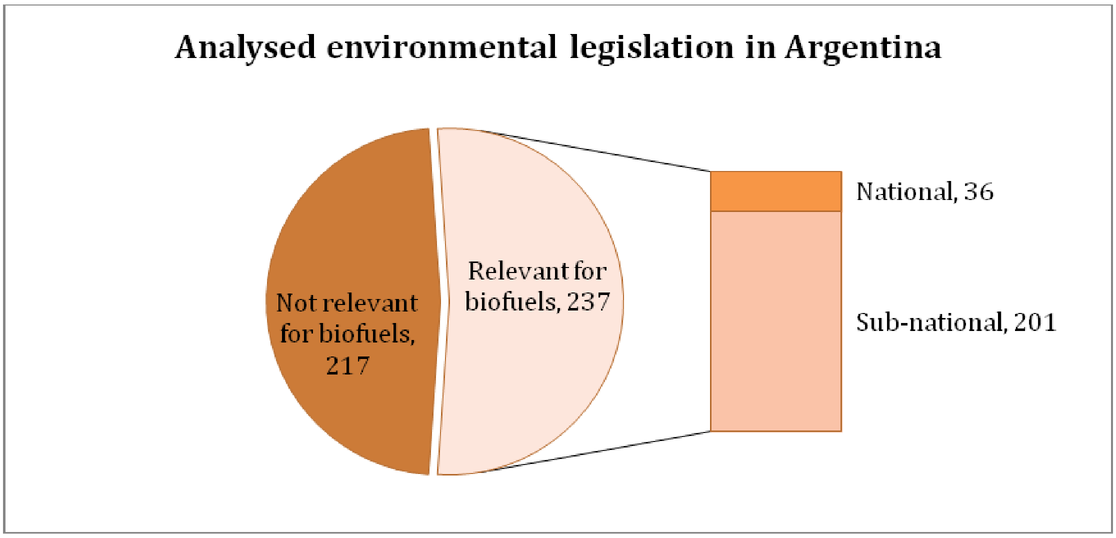


Figure 54. Overview of the analysed environmental legislation in Argentina, including number of laws relevant for biofuels and their national coverage.

Connections to biofuels

As seen in Figure 55, most of the biofuel related laws have connections to the feedstock production phase and particularly agriculture in general. Six laws are specifically connected to biofuel feedstock production, "Law No. 7.560" (sub-national), "Law No. 26.334" (national), "Law No. 13.719 (sub-national), "Law No. 12.692" (sub-national), "Law No. 12.691" (sub-national) and "Law No. 26.093" (national).

Almost one third of the relevant laws have connections to industrial activities. Six laws are specifically connected to biofuel processing, the same laws as specified above for biofuel feedstock production.

Almost one third of the relevant laws have connections to biofuels in other ways than feedstock production or processing. Most common are laws on environmental education / access to environmental information and land-rights.

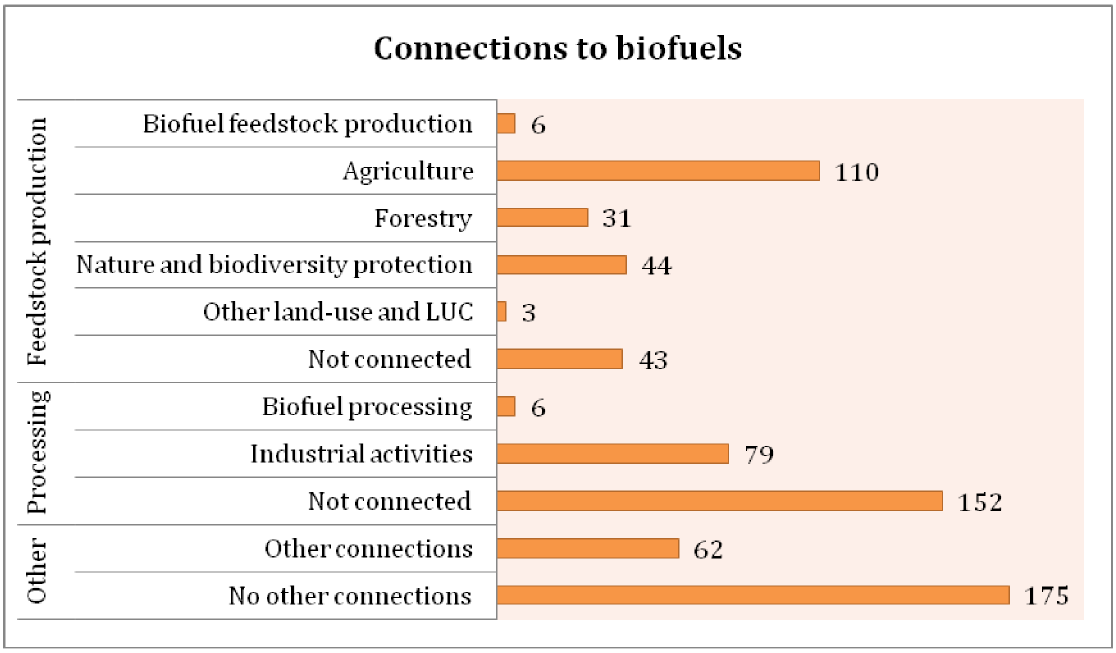


Figure 55. Connections between environmental legislation and biofuels in Argentina.

Relations to RED sustainability considerations

As seen in Figure 56, *Social sustainability*, *Water*, *Biodiversity*, *Land-use* and *Soil* seem to be the most considered RED-topics in Argentina's biofuel related legislation. The least considered topic seems to be *Ecosystem services*.

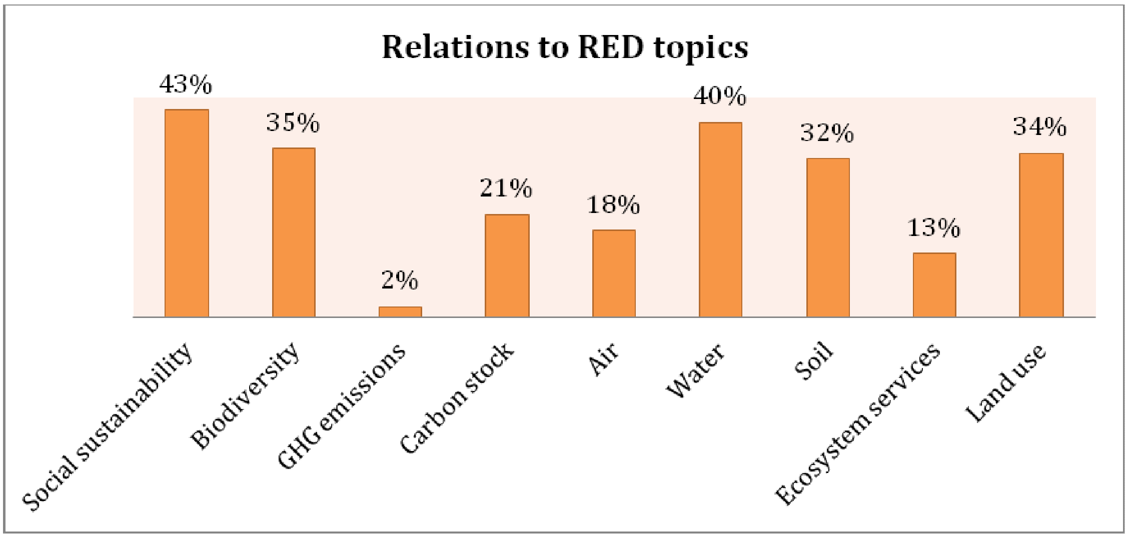


Figure 56. Share of Argentina's biofuel related legislation that consider each RED topic.

Relations to RED sustainability criteria

As seen in Figure 57, most relations were found for *Impacts on areas designated for nature protection purposes* and *Clearing of forests*. Few relations were found for *Conversion of wetlands*, *Conversion of grasslands* and *Drainage of peatlands.*

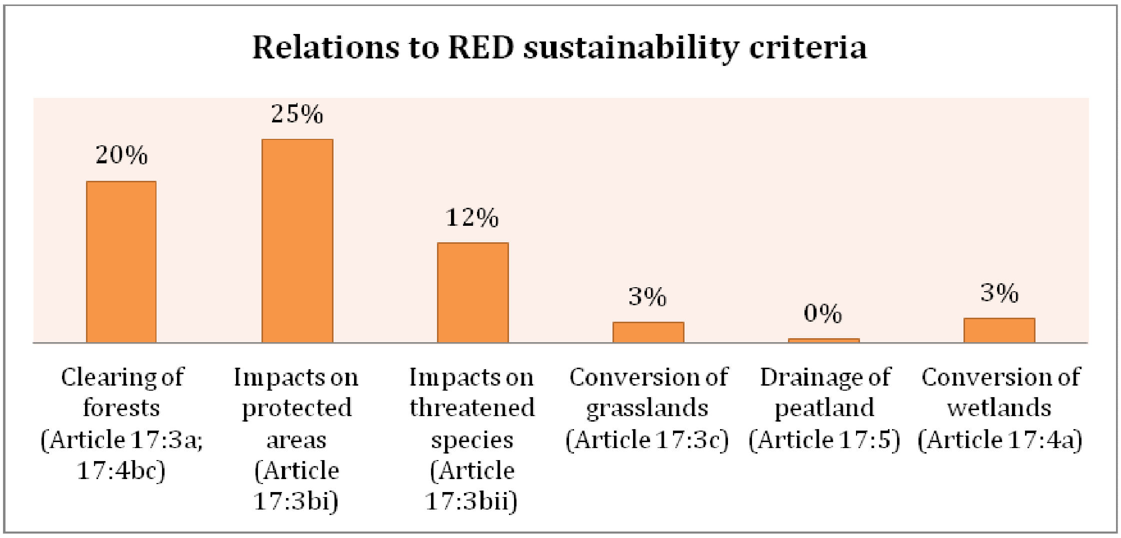


Figure 57. Share of Argentina's biofuel related legislation that consider each RED criterion.

Enforcement

Enforcement is analysed both from the perspective of juridical responsibilities to enforce biofuel related legislation and practical potential to enforce legislation in general.

Enforcement of biofuel legislation in the juridical sense

125 of the 237 laws relevant for biofuels specify institutions responsible for enforcement. This means Institutions responsible for enforcement are specified in-text in 53% of the biofuel related laws. Examples of recurring institutions include "El Ministerio de Asuntos Agrarios" (The Ministry of Agricultural Affairs) and "El Ministerio de Ecología y Recursos Naturales Renovables" (The Ministry of Ecology and Renewable Natural Resources). The other 112 relevant laws do not specify institutions responsible for enforcement.

Enforcement potential of legislation

Table 57 presents the results for Argentina on the CPI, GII, ID, EI and RLI indexes, with the purpose to provide for a discussion on how compliance with legislation in Argentina is managed in the practical sense. Note that this chapter does not focus specifically on how compliance is managed with biofuel legislation, but rather on Argentina's potential to enforce legislation in general.

Table 57. Indices for enforcement potential of legislation in Argentina.

Indicator	Score	Description
CPI - Corruption Perception Index	2.9 / 10	Corruption is perceived high
GII – Global Integrity Index	70 / 100	Anti corruption framework is weak / close to moderate
ID – Index of Democracy	6.8 / 10	Classified as "flawed democracy".
EI - Enforcement Index	5.6 / 10	Potential to enforce legislation is intermediate to weak
RLI – Rule of Law Index [1)]	0.40 / 1	Challenges on corruption and government accountability
RLI – Rule of Law Index [2)]	0.36 / 1	Low potential to enforce legislation

1) Compound index of RLI factors 1 (Limited Government Powers) and 2 (Absence of Corruption)
2) Compound index of RLI factors 6 (open government) and 7 (Regulatory Enforcement).

Argentina is regarded to be a "flawed democracy". Public sector corruption is perceived to be high and the anti-corruption framework is considered to be weak, but close to moderate. Argentina's potential to enforce legislation is classified as "intermediate", although close to "low". However, the RLI score indicates a significantly lower potential.

G 5 Guatemala

Guatemala is part of the *America* region.

Biofuel legislation

Available environmental legislation in Guatemala includes 46 laws, written in Spanish (FAO et al. 2011). As seen in Figure 58, 28 laws are relevant for biofuels and most have a national coverage.

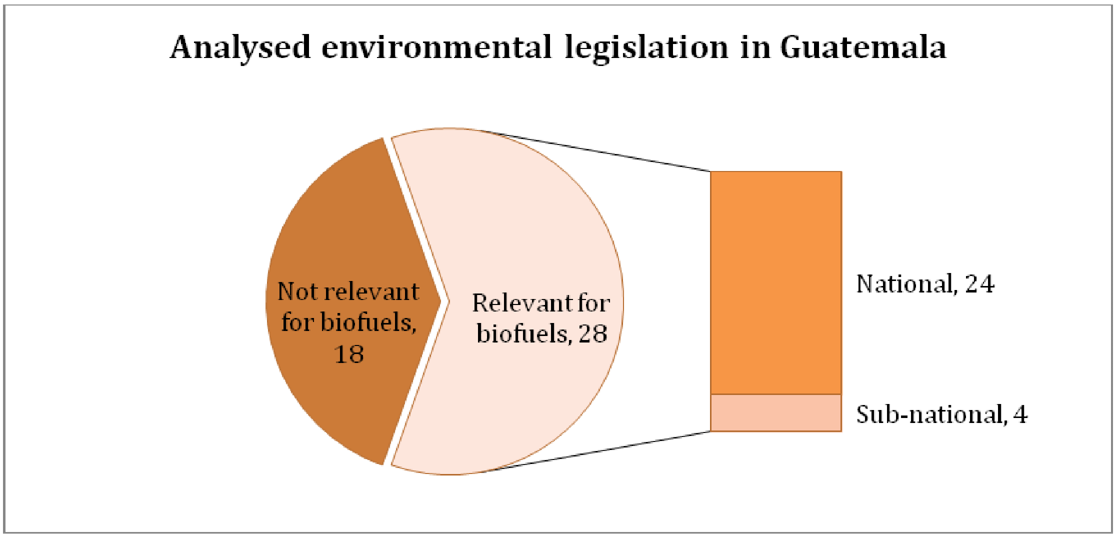


Figure 58. Overview of the analysed environmental legislation in Guatemala, including number of laws relevant for biofuels and their national coverage.

Connections to biofuels

As seen in Figure 59, most of the biofuel related laws have connections to the feedstock production phase and particularly agriculture in general. One national law is specifically connected to biofuel feedstock production, "Decree No. 52/03 - Law on incentives for development of renewable energy projects".

Five of the 28 relevant laws have connections to industrial activities. One law is specifically connected to biofuel processing, "Decree No. 52/03", the same law as for biofuel feedstock production.

More than one third of the relevant laws have connections to biofuels in other ways than feedstock production or processing. Most common are laws on land-rights, although two laws aim towards promoting the spread of environmental awareness and knowledge.

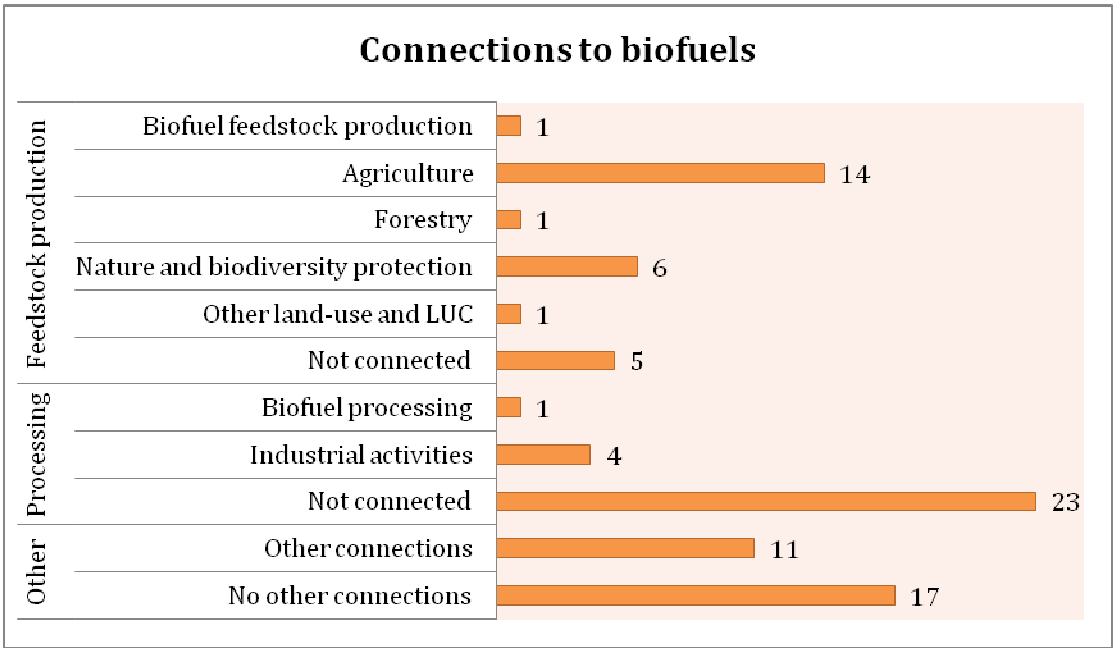


Figure 59. Connections between environmental legislation and biofuels in Guatemala.

Relations to RED sustainability considerations

As seen in Figure 60, *Social sustainability* seems to be the most considered RED-topic in Guatemala's biofuel related legislation, followed by *Water*, *Land-use* and *Biodiversity*. The least considered topics include *Carbon stock*, *Air* and particularly *GHG emissions*, for which no relations were found.

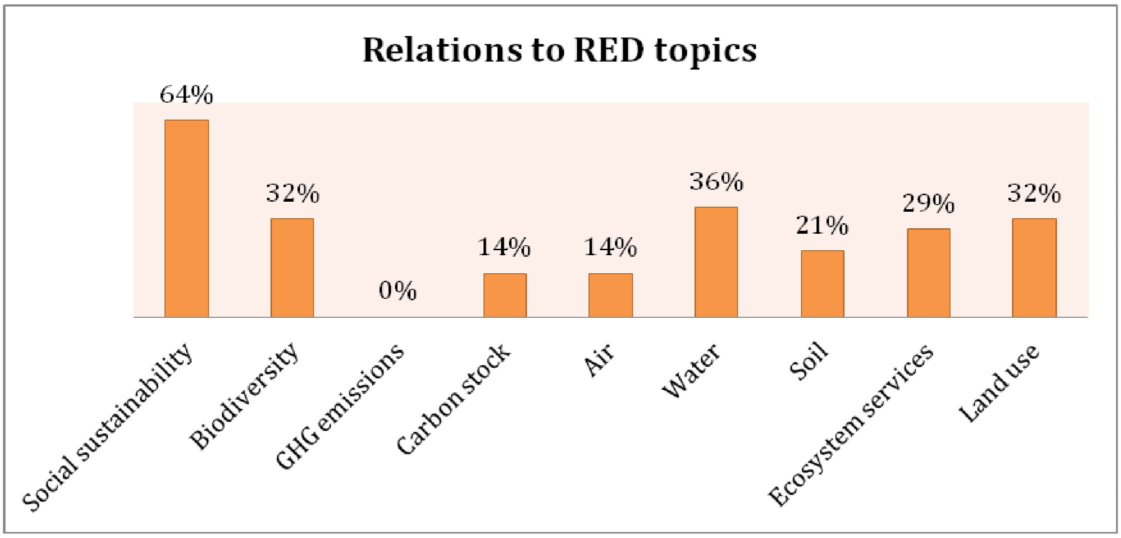


Figure 60.Share of Guatemala's biofuel related legislation that consider each RED topic.

Relations to RED sustainability criteria

As seen in Figure 61, most relations were found for *Impacts on areas designated for nature protection purposes* and *Clearing of forests*. Few relations were found for

Conversion of wetlands. No relations were found for Conversion of grasslands and *Drainage of* peatlands.

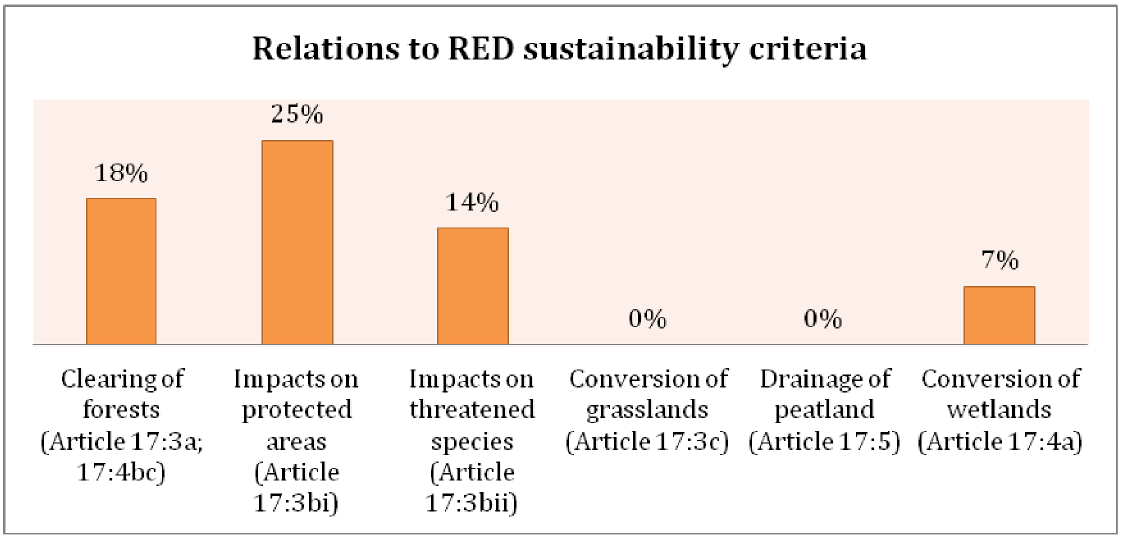


Figure 61. Share of Guatemala's biofuel related legislation that consider each RED topic.

Complementary analysis of regulations

Since no laws related to *Conversion of grasslands* or *Drainage of peatlands* were identified, an effort to identify such relations in regulations was made. One national regulation restricting drainage of peatlands was identified, the "Resolution Nº 1.25/98 - Regulation for the exploitation of mangrove"

No regulations were identified restricting conversion of grasslands.

Enforcement

Enforcement is analysed both from the perspective of juridical responsibilities to enforce biofuel related legislation and practical potential to enforce legislation in general.

Enforcement of biofuel legislation in the juridical sense

16 of the 28 laws relevant for biofuels specify institutions responsible for enforcement. This corresponds to 57% of the relevant laws. Examples of recurring institutions include "El Consejo National de Areas Protegidas" (The National Council of Protected Areas) and "La Comisión Nacional del Medio Ambiente" (The National Environment Commission).

Enforcement potential of legislation

Table 58 presents the results for Guatemala on the CPI, GII, ID and EI indexes, with the purpose to provide for a discussion on how compliance with legislation in Guatemala is managed in the practical sense. Note that this chapter does not focus specifically on how compliance is managed with biofuel legislation, but rather on Guatemala's potential to enforce legislation in general.

Table 58. Indices for enforcement potential of legislation in Guatemala.

Indicator	Score	Description
CPI - Corruption Perception Index	3.2 / 10	Corruption is perceived medium
GII – Global Integrity Index	64 / 100	Anti corruption framework is weak
ID – Index of Democracy	6.1 / 10	Classified as "flawed democracy" close to "hybrid regime"
EI - Enforcement Index	5.2 / 10	Potential to enforce legislation is low
RLI – Rule of Law Index		Not reported

Guatemala is classified as a "flawed democracy", although close to "hybrid regime". Public sector corruption is perceived to exist to a medium extent and the anti-corruption framework is considered to be weak. Guatemala's potential to enforce legislation is classified as "low".

G 6 Indonesia

Indonesia is a major producer of Oil Palm biodiesel and part of the *Asia* region.

Biofuel legislation

Available environmental legislation in Indonesia consists of 27 laws, written in English (FAO et al. 2011). As seen in Figure 62, 18 of the laws are relevant for biofuels and all have a national coverage.

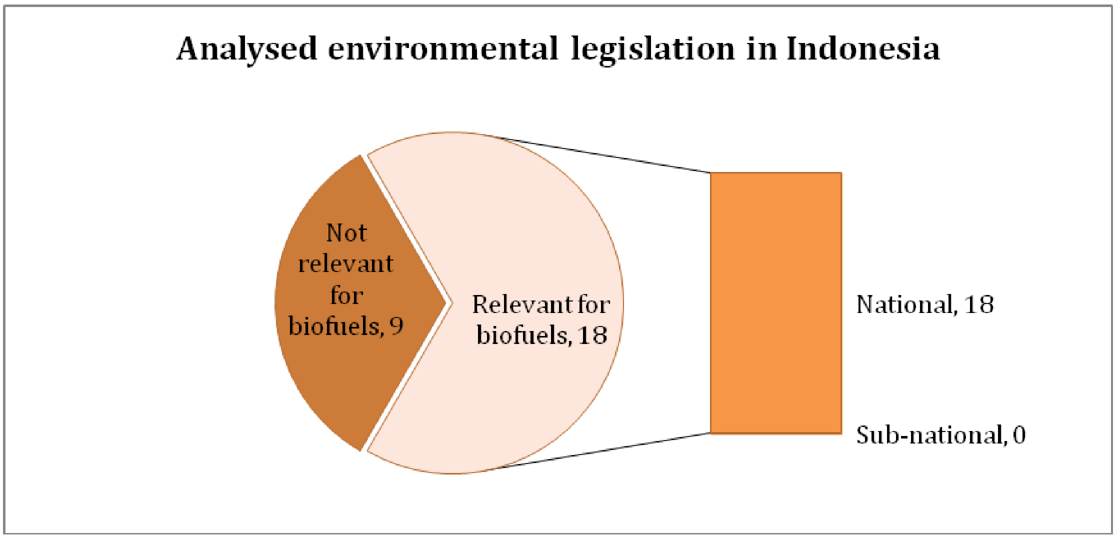


Figure 62. Overview of the analysed environmental legislation in Indonesia, including number of laws relevant for biofuels and their national coverage.

Connections to biofuels

As seen in Figure 63, most of the biofuel related laws have connections to the feedstock production phase and particularly agriculture in general. No laws have specific connections to biofuel feedstock production.

About one fifth of the relevant laws have connections to industrial activities, but no laws have specific connections to biofuel processing.

Almost half of the relevant laws have connections to biofuels in other ways than feedstock production or processing, most commonly these laws cover issues related to land-rights. Other examples include electricity supply and promotion of renewable energy.

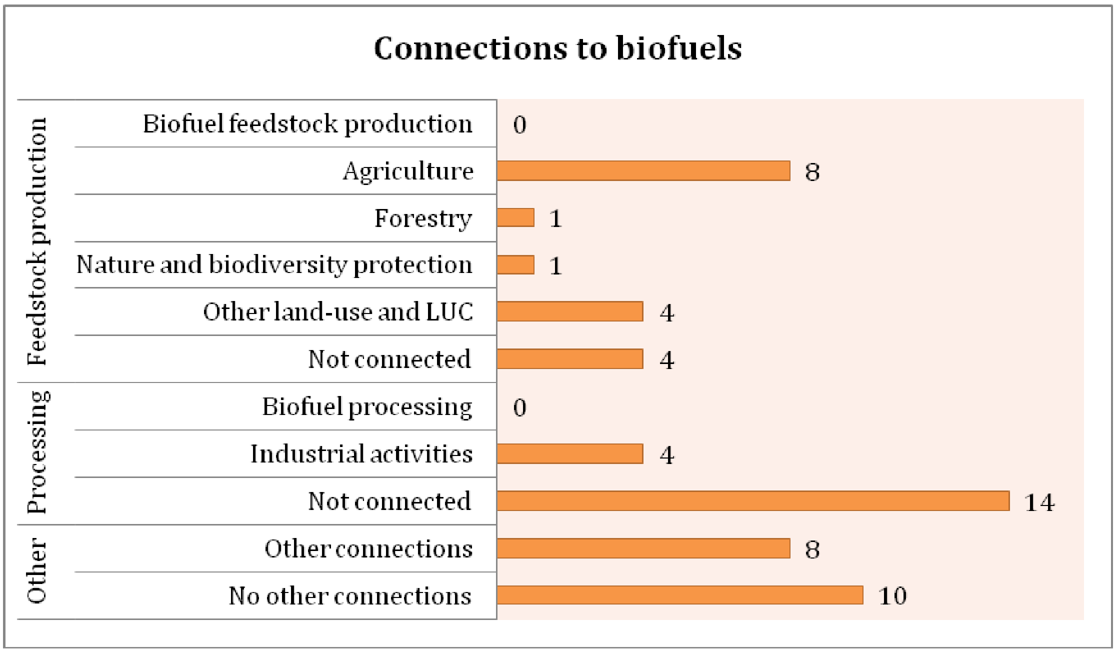


Figure 63. Connections between environmental legislation and biofuels in Indonesia.

Relations to RED sustainability topics

As seen in Figure 64, *Social sustainability* seems to be the most considered RED topic in Indonesia's biofuel related legislation followed by *Land-use*. The least considered topics include *Air* and particularly *GHG emissions*, for which no relations were found.

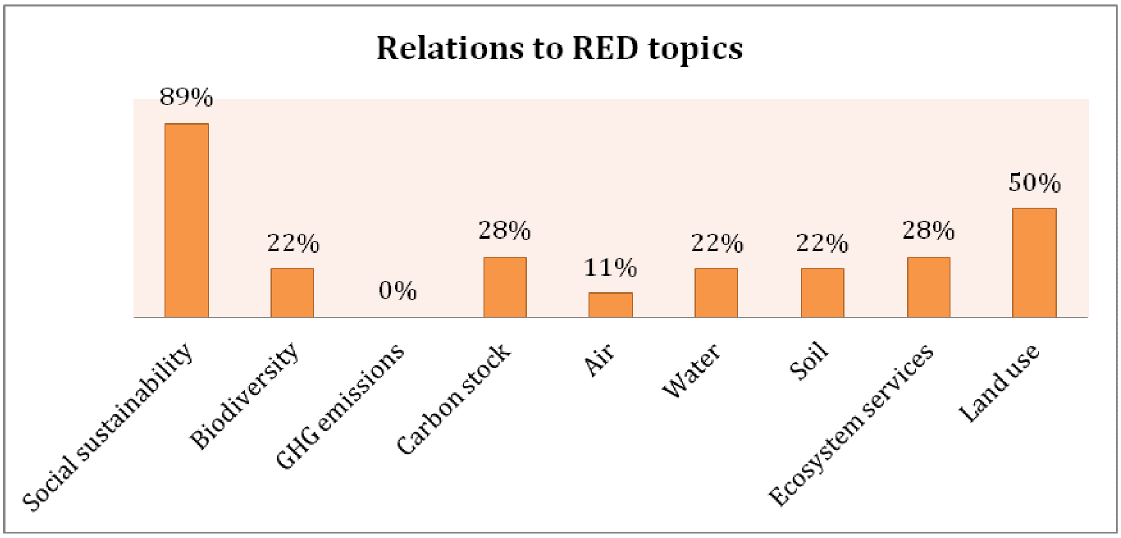


Figure 64. Share of Indonesia's biofuel related legislation that consider each RED topic.

Relations to RED sustainability criteria

As seen in Figure 65, most relations were found for Impacts on areas designated for nature protection purposes. Few relations were found for Clearing of forests, Impacts on rare, threatened and endangered species and Conversion of wetlands. No laws restricting Drainage of peatlands or Conversion of grasslands were found.

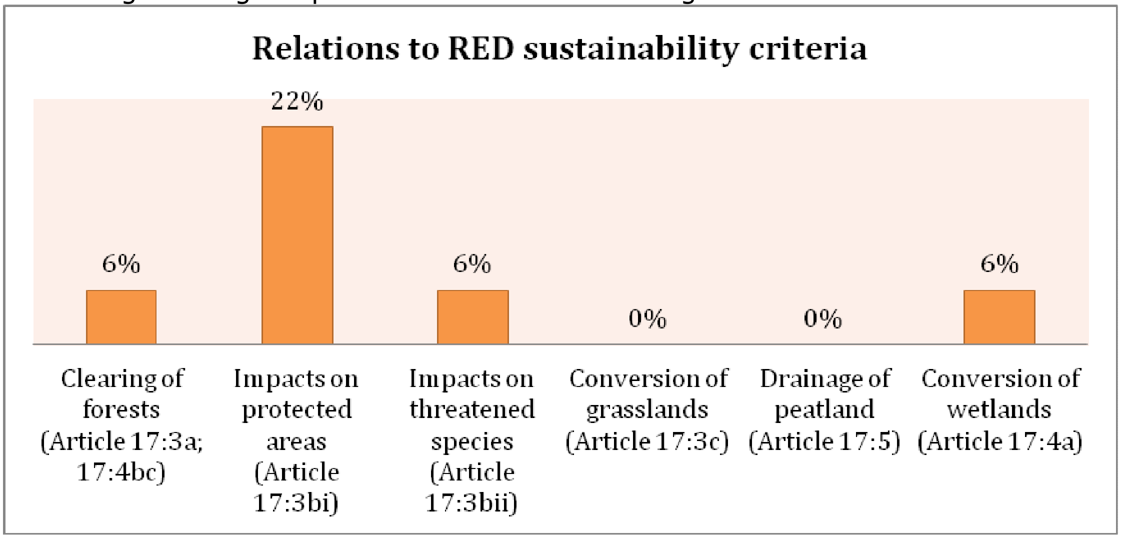


Figure 65. Share of Indonesia's biofuel related legislation that consider each RED criterion

Complementary analysis of regulations

Since no laws related to *Conversion of grasslands* or *Drainage of peatlands* were identified, an effort to identify such relations in regulations was made. Three national regulations restricting drainage of peatland were identified, including "Government Regulation No. 27 Concerning Swamps", "Decree of the State Minister of Environment No. KEP-39/MENLH/8/1996 on the types of business or activities which shall, by way of obligation, be completed with an analysis of environmental impacts" and "Government Regulation on land use management".

No regulations were identified restricting *Conversion of grasslands*.

Enforcement

Enforcement is analysed both from the perspective of juridical responsibilities to enforce biofuel related legislation and practical potential to enforce legislation in general.

Enforcement of biofuel legislation in the juridical sense

With a few exceptions, it is generally not stated in-text how individual laws are supposed to be enforced. Institutions responsible for enforcement are specified in-text in 17% of the identified biofuel related laws. Generally it seems like enforcement of laws is the responsibility of the government, local/regional governments or an unspecified government assigned agency. Exceptions include the National Energy Council, the Plant Variety Protection Office and the Head of First-Level Region through the Land Procurement Committee.

Enforcement potential of legislation

Table 59 presents the results for Indonesia on the various indexes, with the purpose to provide for a discussion on how compliance with legislation in Indonesia is managed in the practical sense. Note that this section does not focus specifically on how compliance with biofuel legislation is managed, but rather on Indonesia's potential to enforce legislation in general.

Table 59. Indices for enforcement potential of legislation in Indonesia.

Indicator	Score	Description
CPI - Corruption Perception Index	2.8 / 10	Corruption is perceived high
GII – Global Integrity Index	74 / 100	Anti corruption framework is moderate
ID – Index of Democracy	6.5 / 10	Classified as flawed democracy
EI - Enforcement Index	5.6 / 10	Potential to enforce legislation is intermediate
RLI – Rule of Law Index 1)	0.50 / 1	Challenges on corruption and government accountability
RLI – Rule of Law Index 2)	0.46 / 1	Intermediate potential to enforce legislation

1) Compound index of RLI factors 1 (Limited Government Powers) and 2 (Absence of Corruption)
2) Compound index of RLI factors 6 (open government) and 7 (Regulatory Enforcement).

Indonesia is regarded to be a "flawed democracy", likely to face challenges related to corruption and government accountability and the anti-corruption framework is considered to be moderate. Indonesia's potential to enforce legislation is classified as intermediate.

G 7 Malaysia

Malaysia is a major producer of Oil Palm biodiesel and part of the *Asia* region.

Biofuel legislation

Available environmental legislation in Malaysia includes 134 laws, written in English (FAO et al. 2011). As seen in Figure 66, 54 of the laws are relevant for biofuels and about two thirds have a national coverage while one third are sub-national.

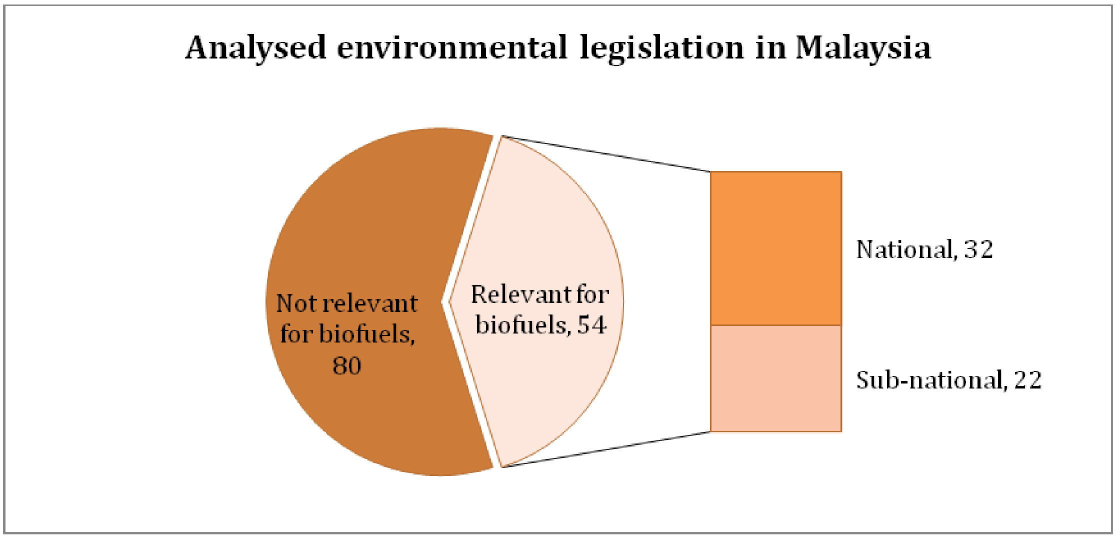


Figure 66. Overview of the analysed environmental legislation in Malaysia, including number of laws relevant for biofuels and their national coverage.

Connections to biofuels

As seen in Figure 67, almost all of the relevant laws have connections to the feedstock production phase, and particularly agriculture in general. Two laws have specific connections to biofuel feedstock production, "Malaysian Biofuel Industry Act 2007 (Act No. 666)" and "Malaysia Energy Commission Act 2001 (Act No. 610)". Both laws are national.

One third of the relevant laws have connections to industrial activities, but no laws have specific connections to biofuel processing.

About one third of the relevant laws have connections to biofuels in other ways than feedstock production or processing, including for example issues regarding land-/property-/building rights, general energy or land-use planning and corruption.

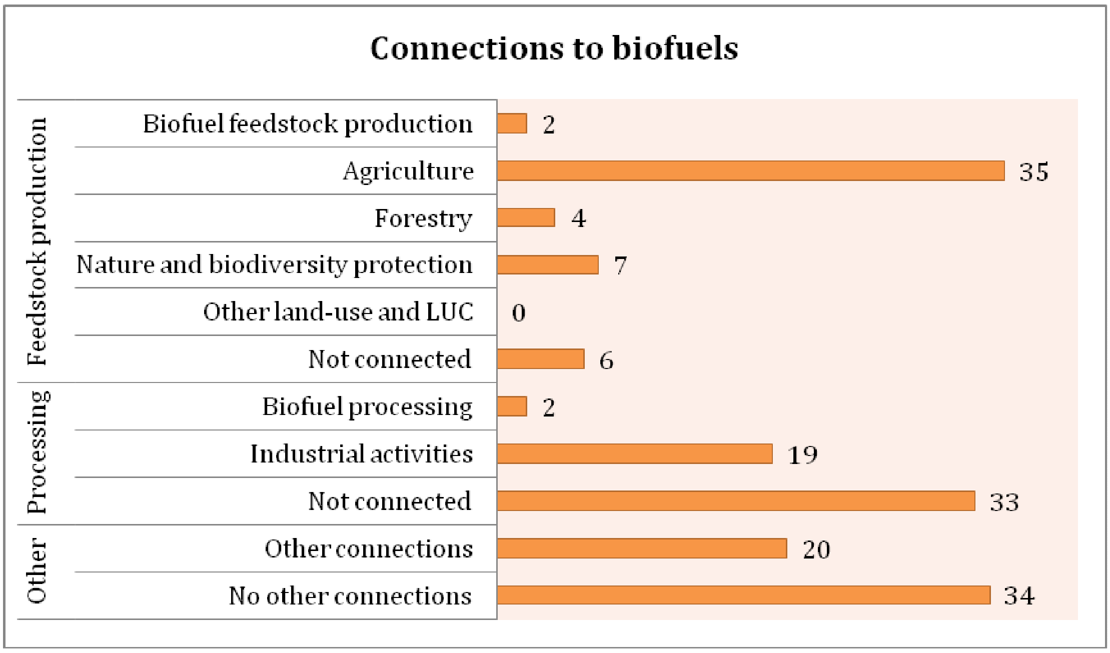


Figure 67. Connections between environmental legislation and biofuels in Malaysia.

Relations to RED sustainability topics

As seen in Figure 68, *Land-use* seem to be the most considered RED topic in Malaysia's biofuel legislation followed by *Social sustainability*. The least considered topics include *Ecosystem services*, *Air*, *Carbon stock* and *GHG emissions*.

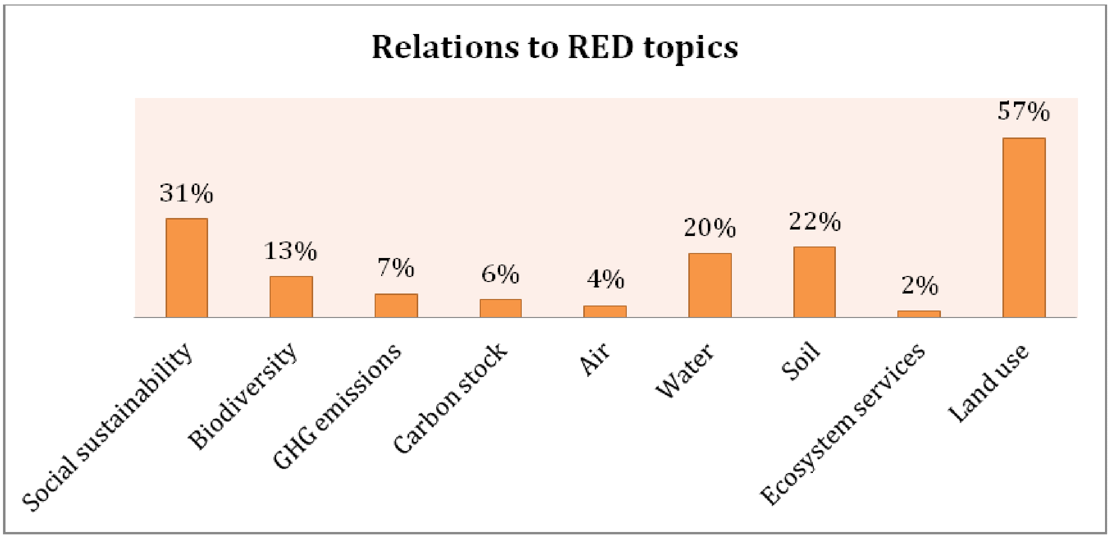


Figure 68. Share of Malaysia's biofuel related legislation that consider each RED topic

Relations to RED sustainability criteria

As seen in Figure 69, most relations were found for Impacts on areas designated for nature protection purposes and Clearing of forests. Few relations were found for Conversion of grasslands, Impacts on rare, threatened and endangered species, Drainage of peatlands and Conversion of wetlands.

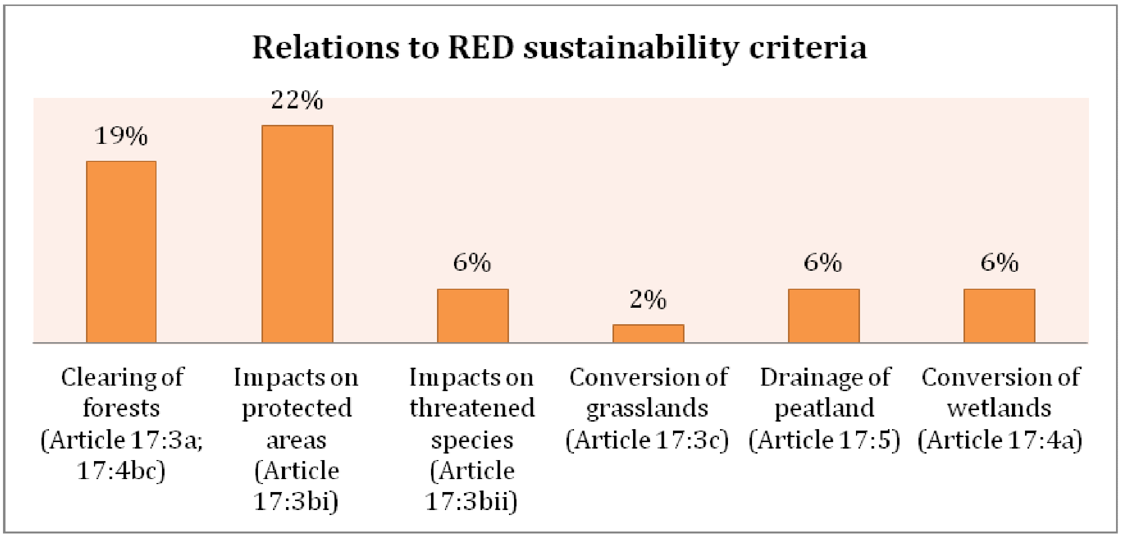


Figure 69. Share of Malaysia's biofuel related legislation that consider each RED criterion

Enforcement

Enforcement of biofuel legislation in the juridical sense

38 of the 54 biofuel related laws in Malaysia specify an institution responsible for enforcement. Particularly recurring (in 14 laws) is "Duli Yang Maha Mulia Seri Paduka Baginda Yang di-Pertuan Agong with the advice and consent of the Dewan Negara and Dewan Rakyat". This means that the constitutional head-of-state of Malaysia is responsible for enforcement with the advice and support of the Senate and the House of Representatives. 16 laws include more specific responsible institutions, mainly specific ministers.

Even though 38 of the 54 biofuel related laws specify an institution responsible for enforcement, only 16 can be regarded as sufficiently specific for the responsibility to be clear. Therefore, institutions responsible for enforcement are specified in-text in 30% of the biofuel related laws.

Enforcement potential of legislation

Table 60 presents the results for Malaysia on the CPI, GII, ID and EI indexes, with the purpose to provide for a discussion on how compliance with legislation in Malaysia is managed in the practical sense. Note that this section does not focus specifically on how compliance with biofuel legislation is managed, but rather on Malaysia's potential to enforce legislation in general.

Table 60. Indices for enforcement potential of legislation in Malaysia.

Indicator	Score	Description
CPI - Corruption Perception Index	4.4 / 10	Corruption is perceived medium
GII – Global Integrity Index [1)]	77 / 100	Anti corruption framework is moderate
ID – Index of Democracy	6.2 / 10	Classified as flawed democracy
EI - Enforcement Index [2)]	6.0 / 10	Potential to enforce legislation is intermediate
RLI – Rule of Law Index		Not reported

1) The GII score was estimated to be similar score to Indonesia (74, similar ID and geographical proximity) and South Africa (79, similar CPI).

2) The EI score was estimated to be intermediate, with the same score as Indonesia.

Malaysia is regarded to be a "flawed democracy". Public sector corruption is perceived to exist to a medium extent and the anti-corruption framework is considered to be moderate. Malaysia's potential to enforce legislation is classified as intermediate.

G 8 Pakistan

Pakistan is a big producer of Sugarcane molasses ethanol and part of the *Asia* region.

Biofuel legislation

Available environmental legislation in Pakistan includes 111 laws, written in English (FAO et al. 2011). As seen in Figure 70, 59 of the laws are relevant for biofuels and most have a sub-national coverage.

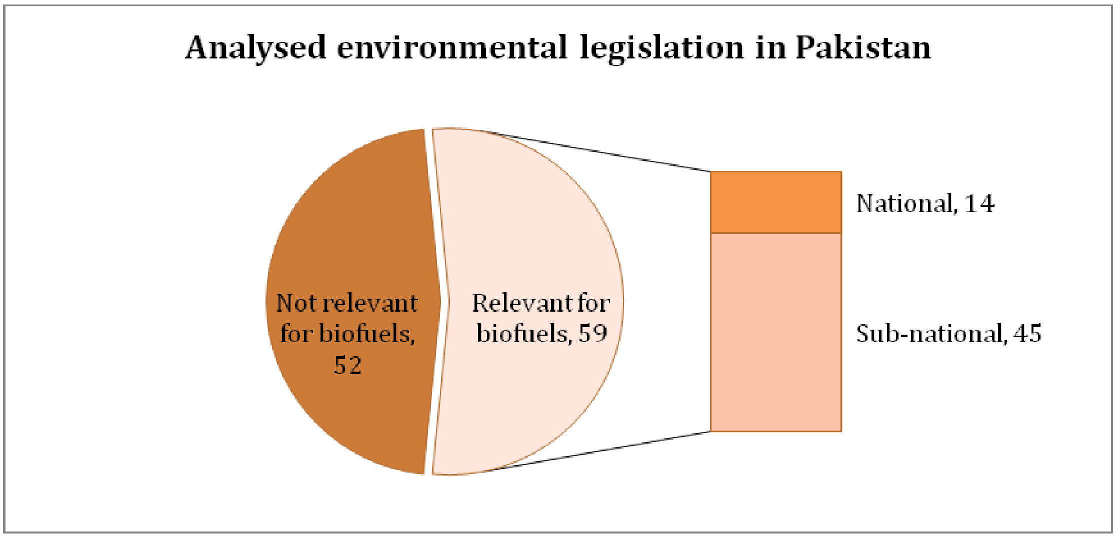


Figure 70. Overview of the analysed environmental legislation in Pakistan, including number of laws relevant for biofuels and their national coverage.

Connections to biofuels

As seen in Figure 71, most of the biofuel related laws have connections to the feedstock production phase and particularly agriculture in general. No laws have specific connections to biofuel feedstock production.

One sixth of the relevant laws are connected to industrial activities, but no laws have specific connections to biofuel processing.

One third of the relevant laws have connections to biofuels in other ways than feedstock production or processing, most commonly these laws cover issues related to land-rights. Other examples include electricity supply and promotion of renewable energy.

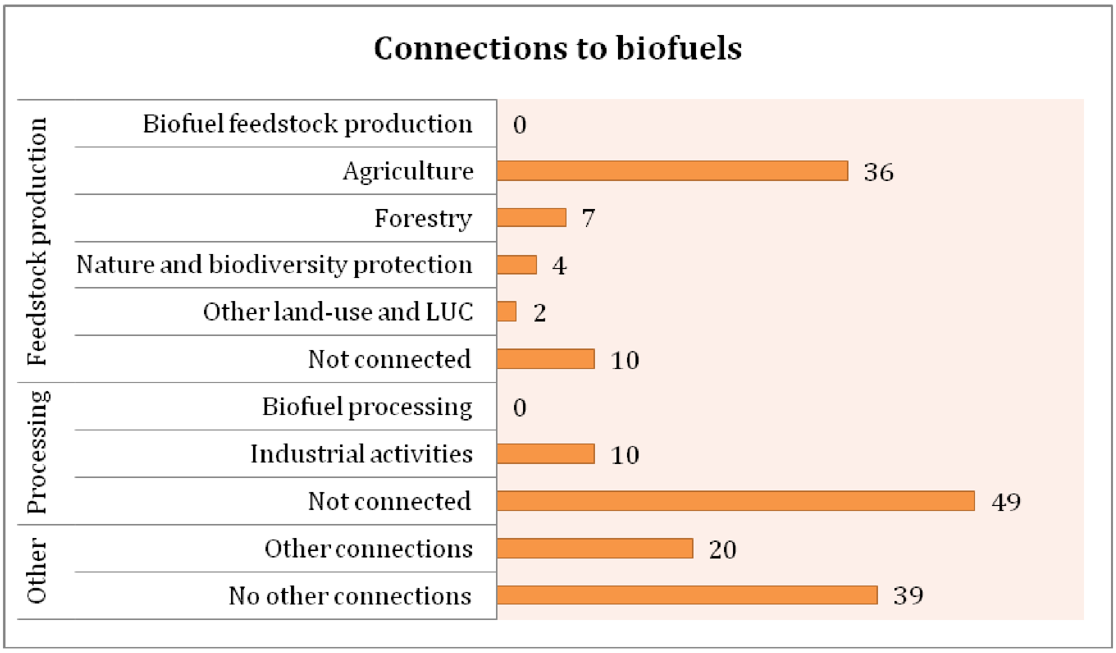


Figure 71. Connections between environmental legislation and biofuels in Pakistan.

Relations to RED sustainability topics

As seen in Figure 72, *Social sustainability* seems to be the most considered RED topic in Pakistan's biofuel legislation, followed by *Water*. The least considered topics include *Biodiversity*, *Air* and particularly *GHG emissions*, for which no relations were found.

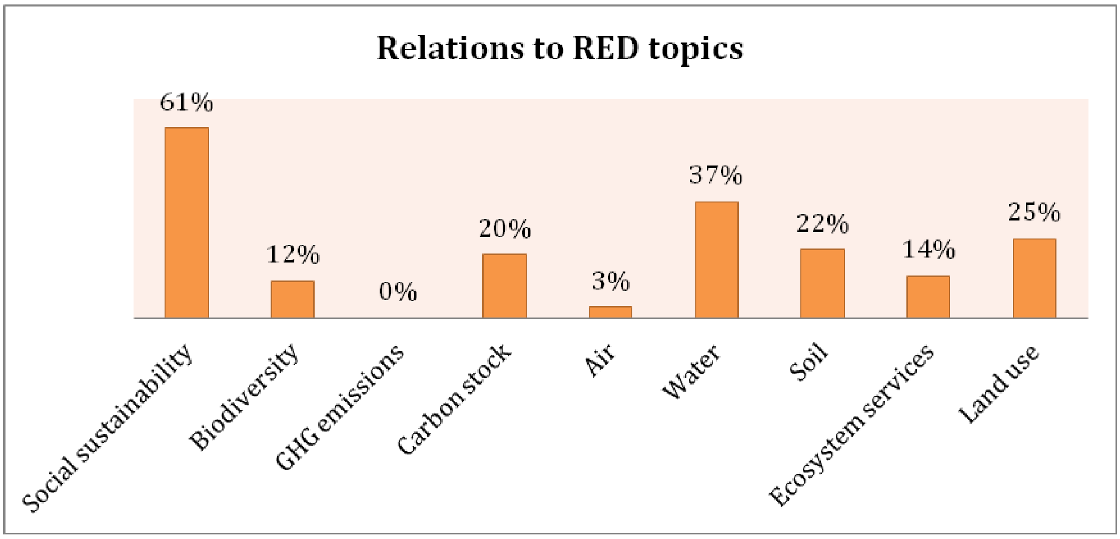


Figure 72. Share of Pakistan's biofuel related legislation that consider each RED topic.

Relations to RED sustainability criteria

As seen in Figure 73, most relations were found for *Clearing of forests*. Few relations were found for *Impacts on rare, threatened and endangered species.* No relations were found for *Conversion of grasslands*, *Drainage of peatlands* and *Conversion of wetlands.*

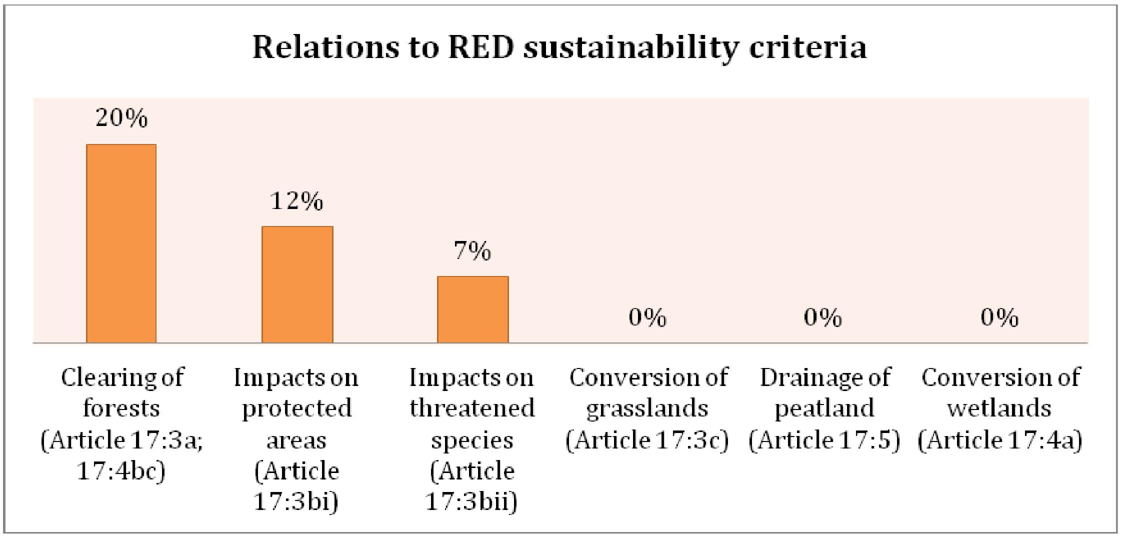


Figure 73. Share of Pakistan's biofuel related legislation that consider each RED criterion.

Complementary analysis of regulations

Since no laws related to *Conversion of grasslands*, *Drainage of peatlands* or *Conversion of wetlands* were identified, an effort to identify such relations in regulations was made.

No regulations were identified restricting Conversion of grasslands, Drainage of peatlands or Conversion of wetlands.

Enforcement

Enforcement is analysed both from the perspective of juridical responsibilities to enforce biofuel related legislation and practical potential to enforce legislation in general.

Enforcement of biofuel legislation in the juridical sense

43 of the 59 biofuel related laws in Pakistan specify an institution responsible for enforcement. However, most laws state that it is the responsibility of the government, the federal government or the provincial government. 13 laws include more specific responsible institutions, such as the Alternative Energy Development Board and the Environmental Protection Council.

Even though 43 of the 59 biofuel related laws specify an institution responsible for enforcement, only 13 can be regarded as sufficiently specific for the responsibility to be clear. Therefore, institutions responsible for enforcement are specified in-text in 22% of the biofuel related laws. It is unclear if specific responsibilities for enforcement are specified in other ways than in the individual laws. However, if responsibilities are unspecified or unclear, it is likely to affect the level of enforcement.

Enforcement potential of legislation

Table 61 presents the results for Pakistan on the CPI, GII, ID, EI and RLI indexes, with the purpose to provide for a discussion on how compliance with legislation in Pakistan is managed in the practical sense. Note that this section does not focus specifically on how compliance is managed with biofuel legislation, but rather on Pakistan's potential to enforce legislation in general.

Table 61. Indices for enforcement potential of legislation in Pakistan.

Indicator	Score	Description
CPI - Corruption Perception Index	2.3 / 10	Corruption is perceived high
GII – Global Integrity Index	72 / 100	Anti corruption framework is moderate
ID – Index of Democracy	4.6 / 10	Classified as "hybrid regime".
EI - Enforcement Index	4.7 / 10	Potential to enforce legislation is low
RLI – Rule of Law Index [1)]	0.24 / 1	Challenges on corruption and government accountability
RLI – Rule of Law Index [2)]	0.30 / 1	Low potential to enforce legislation

1) Compound index of RLI factors 1 (Limited Government Powers) and 2 (Absence of Corruption)
2) Compound index of RLI factors 6 (open government) and 7 (Regulatory Enforcement).

Pakistan is regarded to be a "hybrid regime". Public sector corruption is perceived to be high and the anti-corruption framework is considered to be moderate although with difficulties in practical implementation. Pakistan's potential to enforce legislation is classified as low.

G 9 India

India is part of the *Asia* region.

Biofuel legislation

Available environmental legislation in India includes 219 laws, written in English (FAO et al. 2011). As seen in Figure 74, 91 of the laws are relevant for biofuels and most have a sub-national coverage.

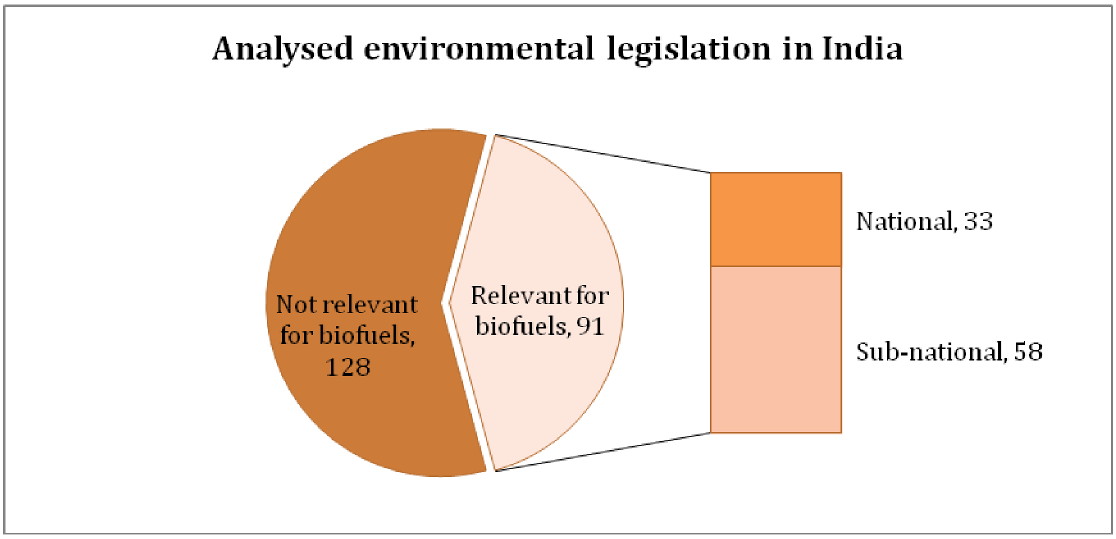


Figure 74. Overview of the analysed environmental legislation in India, including number of laws relevant for biofuels and their national coverage.

Connections to biofuels

As seen in Figure 75, most of the biofuel related laws have connections to the feedstock production phase and particularly agriculture in general. No laws have specific connections to biofuel feedstock production.

Almost half of the relevant laws have connections to industrial activities. One law, Act No. 30 of 2002, is specifically connected to biofuel processing.

About 10% of the relevant laws have connections to biofuels in other ways than feedstock production or processing. Examples include laws on land-rights and distribution of agricultural products.

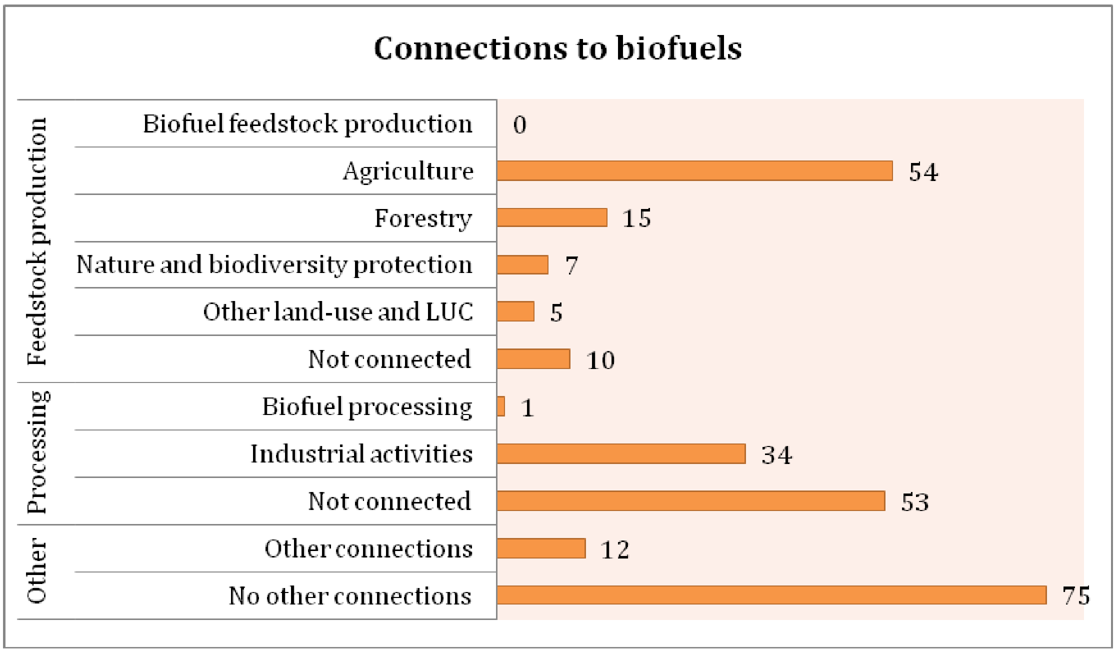


Figure 75. Connections between environmental legislation and biofuels in India.

Relations to RED sustainability topics

As seen in Figure 76, *Social sustainability, Water* and *Land-use* seem to be the most considered RED-topics in India's biofuel related legislation. The least considered topics include *Ecosystem services, Carbon stock*, *Air* and particularly *GHG emissions*, for which no relations were found.

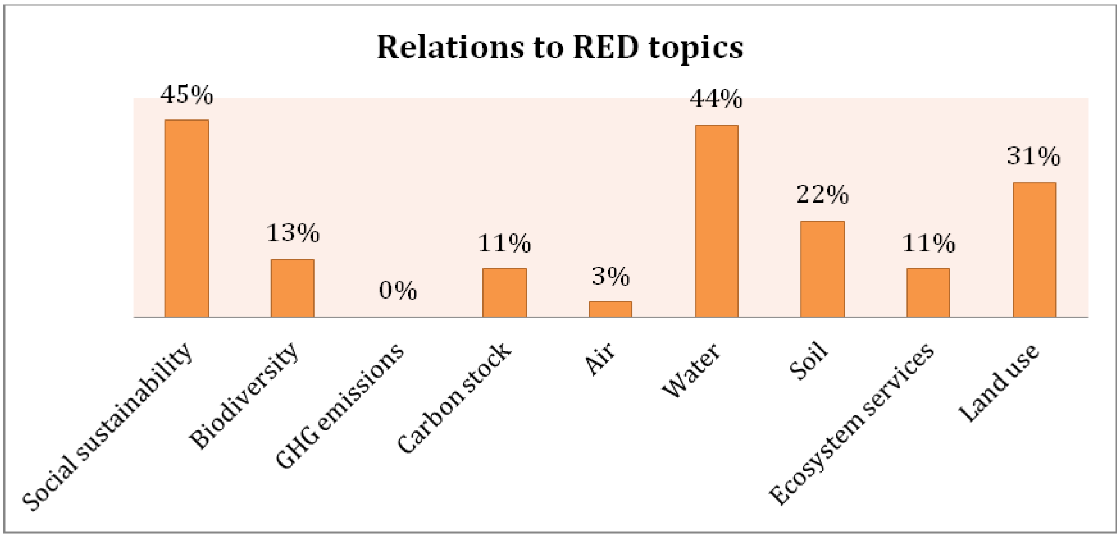


Figure 76. Share of India's biofuel related legislation that consider each RED topic.

Relations to RED sustainability criteria

As seen in Figure 77, most relations were found for Clearing of forests. Few relations were found for Impacts on rare, threatened and endangered species, Drainage of peatlands and Conversion of wetlands. No relations were found for Conversion of grasslands.

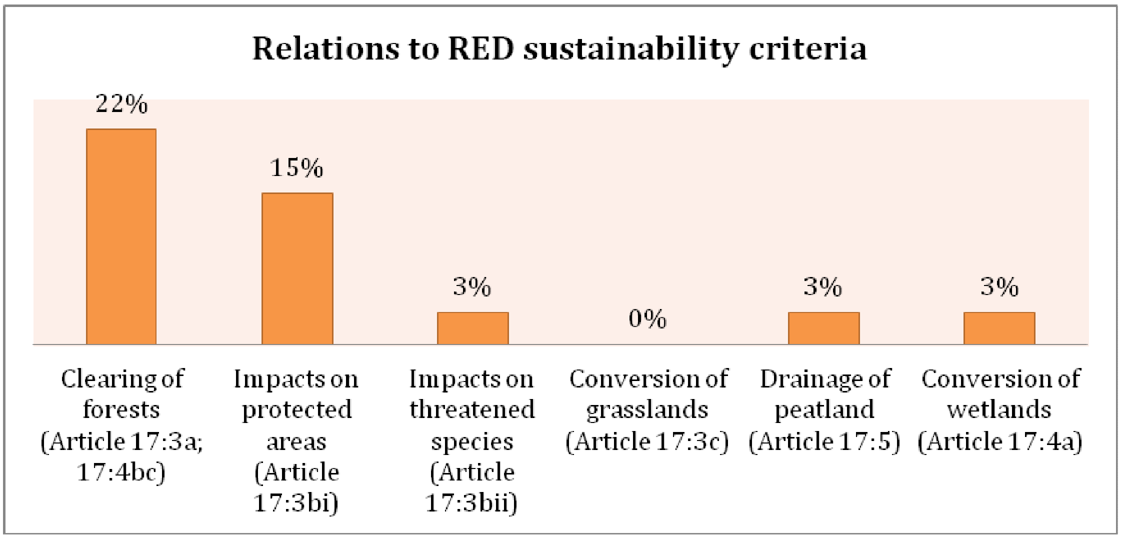


Figure 77. Share of India's biofuel related legislation that consider each RED criterion.

Complementary analysis of regulations

Since no laws related to *Conversion of grasslands* were identified, an effort to identify such relations in regulations was made.

No regulations were identified restricting *Conversion of grasslands*.

Enforcement

Enforcement is analysed both from the perspective of juridical responsibilities to enforce biofuel related legislation and practical potential to enforce legislation in general.

Enforcement of biofuel legislation in the juridical sense

None of the 91 laws relevant for biofuel production specify an institution responsible for enforcement.

Enforcement potential of legislation

This chapter presents the results for India on the CPI, GII, ID, EI and RLI indexes, with the purpose to provide for a discussion on how compliance with legislation in India is managed in the practical sense. Note that this section does not focus specifically on how compliance is managed with biofuel legislation, but rather on India's potential to enforce legislation in general.

Table 62. Indices for enforcement potential of legislation in India.

Indicator	Score	Description
CPI - Corruption Perception Index	3.3 / 10	Corruption is perceived medium
GII – Global Integrity Index	70 / 100	Anti corruption framework is moderate / close to weak
ID – Index of Democracy	7.3 / 10	Classified as "flawed democracy".
EI - Enforcement Index	5.9 / 10	Potential to enforce legislation is intermediate
RLI – Rule of Law Index 1)	0.54 / 1	Limited challenges on corruption and government accountability
RLI – Rule of Law Index 2)	0.52 / 1	Intermediate potential to enforce legislation

1) Compound index of RLI factors 1 (Limited Government Powers) and 2 (Absence of Corruption)
2) Compound index of RLI factors 6 (open government) and 7 (Regulatory Enforcement).

India is regarded to be a "flawed democracy". Public sector corruption is perceived to exist to a medium extent and the anti-corruption framework is considered to be moderate, although close to weak. India's potential to enforce legislation is classified as "intermediate".

G 10 Tanzania

Tanzania is part of the *Africa* region.

Biofuel legislation

Available environmental legislation in Tanzania includes 100 laws, written in English (FAO et al. 2011). As seen in Figure 78, 30 of the laws are relevant for biofuels. Most laws have a national coverage but 11 laws are sub-national, mainly covering either the Tanganyika or Zanzibar regions.

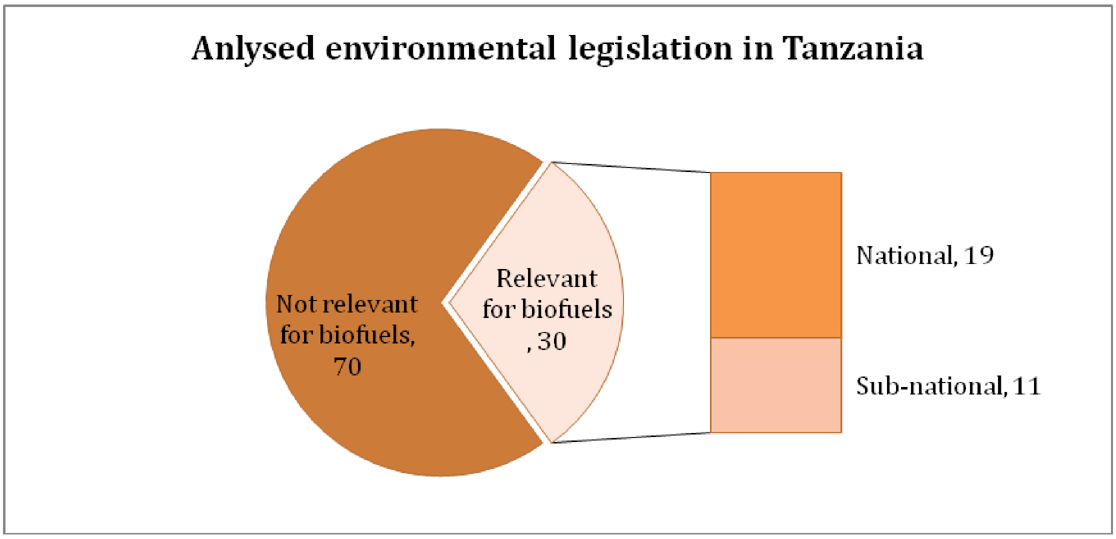


Figure 78. Overview of the analysed environmental legislation in Tanzania, including number of laws relevant for biofuels and their national coverage.

Connections to biofuels

As seen in Figure 79, almost all of the relevant laws have connections to the feedstock production phase, and particularly agriculture in general. One of the laws, the Sugar Industry Act (Act No. 26 of 2001) is specifically connected to biofuel feedstock production.

Two fifth of the relevant laws have connections to industrial activities, but no laws have specific connections to biofuel processing.

About two thirds of the relevant laws have connections to biofuels in other ways than feedstock production or processing. Most commonly these laws cover issues related to land-rights.

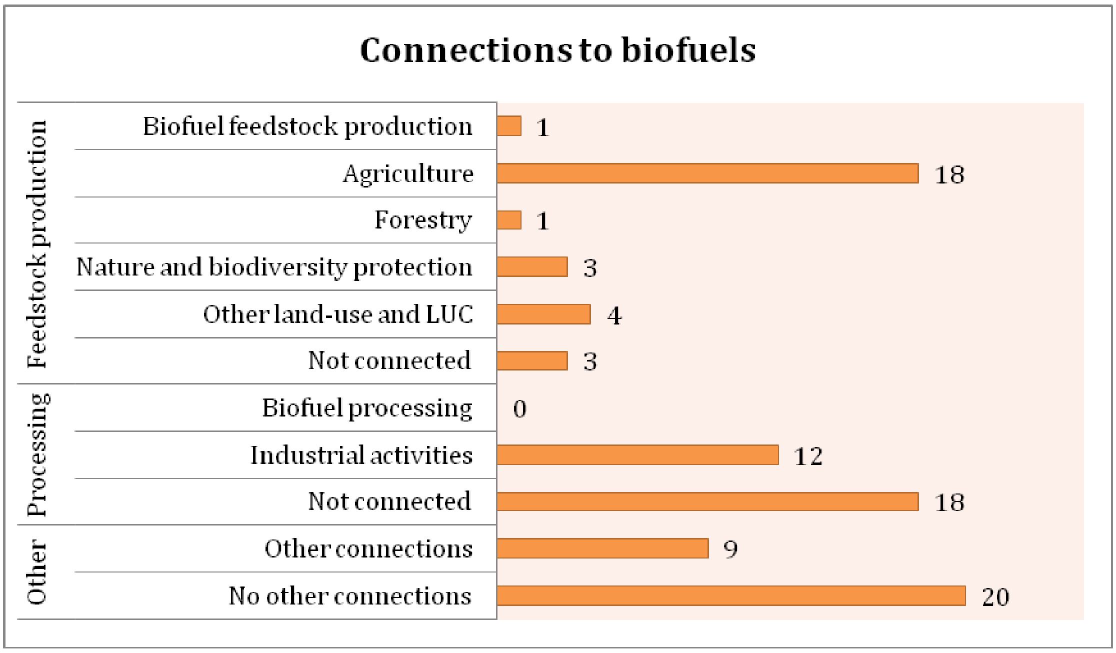


Figure 79. Connections between environmental legislation and biofuels in Tanzania.

Relations to RED sustainability considerations

As seen in Figure 80, *Land-use*, *Water* and *Social sustainability* seem to be the most considered RED topics in Tanzania's biofuel related legislation. The least considered topics include *Ecosystem services, GHG emissions* and *Air*.

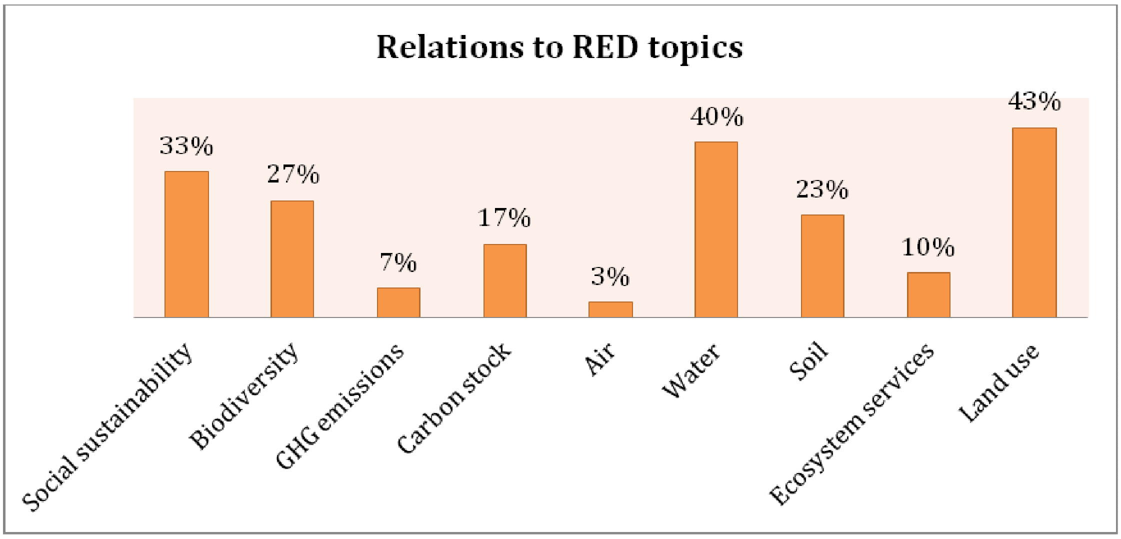


Figure 80. Share of Tanzania's biofuel related legislation that consider each RED topic.

Relations to RED sustainability criteria

As seen in Figure 81, most relations were found for *Impacts on areas designated for nature protection purposes*. Few relations were found for *Conversion of grasslands*. No relations were found for *Drainage of peatlands.*

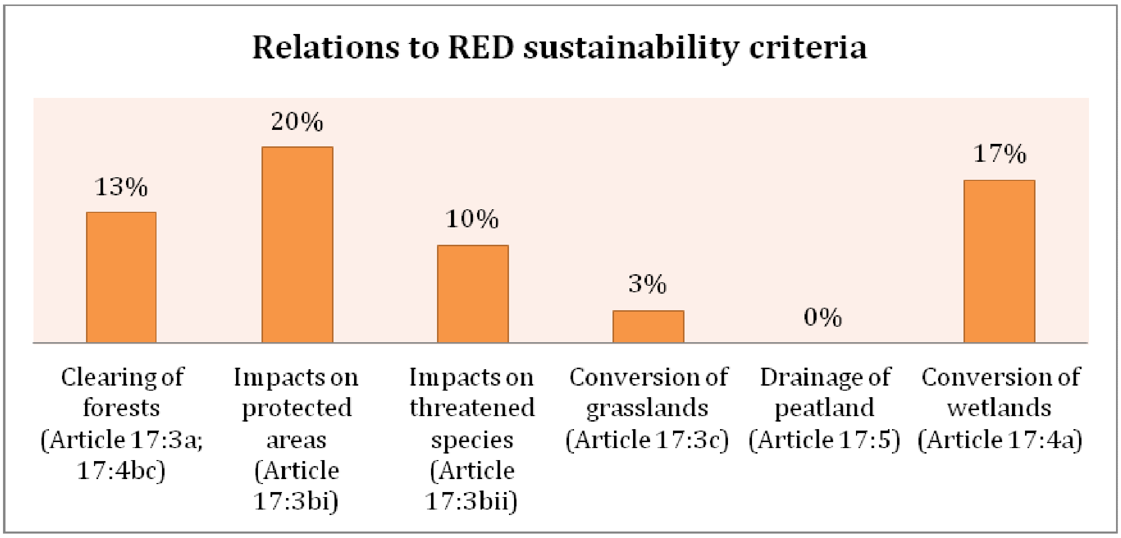


Figure 81. Share of Tanzania's biofuel related legislation that consider each RED criterion.

Complementary analysis of regulations

Since no laws related to *Drainage of peatlands* were identified, an effort to identify such relations in regulations was made. One sub-national regulation was identified restricting drainage of peatlands, the "Ukerewe District Council (Planting and Conservation of Trees and Forests) By-laws, 1994 (G.N. No. 542 of 1994)".

Enforcement

Enforcement is analysed both from the perspective of juridical responsibilities to enforce biofuel related legislation and practical potential to enforce legislation in general.

Enforcement of biofuel legislation in the juridical sense

19 of the 30 laws relevant for biofuels specify institutions responsible for enforcement. This corresponds to 63% of the relevant laws. Examples of recurring institutions include Minister/Ministry/Commissioner responsible for land and Minister/Ministry responsible for agriculture.

Enforcement potential of legislation

Table 63 presents the results for Tanzania on the CPI, GII, ID and EI indexes, with the purpose to provide for a discussion on how compliance with legislation in Tanzania is managed in the practical sense. Note that this chapter does not focus specifically on how compliance is managed with biofuel legislation, but rather on Tanzania's potential to enforce legislation in general.

Table 63. Indices for enforcement potential of legislation in Tanzania.

Indicator	Score	Description
CPI - Corruption Perception Index	2.7 / 10	Corruption is perceived high
GII – Global Integrity Index	60 / 100	Anti corruption framework is weak
ID – Index of Democracy	5.6 / 10	Classified as "hybrid regime"
EI - Enforcement Index	4.8 / 10	Potential to enforce legislation is low
RLI – Rule of Law Index		Not reported

Tanzania is classified as a "hybrid regime". Public sector corruption is perceived to be high and the anti-corruption framework is considered to be weak. Tanzania's potential to enforce legislation is classified as "low".

G 11 Malawi

Malawi is part of the *Africa* region.

Biofuel legislation

Available environmental legislation in Malawi includes 19 laws, written in English (FAO et al. 2011). As seen in Figure 82, 12 of the laws are relevant for biofuels. All of the relevant laws have a national coverage.

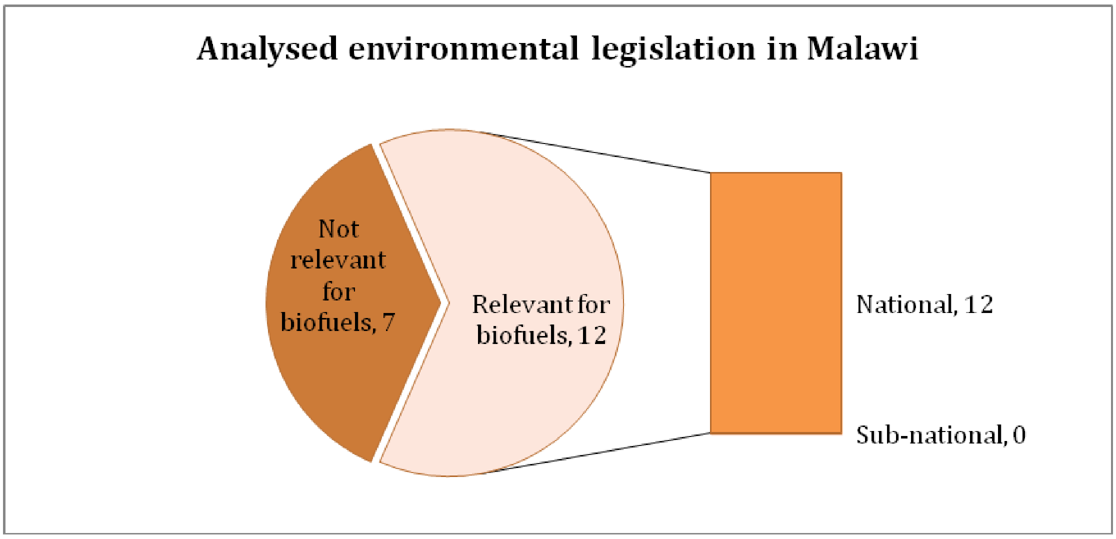


Figure 82. Overview of the analysed environmental legislation in Malawi, including number of laws relevant for biofuels and their national coverage.

Connections to biofuels

As seen in Figure 83, almost all of the relevant laws have connections to the feedstock production phase, and particularly agriculture in general. No laws have specific connections to biofuel feedstock production.

One fourth of the relevant laws have connections to industrial activities, but no laws have specific connections to biofuel processing.

One fourth of the relevant laws have connections to biofuels in other ways than feedstock production or processing. These laws cover issues related to land-rights, seed imports and environmental awareness.

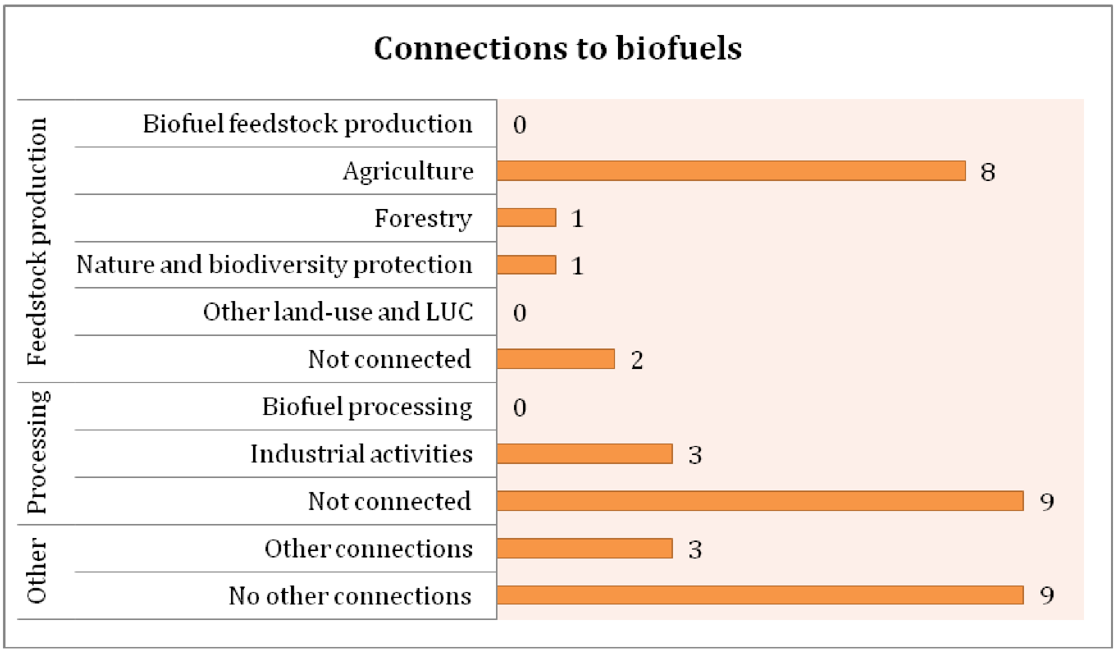


Figure 83. Connections between environmental legislation and biofuels in Malawi.

Relations to RED sustainability considerations

As seen in Figure 84, *Social sustainability* and *Water* seem to be the most considered RED topics in Malawi's biofuel related legislation. The least considered topics include *Ecosystem services, Air, Carbon stock* and particularly *GHG emissions*, for which no relations were found.

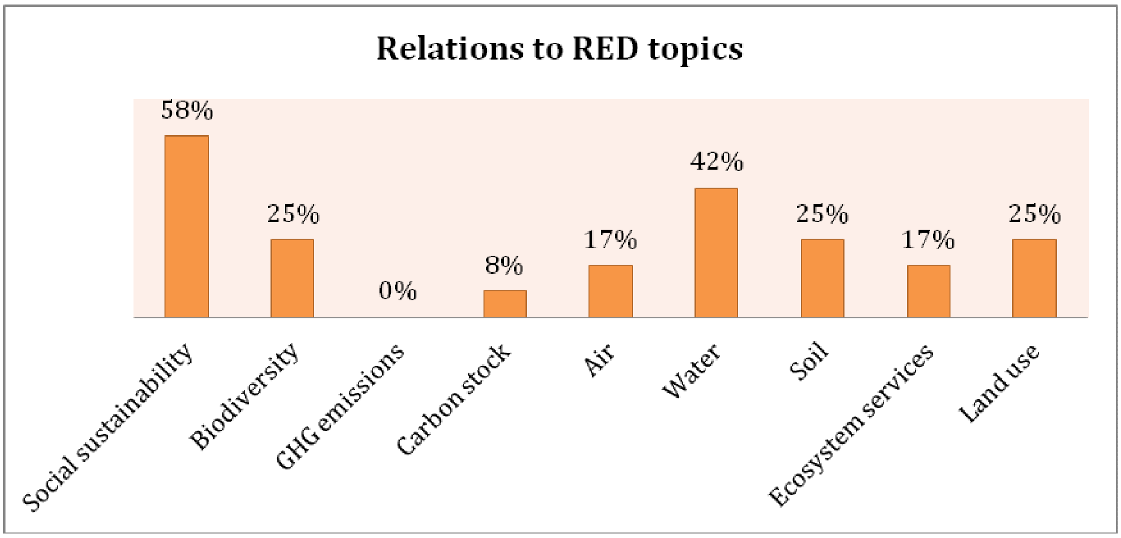


Figure 84. Share of Malawi's biofuel related legislation that consider each RED topic.

Relations to RED sustainability criteria

As seen in Figure 85, most relations were found for *Impacts on areas designated for nature protection purposes* and *Impacts on rare, threatened and endangered* *species*. Few relations were found for *Clearing of forests.* No relations were found for *Conversion of wetlands*, *Conversion of grasslands* or *Drainage of peatlands.*

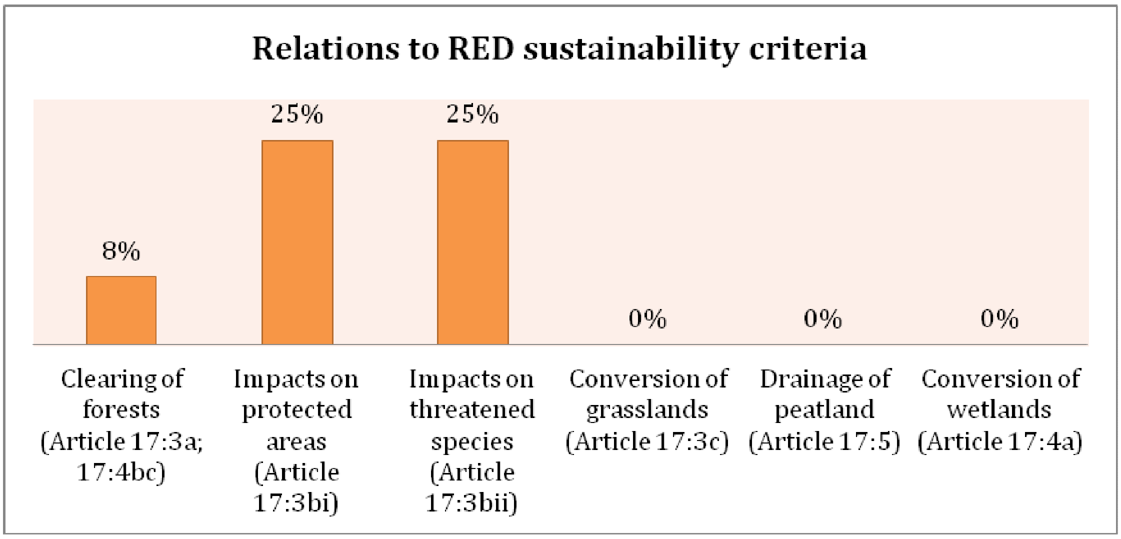


Figure 85. Share of Malawi's biofuel related legislation that consider each RED criterion.

Complementary analysis of regulations

Since no laws related to *Conversion of grasslands*, *Drainage of peatlands* or *Conversion of wetlands* were identified, an effort to identify such relations in regulations was made.
No regulations restricting Conversion of grasslands, Drainage of peatlands or Conversion of wetlands were identified.

Enforcement

Enforcement is analysed both from the perspective of juridical responsibilities to enforce biofuel related legislation and practical potential to enforce legislation in general.

Enforcement of biofuel legislation in the juridical sense

11 of the 12 laws relevant for biofuels specify institutions responsible for enforcement. However, in 6 laws it is only stated that "The Minister" is responsible. Thus, 5 of the 12 relevant laws include more specific responsible institutions. This corresponds to 42%.

Enforcement potential of legislation

Table 64 presents the results for Malawi on the CPI, GII, ID and EI indexes, with the purpose to provide for a discussion on how compliance with legislation in Malawi is managed in the practical sense. Note that this chapter does not focus specifically on how compliance is managed with biofuel legislation, but rather on Malawi's potential to enforce legislation in general.

Table 64. Indices for enforcement potential of legislation in Malawi.

Indicator	Score	Description
CPI - Corruption Perception Index	3.4 / 10	Corruption is perceived medium
GII – Global Integrity Index	73 / 100	Anti corruption framework is moderate
ID – Index of Democracy	5.8 / 10	Classified as "hybrid regime"
EI - Enforcement Index	5.5 / 10	Potential to enforce legislation is intermediate
RLI – Rule of Law Index		Not reported

Malawi is classified as a "hybrid regime". Public sector corruption is perceived to exist to a medium extent and the anti-corruption framework is considered to be moderate. Malawi's potential to enforce legislation is classified as "intermediate".

G 12 Mozambique

Mozambique is part of the *Africa* region.

Biofuel legislation

Available environmental legislation in Mozambique includes 24 laws, written in Portuguese (FAO et al. 2011). As seen in Figure 86, 10 of the laws are relevant for biofuels and all have a national coverage. Interesting to note is that two of the relevant laws were put into place by the Portuguese administration before Mozambique's independence in 1975. These are not unique for Mozambique but cover also other former Portuguese colonies. "Act No. 6/73 approving the Overseas Land Act" covers Mozambique, Cape Verde, Guinea-Bissau and Sao Tome and Principe. "Decree No. 44531 on Forest Resources" covers Mozambique, Angola and Guinea-Bissau.

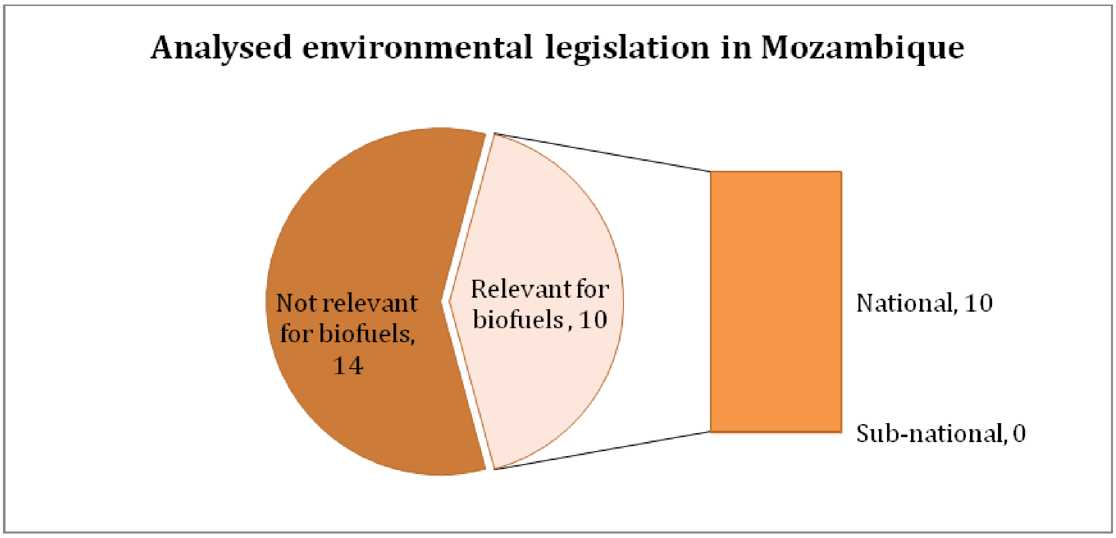


Figure 86. Overview of the analysed environmental legislation in Mozambique, including number of laws relevant for biofuels and their national coverage.

Connections to biofuels

As seen in Figure 87, seven of the 10 relevant laws have connections to the feedstock production phase and primarily agriculture in general. No laws have specific connections to biofuel feedstock production.

Half of the laws have connections to industrial activities but no laws have specific connections to biofuel processing.

Seven of the 10 relevant laws have connections to biofuels in other ways than feedstock production or processing. Most commonly these laws cover issues related to land-rights or environmental education.

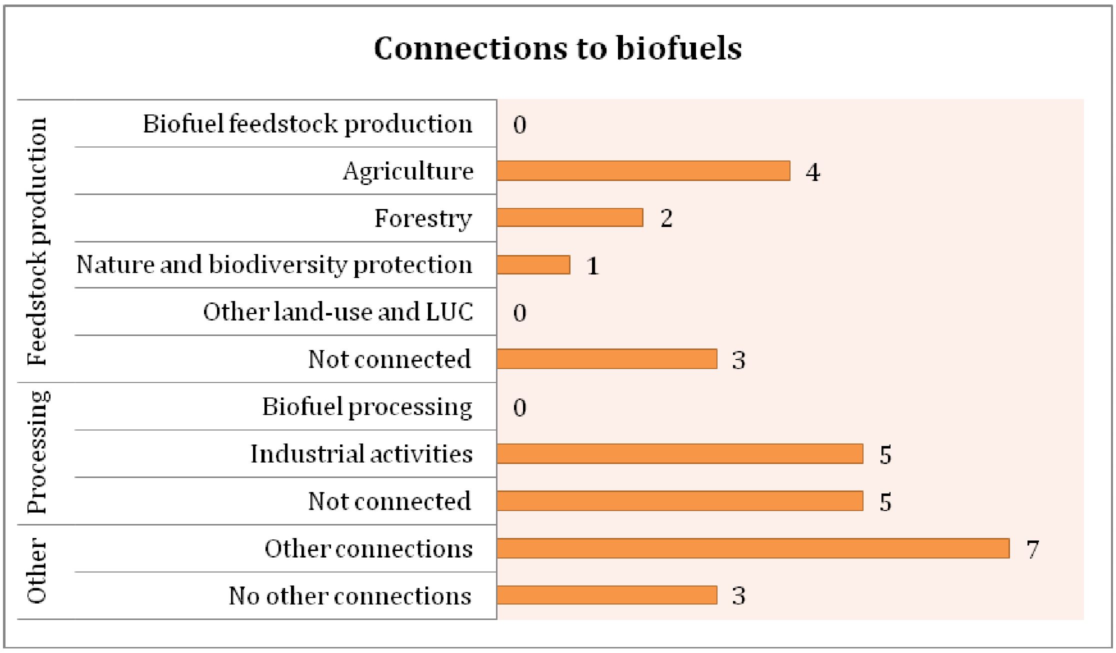


Figure 87. Connections between environmental legislation and biofuels in Mozambique.

Relations to RED sustainability considerations

As seen in Figure 88, *Land-use, Social sustainability and Biodiversity* seem to be the most considered RED-topics in Mozambique's biofuel related legislation. The least considered topics include *Air* and particularly *GHG emissions*, for which no relations were found.

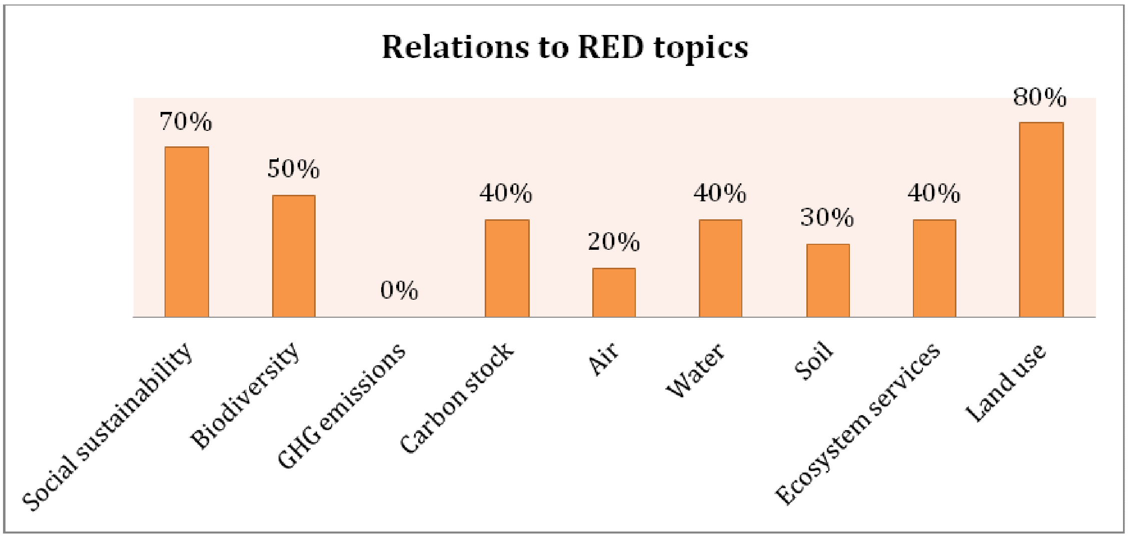


Figure 88. Share of Mozambique's biofuel related legislation that consider each RED topic.

Relations to RED sustainability criteria

As seen in Figure 89, most relations were found for Impacts on areas designated for nature protection purposes, Impacts on rare, threatened and endangered species and Clearing of forests. Few relations were found for Conversion of wetlands. No relations were found for Drainage of peatlands or Conversion of wetlands.

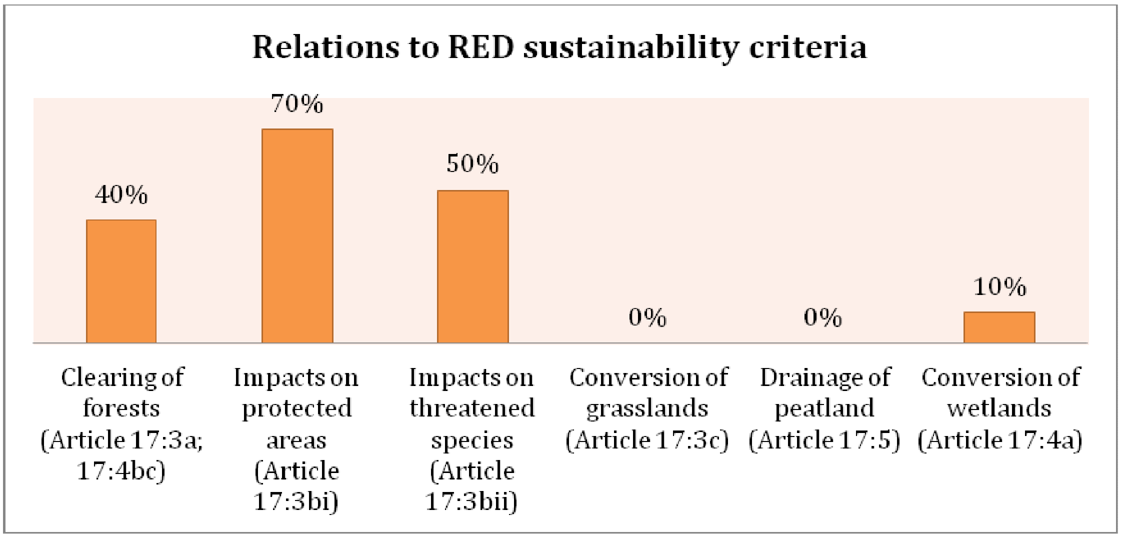


Figure 89. Share of Mozambique's biofuel related legislation that consider each RED criterion.

Complementary analysis of regulations

No complementary analysis of regulations was made for Mozambique. It should be noted though that the number of Mozambique regulations in ECOLEX (274) is far greater than the number of legislations (26). It is therefore likely that a complementary analysis of regulations could be very useful to better understand the Mozambique case.

Enforcement

Enforcement is analysed both from the perspective of juridical responsibilities to enforce biofuel related legislation and practical potential to enforce legislation in general.

Enforcement of biofuel legislation in the juridical sense

None of the 10 laws relevant for biofuels include specific institutions responsible for enforcement. However, in 7 laws it is stated that "The Government" is responsible.

Enforcement potential of legislation

Table 65 presents the results for Mozambique on the CPI, GII, ID and EI indexes, with the purpose to provide for a discussion on how compliance with legislation in Mozambique is managed in the practical sense. Note that this chapter does not focus specifically on how compliance is managed with biofuel legislation, but rather on Mozambique's potential to enforce legislation in general.

Table 65. Indices for enforcement potential of legislation in Mozambique.

Indicator	Score	Description
CPI - Corruption Perception Index	2.7 / 10	Corruption is perceived high
GII – Global Integrity Index	59 / 100	Anti corruption framework is very weak
ID – Index of Democracy	4.9 / 10	Classified as "hybrid regime"
EI - Enforcement Index	4.5 / 10	Potential to enforce legislation is low
RLI – Rule of Law Index		Not reported

Mozambique is classified as a "hybrid regime". Public sector corruption is perceived to be high and the anti-corruption framework is considered to be very weak. Mozambique's potential to enforce legislation is classified as "low".

G 13 Uganda

Uganda is part of the *Africa* region.

Biofuel legislation

Available environmental legislation in Uganda consists of 83 laws, written in English (FAO et al. 2011). As seen in Figure 90, 41 of the laws are relevant for biofuels and all but one have a national coverage.

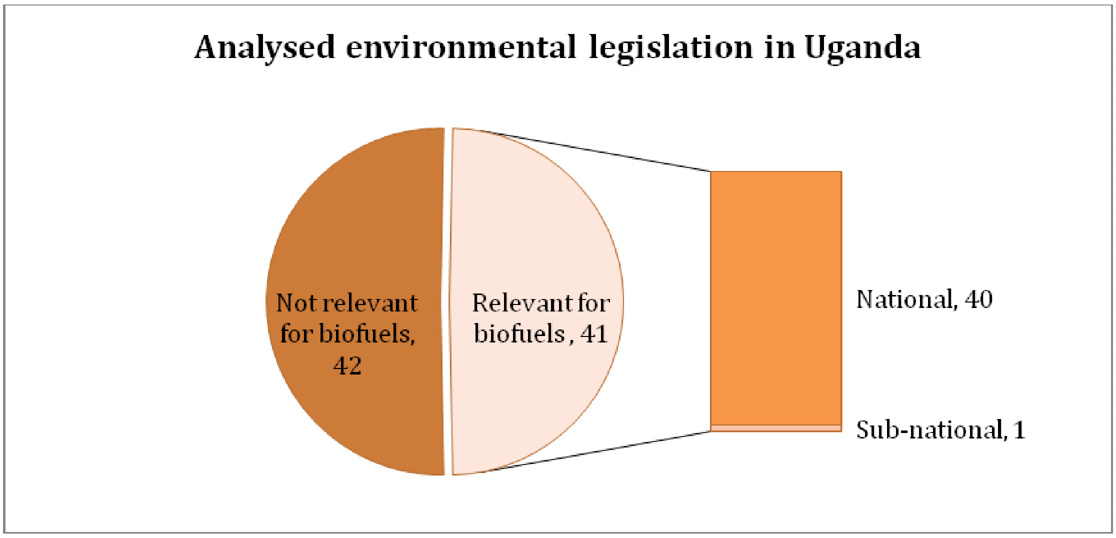


Figure 90. Overview of the analysed environmental legislation in Uganda, including number of laws relevant for biofuels and their national coverage.

Connections to biofuels

As seen in Figure 91, about three fourth of the relevant laws have connections to the feedstock production phase and primarily agriculture in general. No laws have specific connections to biofuel feedstock production.

About one fifth of the relevant laws have connections to industrial activities but no laws have specific connections to biofuel processing.

Half of the relevant laws have connections to biofuels in other ways than feedstock production or processing. Most commonly these laws cover issues related to land-rights.

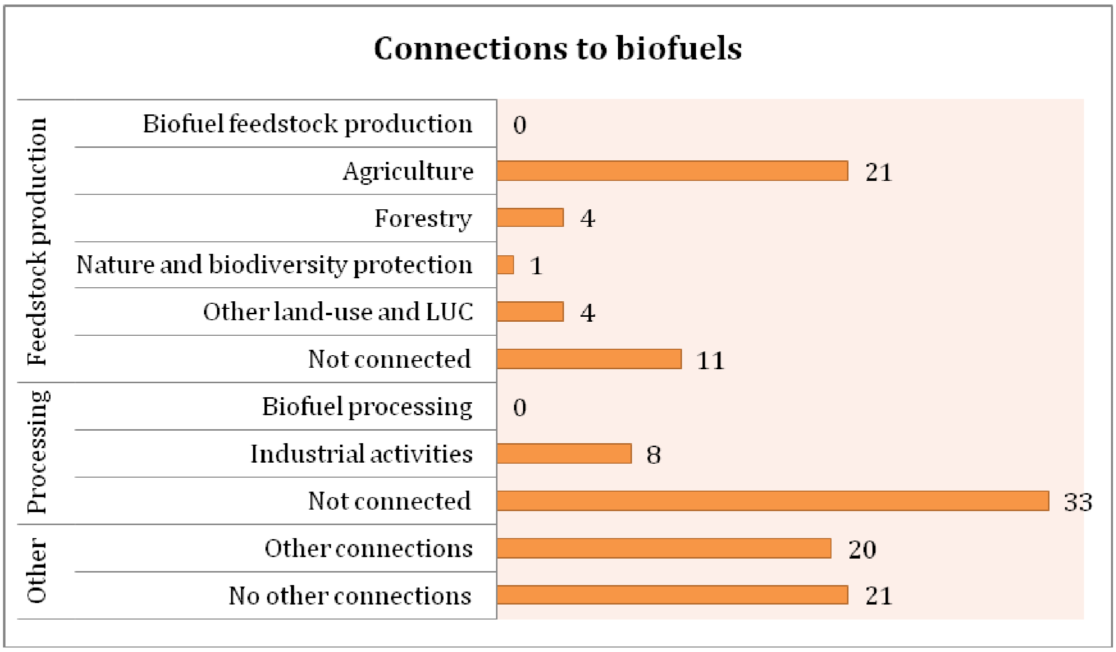


Figure 91. Connections between environmental legislation and biofuels in Uganda.

Relations to RED sustainability considerations

As seen in Figure 92*, Social sustainability* seem to be the most considered RED topic in Uganda's biofuel related legislation. The least considered topics include *Carbon stock, Air, Ecosystem services, Soil and* particularly *GHG emissions*.

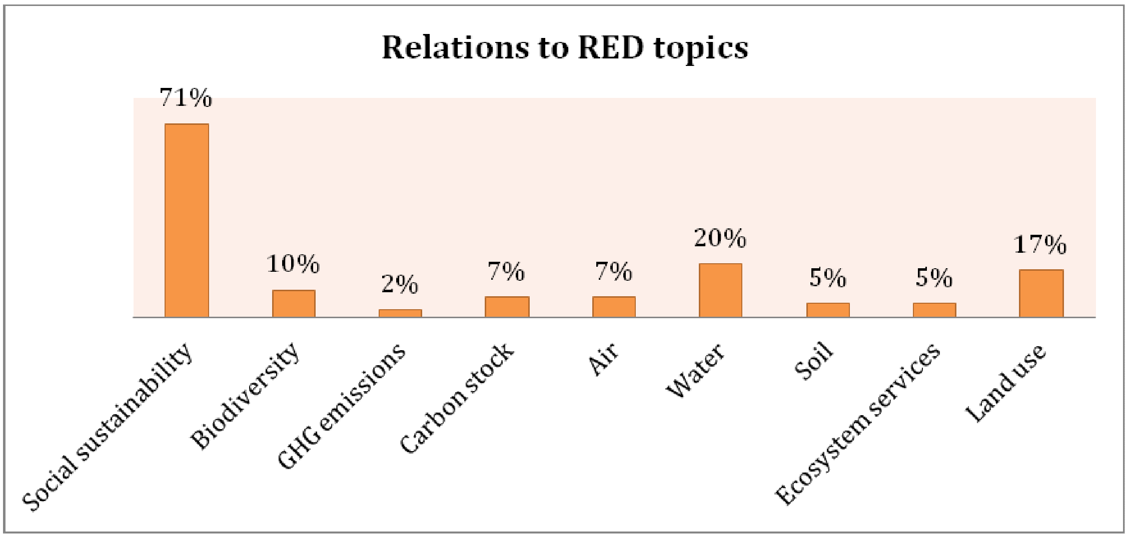


Figure 92. Share of Uganda's biofuel related legislation that consider each RED topic.

Relations to RED sustainability criteria

As seen in Figure 93, most relations were found for *Impacts on areas designated for nature protection purposes*. Few relations were found for *Conversion of grasslands*. No relations were found for *Drainage of peatlands.*

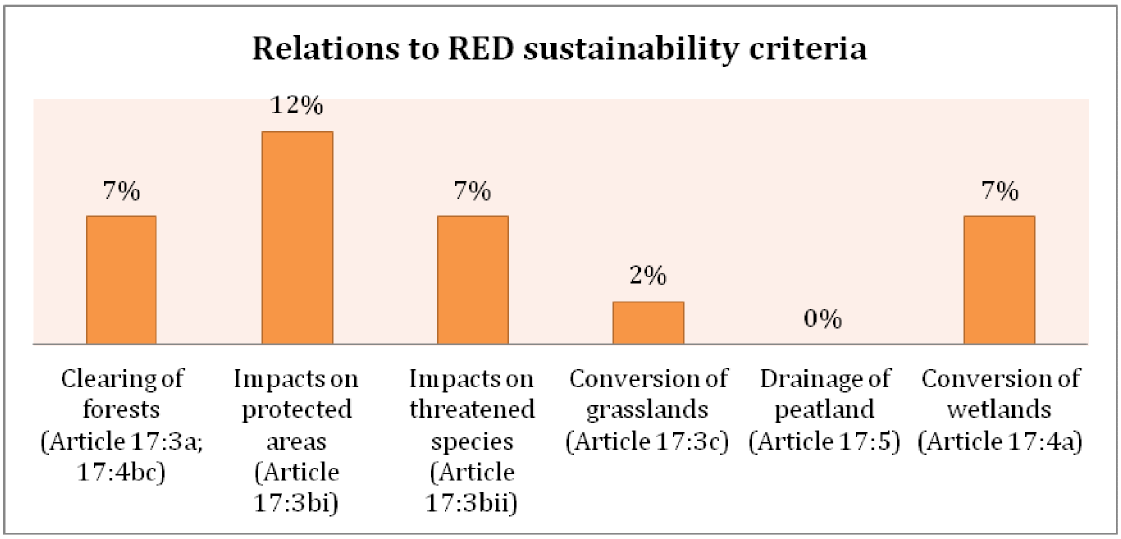


Figure 93. Share of Uganda's biofuel related legislation that consider each RED criterion.

Complementary analysis of regulations

Since no laws related to *Drainage of peatlands* were identified, an effort to identify such relations in regulations was made. One national regulation was identified restricting drainage of peatlands, the "National Environment (Wetlands, River Banks and Lake Shores Management) Regulations, 2000 (No. 3 of 2000)".

Enforcement

Enforcement is analysed both from the perspective of juridical responsibilities to enforce biofuel related legislation and practical potential to enforce legislation in general.

Enforcement of biofuel legislation in the juridical sense

21 of the 41 laws relevant for biofuels include specific institutions responsible for enforcement, particularly different ministers. This corresponds to 51%. In 15 laws it is stated that "The Government" is responsible while 5 laws do not specify a responsible institution at all.

Enforcement potential of legislation

Table 66 presents and interprets the results for Uganda on the CPI, GII, ID and EI indexes, with the purpose to provide for a discussion on how compliance with legislation in Uganda is managed in the practical sense. Note that this chapter does not focus specifically on how compliance is managed with biofuel legislation, but rather on Uganda's potential to enforce legislation in general.

Table 66. Indices for enforcement potential of legislation in Uganda.

Indicator	Score	Description
CPI - Corruption Perception Index	2.5 / 10	Corruption is perceived high
GII – Global Integrity Index	69 / 100	Anti corruption framework is weak
ID – Index of Democracy	5.1 / 10	Classified as “hybrid regime”
EI - Enforcement Index	4.8 / 10	Potential to enforce legislation is low
RLI – Rule of Law Index		Not reported

Uganda is classified as a “hybrid regime”. Public sector corruption is perceived to be high and the anti-corruption framework is considered to be weak. Uganda’s potential to enforce legislation is classified as “low”.

G 14 Ethiopia

Ethiopia is part of the *Africa* region.

Biofuel legislation

Available environmental legislation in Ethiopia consists of 93 laws, written in English (FAO et al. 2011). As seen in Figure 94, 48 of the laws are relevant for biofuels and all but two have a national coverage.

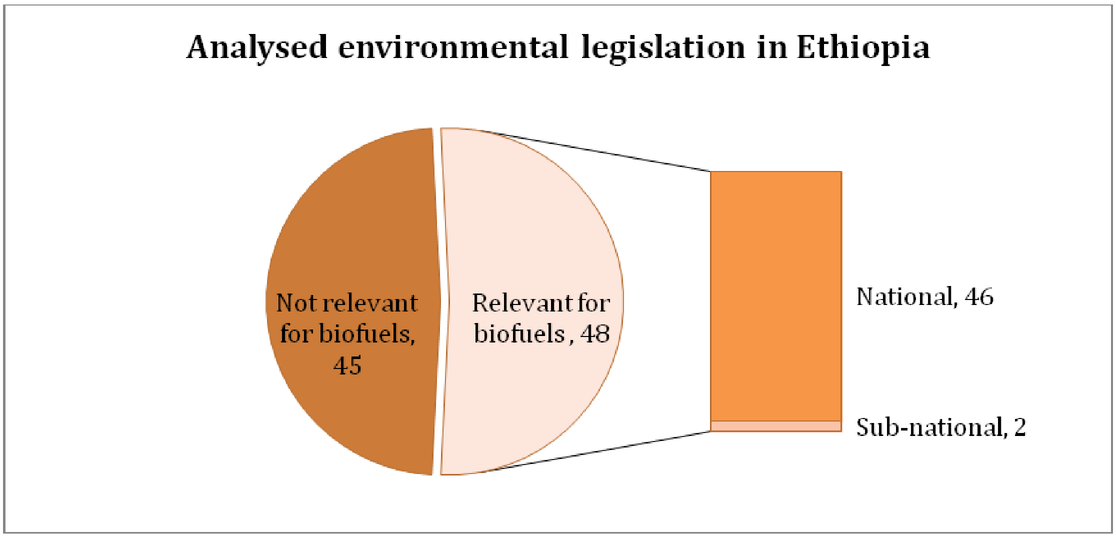


Figure 94. Overview of the analysed environmental legislation in Ethiopia, including number of laws relevant for biofuels and their national coverage.

Connections to biofuels

As seen in Figure 95, about three fourth of the relevant laws have connections to the feedstock production phase and primarily agriculture in general. No laws have specific connections to biofuel feedstock production.

About one fifth of the relevant laws have connections to industrial activities but no laws have specific connections to biofuel processing.

About two fifth of the relevant laws have connections to biofuels in other ways than feedstock production or processing. Most commonly these laws cover issues related to land-rights. Other examples include ratifications of international treaties and rights of cooperative societies.

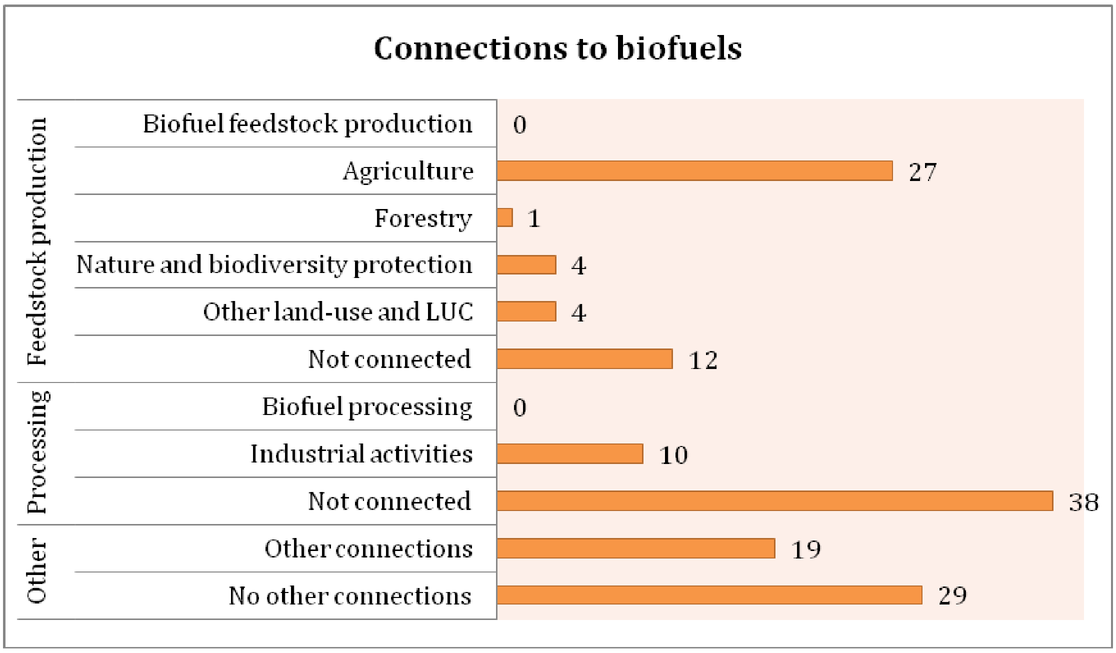


Figure 95. Connections between environmental legislation and biofuels in Ethiopia.

Relations to RED sustainability considerations

As seen in Figure 96, *Social sustainability* and *Water* seem to be the most considered RED topics in Ethiopia's biofuel related legislation. The least considered topics include *Air, Ecosystem services, Carbon stock and GHG emissions*.

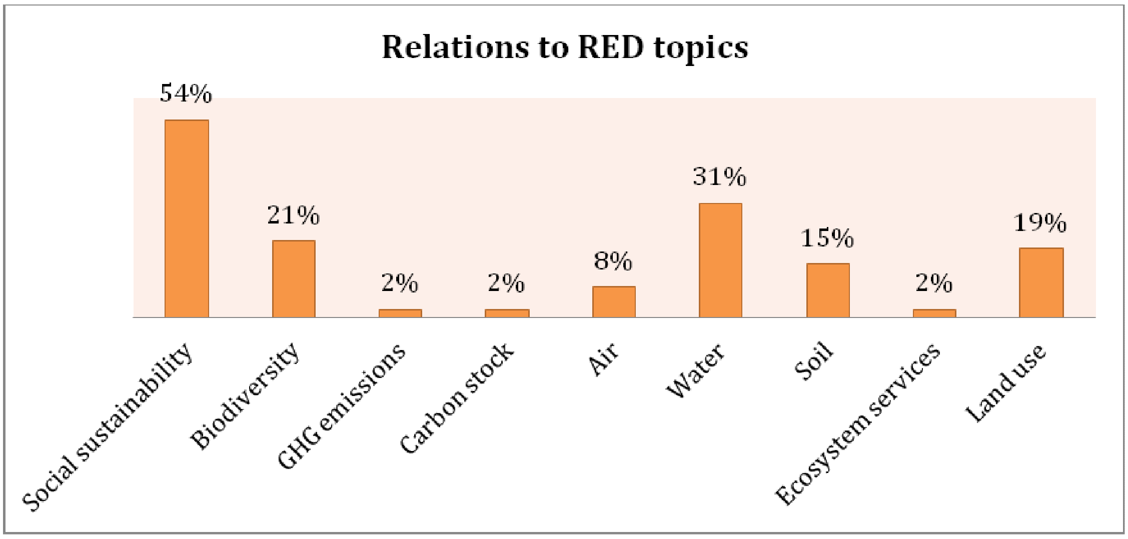


Figure 96. Share of Ethiopia's biofuel related legislation that consider each RED topic.

Relations to RED sustainability criteria

As seen in Figure 97, most relations were found for *Impacts on areas designated for nature protection services*. Overall, few relations were found for the RED criteria in Ethiopia's biofuel related legislation, particularly *Drainage of peatlands* and *Conversion of grasslands*, for which no relations were found.

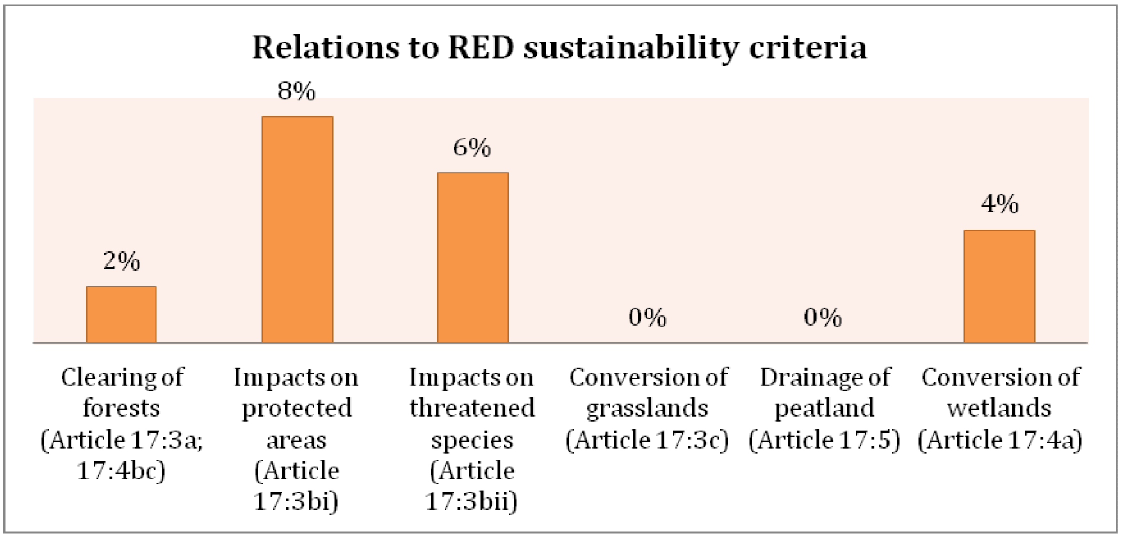


Figure 97. Share of Ethiopia's biofuel related legislation that consider each RED criterion.

Complementary analysis of regulations

Since no laws related to *Conversion of grasslands* or *Drainage of peatlands* were identified, an effort to identify such relations in regulations was made.

No regulations were identified restricting *Conversion of grasslands* or *Drainage of peatlands*.

Enforcement

Enforcement is analysed both from the perspective of juridical responsibilities to enforce biofuel related legislation and practical potential to enforce legislation in general.

Enforcement of biofuel legislation in the juridical sense

17 of the 48 laws relevant for biofuels include specific institutions responsible for enforcement. This corresponds to 35%. Examples of recurring institutions include "The Environmental Protection Authority" and "The Ministry of Agriculture and Rural Development". In 10 laws it is stated that "The Council of Ministers" is responsible, while 20 laws do not specify a responsible institution at all.

Enforcement potential of legislation

Table 67 presents the results for Ethiopia on the CPI, GII, ID and EI indexes, with the purpose to provide for a discussion on how compliance with legislation in Ethiopia is managed in the practical sense. Note that this chapter does not focus specifically on how compliance is managed with biofuel legislation, but rather on Ethiopia's potential to enforce legislation in general.

Table 67. Indices for enforcement potential of legislation in Ethiopia.

Indicator	Score	Description
CPI - Corruption Perception Index	2.7 / 10	Corruption is perceived high
GII – Global Integrity Index	56 / 100	Anti corruption framework is very weak
ID – Index of Democracy	3.7 / 10	Classified as "authoritarian regime"
EI - Enforcement Index	4.0 / 10	Potential to enforce legislation is low
RLI – Rule of Law Index		Not reported

Ethiopia is classified as an "authoritarian regime". Public sector corruption is perceived to be high and the anti-corruption framework is considered to be very weak. Ethiopia's potential to enforce legislation is classified as "low".

G 15 Nigeria

Nigeria is part of the *Africa* region.

Biofuel legislation

Available environmental legislation in Nigeria consists of 55 laws, written in English (FAO et al. 2011). As seen in Figure 98, 19 of the laws are relevant for biofuels and all but one have a national coverage.

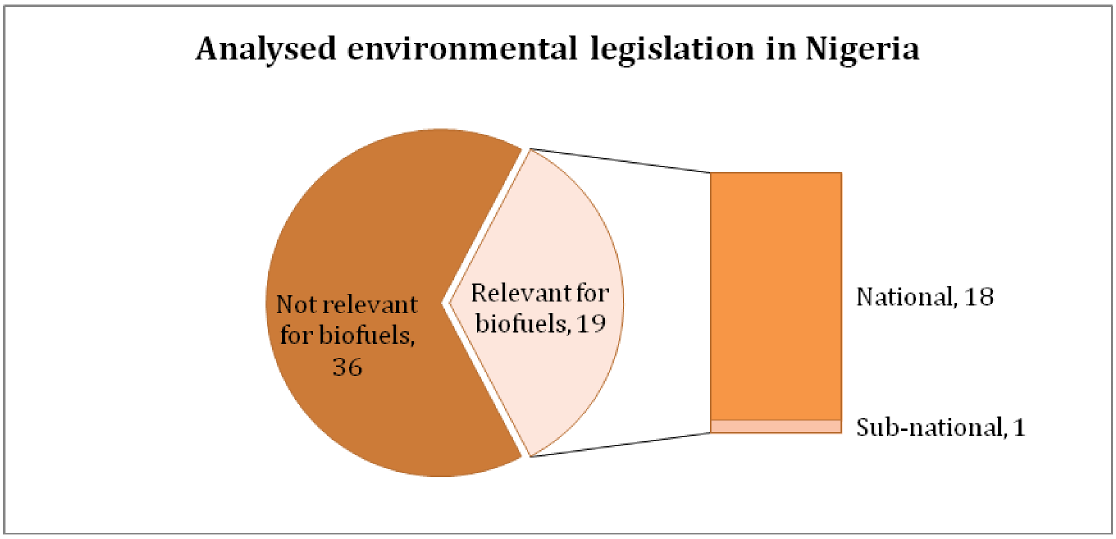


Figure 98. Overview of the analysed environmental legislation in Nigeria, including number of laws relevant for biofuels and their national coverage.

Connections to biofuels

As seen in Figure 99, all but one of the relevant laws have connections to the feedstock production phase and primarily agriculture in general. No laws have specific connections to biofuel feedstock production.

About one fifth of the relevant laws have connections to industrial activities but no laws have specific connections to biofuel processing.

About one fourth of the relevant laws have connections to biofuels in other ways than feedstock production or processing. These laws cover issues like land-rights, access to environmental information and promotion of "new" energy.

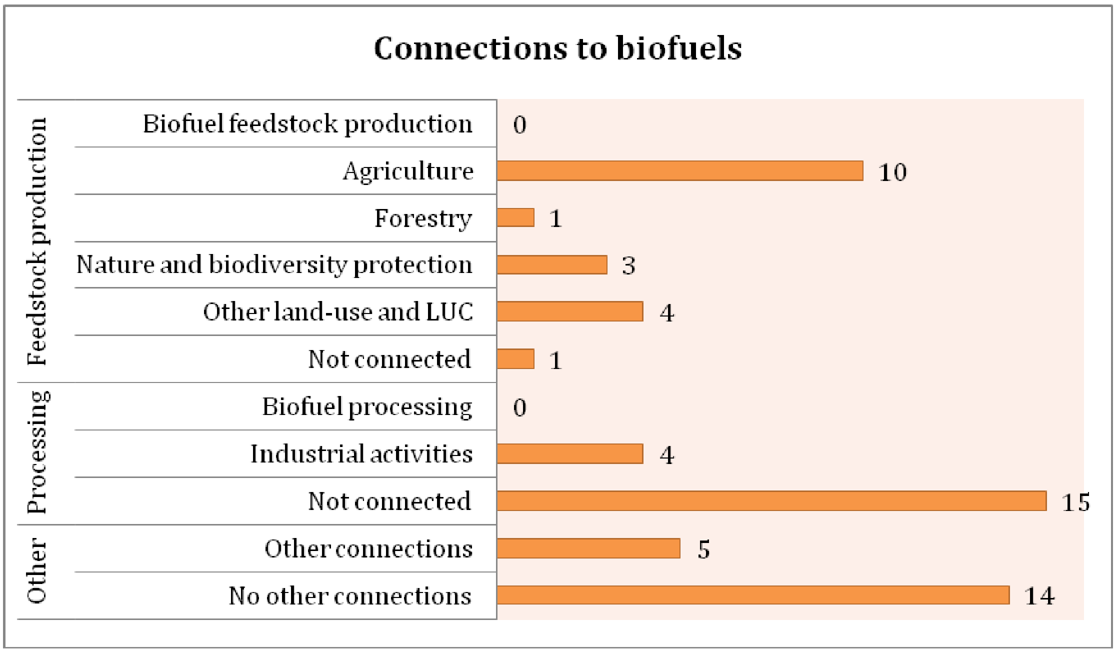


Figure 99. Connections between environmental legislation and biofuels in Nigeria.

Relations to RED sustainability considerations

As seen in Figure 100, *Social sustainability* and *Land-use* seem to be the most considered RED-topics in Nigeria's biofuel related legislation. The least considered topics include *Carbon stock, Air* and particularly *Ecosystem services* and *GHG emissions*, for which no relations were found.

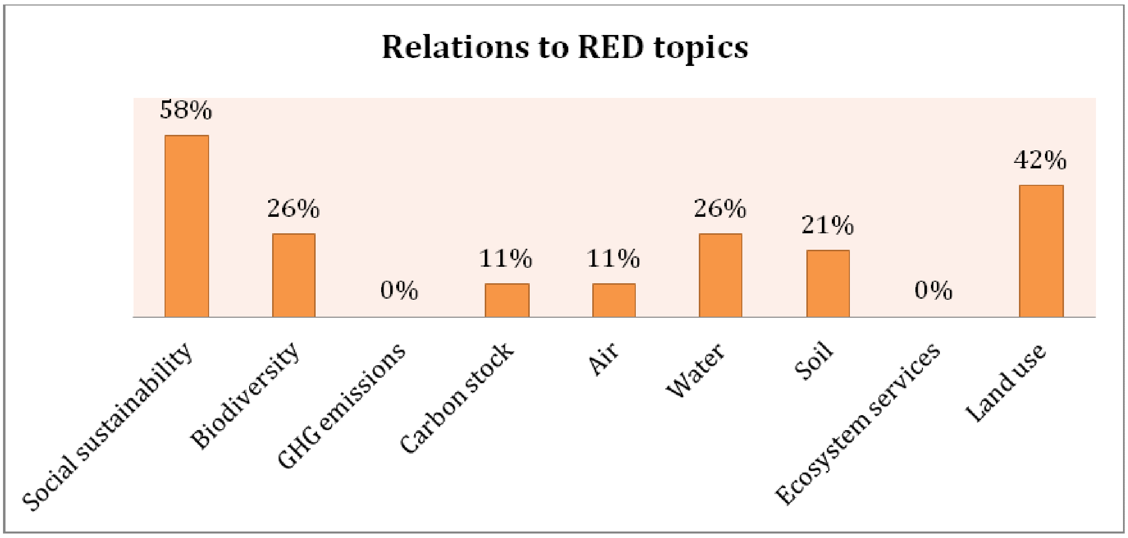


Figure 100. Share of Nigeria's biofuel related legislation that consider each RED topic.

Relations to RED sustainability criteria

As seen in Figure 101, most relations were found for *Impacts on areas designated for nature protection purposes* and *Clearing of forests*. Few relations were found for

Conversion of wetlands. No relations were found for *Drainage of peatlands* and *Conversion of grasslands*.

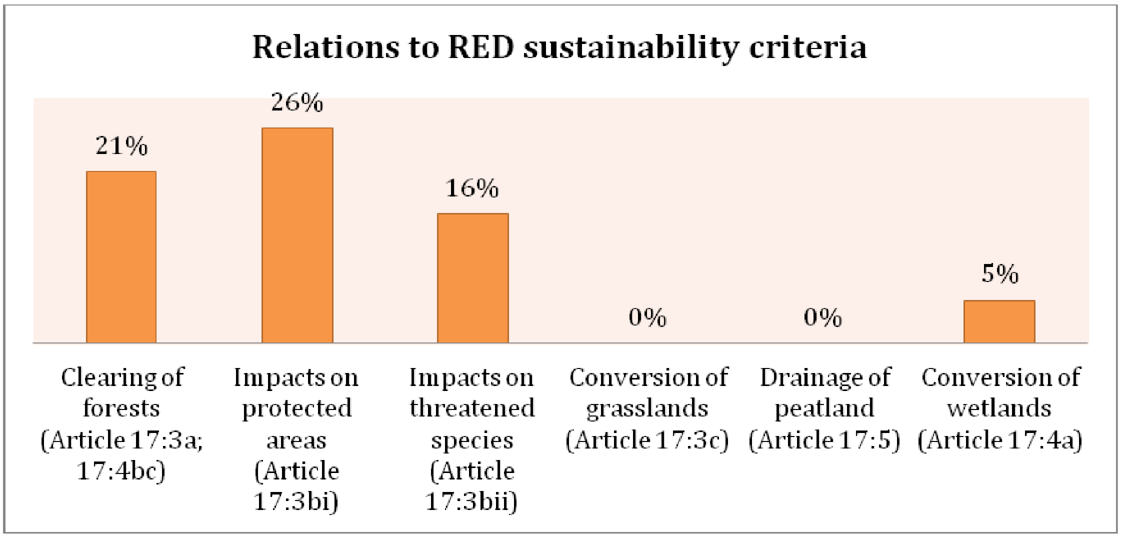


Figure 101. Share of Nigeria's biofuel related legislation that consider each RED criterion.

Complementary analysis of regulations

Since no laws related to *Clearing of natural forests*, *Conversion of wetlands* or *Drainage of peatlands* were identified, an effort to identify such relations in regulations was made. One national regulation was identified restricting *Conversion of natural forests*, the "Forest Regulations of 1963".

No regulations were identified restricting *Conversion of wetlands* or *Drainage of peatlands*.

Enforcement

Enforcement is analysed both from the perspective of juridical responsibilities to enforce biofuel related legislation and practical potential to enforce legislation in general.

Enforcement of biofuel legislation in the juridical sense

14 of the 19 laws relevant for biofuels include specific institutions responsible for enforcement, for example the "Federal Environmental Protection Agency". This corresponds to 74%. One law states that "The President" is responsible, while 4 laws do not specify a responsible institution.

Enforcement potential of legislation

Table 68 presents the results for Nigeria on the CPI, GII, ID, EI and RLI indexes, with the purpose to provide for a discussion on how compliance with legislation in Nigeria is managed in the practical sense. Note that this chapter does not focus specifically on how compliance is managed with biofuel legislation, but rather on Nigeria's potential to enforce legislation in general.

Table 68. Indices for enforcement potential of legislation in Nigeria.

Indicator	Score	Description
CPI - Corruption Perception Index	2.4 / 10	Corruption is perceived high
GII – Global Integrity Index	64 / 100	Anti corruption framework is weak
ID – Index of Democracy	3.5 / 10	Classified as "authoritarian regime"
EI - Enforcement Index	4.1 / 10	Potential to enforce legislation is low
RLI – Rule of Law Index [1)]	0.43 / 1	Challenges on corruption and government accountability
RLI – Rule of Law Index [2)]	0.41 / 1	Low potential to enforce legislation

1) Compound index of RLI factors 1 (Limited Government Powers) and 2 (Absence of Corruption)
2) Compound index of RLI factors 6 (open government) and 7 (Regulatory Enforcement).

Nigeria is regarded to be an "authoritarian regime". Public sector corruption is perceived to be high and the anti-corruption framework is considered to be weak. Nigeria's potential to enforce legislation is classified as "low".

G 16 Summary

A total of 1185 laws have been individually assessed in this study, but there is a significant variation between countries in the number of laws that are available. In addition, some countries primarily use national laws while others primarily use sub-national laws. It is therefore difficult to compare the performance of individual countries in the analysis. Instead of grading countries on their performance, this study has focused on identifying the target countries' general legislative readiness to produce RED-sustainable biofuels.

The target countries' general legislative readiness to produce biofuels complying with the existing Renewable Energy Directive sustainability requirements is based on the number of laws in each target country that restrict activities in ways similar to the Directive's criteria. By complementing with a more detailed analysis of the specific activities that the individual laws restrict, it would become possible to also determine each country's individual legislative readiness.

In addition to the legislative readiness regarding the existing RED criteria, RED topics that are well considered (covered by many laws) and poorly considered (covered by few laws) in national legislation have been identified. This provides for an illustration of the target countries' general legislative readiness to produce biofuels that would comply with potential mandatory requirements related to the different topics of the Renewable Energy Directive, which could be added to the Directive when revised.

Coverage in legislation

As can be seen in Table 69, there are rather many laws available for the countries in the Asia region, besides for Indonesia, although few laws are specifically aimed for biofuels. The coverage of legislation varies between 100% national to 76% sub-national within this region. Indonesia and Malaysia typically have laws with a national coverage while Pakistan and India typically have laws with a sub-national coverage.

Table 69. Overview of environmental legislation relevant for biofuels.

Region / country	Available laws	Relevant for biofuels	Aimed for biofuels	Coverage of relevant laws
Asia				
Indonesia	27	18	0	100% national
Malaysia	134	54	4	59% national
Pakistan	111	59	0	76% sub-national
India	219	91	1	64% sub-national
South America				
Brazil	257	150	7	54% national
Argentina	454	237	12	85% sub-national
Guatemala	46	28	2	86% national
Africa				
Tanzania	100	30	1	63% national
Malawi	19	12	0	100% national
Mozambique	24	10	0	100% national
Uganda	83	41	0	98% national
Ethiopia	93	48	0	96% national
Nigeria	55	19	0	95% national

Also, there are rather many laws available for the countries in the South America region, particularly for Brazil and Argentina, rather many laws are also specifically aimed for biofuels. The coverage of legislations varies largely within this region. Notable is that 86% of the laws in Argentina are sub-national, higher than any other country in this analysis.

There are generally fewer laws available for the countries in the Africa region compared to the *Asia* and the *America* regions, and laws specifically aimed for biofuels seem very rare. Laws in the African countries generally seem to have a national coverage. Sub-national laws are almost entirely restricted to Tanzania, where they cover either the Tanganyika or the Zanzibar region.

Renewable Energy Directive topics considered in biofuel related legislation

As seen in Table 70, In Asia, Social sustainability is universally well considered, Land-use is generally well considered and Biodiversity and Soil are both relatively considered. Carbon stock is relatively poorly considered and Air and particularly GHG emissions are both universally poorly considered. There do not seem to be any large variations between the Asian countries regarding how they consider the Renewable Energy Directive sustainability topics in their biofuel related legislation.

Table 70. Regional overview of RED-topics considered in biofuel related legislation: Asia

	Social sustainability	Bio-diversity	GHG emissions	Carbon stock	Air	Water	Soil	Ecosystem services	Land-use
Asia									
Indonesia	+		0		-				+
Malaysia	+		-	-	-			-	+
Pakistan	+	-	0		-	+			
India	+		0	-	-	+		-	+
Region	+ + +		- - -	-	- - -	+		-	+ +
South America									
Brazil	+		-			+			+
Argentina	+	+	-			+	+		+
Guatemala	+	+	0	-	-	+			+
Region	+ + +	+ +	- - -	-	-	+ + +	+		+ + +
Africa									
Tanzania	+		-		-	+		-	+
Malawi	+		0	-	-	+		-	
Mozam-bique	+	+	0	+	-	+		+	+
Uganda	+	-	-	-	-		-		
Ethiopia	+		-	-	-	+		-	
Nigeria	+		0	-	-			0	+
Region	+ + +		- - -	-	- - -	+ +		-	+

In South America, Land-use and Water are all universally well considered, Biodiversity is generally well considered and Ecosystem services is relatively considered. Carbon stock and Air are both relatively poorly considered and GHG emissions is universally poorly considered. There do not seem to be any large variations between the countries regarding how they consider the Renewable Energy Directive sustainability topics in their biofuel related legislation.

In Africa Social sustainability is universally well considered, Water is generally well considered, Land-use is relatively well considered and Biodiversity and Soil are both relatively considered. Carbon stock and Air are relatively poorly considered and Air and GHG emissions are both universally poorly considered. Variations within the region regarding how they consider Renewable Energy Directive sustainability topics in their biofuel related legislation is found for Biodiversity and Ecosystem services.

Coverage of Land use change criteria in biofuel related legislation

As seen in Table 71, Clearing of forests and Impacts on areas designated for nature protection purposes are both relatively well considered. Impacts on rare, threatened and endangered species, Conversion of wetlands, Drainage of peatlands and particularly Conversion of grasslands are all universally poorly considered.

Table 71. Regional overview of RED-criteria considered in biofuel related legislation: Asia

	Clearing of forests	Impacts on protected areas	Impacts on threatened species	Conversion of grasslands	Drainage of peatlands	Conversion of wetlands
Asia						
Indonesia	-	+	-	0	-	-
Malaysia	+	+	-	-	-	-
Pakistan	+		-	0	0	0
India	+		-	0	-	-
Region	+	+	- - -	- - -	- - -	- - -
South America						
Brazil	+	+		-	0	-
Argentina	+	+		-	-	-
Guatemala	+	+		0	0	-
Region	+ + +	+ + +		- - -	- - -	- - -
Africa						
Tanzania		+		-	0	
Malawi	-	+	+	0	0	0
Mozambique	+	+	+	0	0	-
Uganda				-	0	
Ethiopia	-		-	0	0	-
Nigeria	+	+		0	0	-
Region		+ +		- - -	- - -	- -

In South America, Clearing of forests and Impacts on areas designated for nature protection purposes are both universally well considered and Impacts on rare, threatened and endangered species is relatively considered. Conversion of wetlands, Drainage of peatlands and Conversion of grasslands are all universally poorly considered.

In Africa, Impacts on areas designated for nature protection purposes is generally considered and Clearing of forests and Impacts on rare, threatened and endangered species are both relatively considered. Conversion of wetlands, Drainage of peatlands and Conversion of grasslands are all universally poorly considered.

Enforcement

Unless legislation is sufficiently enforced, the legislative readiness, as previously determined, is of little value. The results, as summarised in Table 72, show that seven of the assessed countries were classified as having a low potential to enforce legislation, six countries were classified as having an intermediate potential while no countries were classified as having a high potential to enforce legislation. In addition, most countries do not specify institutions responsible for enforcement in-text in their biofuel related legislation. It is unknown if such responsibilities are specified in other ways in the different countries, but if the responsibilities are not sufficiently clear; it is likely to negatively affect the level of enforcement.

Table 72. Global overview of enforcement potential and share of biofuel related laws that specify institutions responsible for enforcement

	Perceived public sector corruption	Anti-corruption framework	Democracy level	Potential to enforce legislation	Share of biofuel related laws that specify institutions responsible for enforcement
Indonesia	High	Moderate	Flawed democracy	Intermediate	17%
Malaysia	Medium	Moderate	Flawed democracy	Intermediate	30%
Pakistan	High	Moderate	Hybrid regime	Low	22%
India	Medium	Moderate	Flawed democracy	Intermediate	0%
Brazil	Medium	Moderate	Flawed democracy	Intermediate	0%
Argentina	High	Weak [1)]	Flawed democracy	Intermediate [2)]	53%
Guatemala	Medium	Weak	Flawed democracy [3)]	Low	57%
Tanzania	High	Weak	Hybrid regime	Low	63%
Malawi	Medium	Moderate	Hybrid regime	Intermediate	42%
Mozambique	High	Very weak	Hybrid regime	Low	0%
Uganda	High	Weak	Hybrid regime	Low	51%
Ethiopia	High	Very weak	Authoritarian regime	Low	35%
Nigeria	High	Weak	Authoritarian regime	Low	74%

1) Close to Moderate
2) The RLI score indicates a significantly lower potential to enforce legislation than the EI
3) Close to Hybrid regime

Implications

The results indicate that the legislative readiness cannot be determined other than on a theoretical level, since challenges related to enforcement seem to be consistent among the assessed exporting countries. This means that the EU cannot expect countries to be well prepared to produce biofuels complying with the RED criteria, even though the legislative readiness in some cases indicates so. It is therefore essential that the EU supports the development, or consolidation, of third-party institutions, either national or international, which can monitor developments of biofuel projects and verify that biofuels aimed for the EU-RED market are produced in compliance with the RED criteria.

G 17 Method

In this chapter, methodologies are presented for the country level analysis, the complementary regulation analysis, the regional analysis and the enforcement analysis.

Legislation

Each target country's environmental legislation has been extracted from the ECOLEX database. ECOLEX is an information service on environmental law, operated jointly by FAO, IUCN and UNEP. Its purpose is to build capacity worldwide by providing the most comprehensive possible global source of information on environmental law (FAO et al. 2011).

National level legislation analysis

All legislative documents has been systematically analysed using an analysis tool developed specifically for this task. The following methodology has been used:

Elements relevant for all legislation

The following elements of the analysis are relevant for all legislations.

Basic information

Basic information has been collected for all available legislation, including:

- Full name of the legislation
- Translation to English (if necessary)
- ECOLEX subject(s)
- Direct link to the legislation summary in the ECOLEX database
- Relevance for biofuels, i.e. whether the legislation is relevant for biofuels or not

Elements only relevant for biofuel related legislation

The following elements of the analysis are only relevant for biofuel related legislation.

Connections to biofuels

Legislation can be related to biofuels in different ways. The obvious connections are to feedstock production and processing but there are also other possible connections. For example, legislation on labour issues are not connected to the production of feedstock or processing per se, but it is nevertheless necessary for biofuel producers to comply with. Therefore, legislation can be connected to biofuels in three main ways;

- Feedstock production,
- Processing and
- Other

These categories have been further subcategorised to be able to further specify the connections between specific legislation and biofuels. Each subcategory, or connection, has a different relation to biofuels and one law can be related to several of the connections. However, only the connection that has the closest relation to biofuels has been chosen for each law in the analysis.

The closest connection to feedstock production is naturally "biofuel feedstock production" followed by "agriculture", "forestry, "nature and biodiversity protection" and "other land-use and LUC".

The closest connection to processing is "biofuel processing" followed by "industrial activities".

The last category, "Other", includes "other relevance" or "no other relevance". The reason for choosing "other relevance" has been noted in all cases.

Relations to sustainability considerations of the Renewable energy Directive
As further described in the study about Environmental Impact Assessments (EIAs), the RED has been translated into seven topics and 31 underlying aspects. The Directive's topics are supposed to represent main areas of interest in the Directive. They include:

- Social sustainability
- Biodiversity
- GHG emissions
- Carbon stock
- Air, water and soil
- Ecosystem services
- Land-use

In order to identify which environmental considerations that exist in biofuel legislation, the Directive's topics have been used as a basis for evaluation of each analysed law. This has been done by analysing whether or not the laws are related to each of the topics (yes/no). The topic "air water and soil" was split up into the three topics; "air", "water" and "soil" for this analysis.

Relations to sustainability criteria of the Renewable Energy Directive
The Directive's topics represent the main, broad areas of interest in the Renewable Energy Directive, but the sustainability criteria in Article 17 are more specific and of particular interest for this study.

Each legislative document has been evaluated on whether or not it restricts activities in similar ways as each of the Directive's criteria. For each target country, this analysis shows how much legislation that are restricting biofuel related activities similar to the ways required by the EU through the sustainability criteria in the Directive. Criterion 17:2 on GHG emissions savings has been excluded from the analysis.

Note that the sole existence of legislation related to, for example, criterion 17:3a on clearing on natural forests does not automatically mean that clearing of natural forests is restricted per se. It might mean that it is prohibited without permission or in specific areas. However, it is assumed that the more laws that restrict activities in similar ways as a specific criterion, the higher the legislative readiness for producing biofuels in a way that complies with that specific criterion. Analogously, if few laws exist restricting certain activities, it is assumed that the legislative readiness for producing biofuels in a way that complies with the corresponding criterion is low.

Coverage
All biofuel related legislations have been marked with either national or sub-national, depending on their coverage. Sub-national legislation means that it is provincial or local, or that it is only relevant for a specific area (e.g. establishment of a defined protected area). National legislation means that it is nation-wide.

Institution responsible for enforcement
If stated in-text in the legislation, the institution responsible for enforcement has been noted. This is done in order to identify how biofuel related legislations are enforced in the juridical sense.

Database development
Each legislative document has been downloaded as a pdf file in order to provide for the development of a database on biofuel related legislation.

Complementary regulation analysis

Due to the different cultures and traditions that exist regarding legislation in different countries, we assumed that some countries restrict certain activities primarily in *legislation* and others primarily in *regulation*. Therefore, in an attempt to avoid erroneous conclusions about certain countries' legislative coverage in relation to the Renewable Energy Directive sustainability criteria, a complementary analysis of regulations was made in cases where no laws were found related to a certain sustainability criterion in the Directive.

The analysis was performed in a similar way as for the legislation, although restricted to identifying relations to the specific sustainability criteria from the Directive that were missing in legislation. Besides, in contrary to the legislation analysis, all regulations were not analysed. A selection was made before the analysis based on a keyword search in the ECOLEX regulation database, as specified below.

Clearing of forests - (Article 17:3a; 17:4bc)
No complementary analysis necessary since all countries had laws related to this criterion.

Impacts on areas designated on nature protection purposes - (Article 17:3bi)
No complementary analysis necessary since all countries had laws related to this criterion.

Impacts on rare, threatened and endangered species - (Article 17:3bii)
No complementary analysis necessary since all countries had laws related to this criterion.

Conversion of grasslands - (Article 17:3c)
Keywords: "desertification" "ecosystem preservation" "land-clearing" "management/conservation" "protected area" "national parks" "protection of habitats" "wild flora"

Drainage of peatlands - (Article 17:5)
Keywords: "drainage/land reclamation" "ecosystem preservation" "land-clearing" "management/conservation" "protected area" "national parks" "protection of habitats" "wild flora"

Conversion of wetlands - (Article 17:4a)
Keywords: "drainage/land reclamation" "estuaries" "mangroves" "water conservation zone" "wetlands" "ecosystem preservation" "land-clearing" "management/conservation" "protected area" "national parks" "protection of habitats" "wild flora"

Regional level analysis

The assessed countries were grouped into three regions in order to identify similarities and differences, both between countries within the same region and between regions.

In order to illustrate how the RED aspects/criteria are considered on a national level, three levels of consideration were defined, as described in Table 74.

Table 73. National level of consideration for RED topics/criteria in legislation

National level of consideration for RED topics/criteria	Code
RED aspect/criteria *well considered* (considered by relatively many laws)	+
RED aspect/criteria *relatively considered*	
RED aspect/criteria *poorly considered* (considered by relatively few laws)	-

In order to determine the national level of consideration for each RED topic/criterion, thresholds were defined, as described in Table 74. The thresholds were calculated to allow for an even distribution of levels among countries, regardless of the number of available laws.

The upper limit for *poorly considered* varies depending on the number of available laws and is consequently twice as high for RED topics as for the more specific RED criteria. The lower limit for *well considered* is constant in both cases; 30% for RED topics and 18% for RED criteria.

RED topics/criteria that fall in between the limits, i.e. considered by neither relatively many nor relatively few laws, are classified as *relatively considered*.

Table 74. Thresholds for determining national level of compliance for RED topics/criteria in legislation

Number of available laws relevant for biofuels	RED topics		RED criteria	
	-	+	-	+
<20	<16%	>30%	<8%	>18%
21-40	<14%	>30%	<7%	>18%
41-100	<13%	>30%	<6.5%	>18%
100-200	<11%	>30%	<5.5%	>18%
>200	<9%	>30%	<4.5%	>18%

In order to compare regions on a global level, national levels of consideration were aggregated to regional levels of consideration, as defined in Table 75.

Table 75. Regional level of consideration for RED topics/criteria in legislation

Regional levels of consideration	Code
Universally well considered	+ + +
Generally well considered	+ +
Relatively well considered	+
Relatively considered	
Relatively poorly considered	-
Generally poorly considered	- -
Universally poorly considered	- - -

The regional levels of consideration were determined by calculating the percentage of aspects/criteria that are *well considered* or *poorly considered* for each topic/criteria, as described in Table 76. In cases where different national levels of consideration exist for the same topic/criteria in a region, the national levels *well considered* and *poorly considered* have been settled to resulting *relatively considered* levels. This means that contradicting national levels within a region results in a lower regional level of consideration.

Table 76. Methodology for determining regional level of consideration

Percentage of RED topics/criteria with the same national level of consideration in a region	Code	
0-25		
26-50	+	-
51-75	+ +	- -
76-100	+ + +	- - -

Enforcement

Enforcement in the juridical sense

Institutions responsible for enforcement were identified in the legislative texts, if specified. Besides detailed information about institutions responsible for enforcing biofuel related legislation in each country, this allows for an illustration of whether or not the different countries tend to specify institutions responsible for enforcement in-text in their biofuel related legislation.

Enforcement in the practical sense

On a country level, it is not feasible to assess how each and every law is enforced in practice. Instead, the enforcement potential for each target country is discussed based on global indexes indicating the general potential to enforce legislation.

<u>Corruption Perception Index (CPI)</u>
CPI is developed by Transparency International and has the purpose to indicate the perceived level of public-sector corruption in a country. The corruption index ranges between 0-10 and a high index indicates low levels of corruption. (Transparency International 2010)

<u>Global Integrity Index (GII)</u>
GII is developed by Global Integrity and has the purpose to indicate the existence, effectiveness, and citizen access to key national-level anti-corruption mechanisms used to hold governments accountable. GII ranges between 0-100 and a high index indicates a strong anti-corruption framework. (Global Integrity 2009)

<u>Index of Democracy (ID)</u>
ID is developed by The Economist Intelligence Unit and has the purpose to indicate the state of democracy, including e.g. the electoral process, functioning of government and political participation. The democracy index ranges between 0-10 and a high index indicates a strong democracy. (The Economist Intelligence Unit 2010)

<u>Enforcement Index (EI)</u>
EI is an index consisting of the CPI, GII and ID indexes combined. The results for each index have been normalized and combined with equal weight in order to present a combined result for the three indexes, representing the potential to enforce legislation. The EI ranges between 0-10 and a high index indicates a strong potential to enforce legislation.

The CPI, GII and ID all suggest ways to interpret their respective systems. For example, an integrity index of 70-80 means that the country is placed in the *moderate performance* group. These interpretations have been aggregated and combined and a system for interpretation of the EI has been created, as illustrated in Table 77.

Table 77. Interpretation of Enforcement Index

Enforcement Index	Potential to enforce legislation
≥ 7,7	High
5,6 - 7,6	Intermediate
≤ 5,5	Low

Rule of Law Index (RLI)

RLI is developed by the World Justice Project and intends to provide detailed information and original data regarding a variety of dimensions of the rule of law, which enables stakeholders to assess a nation's adherence to the rule of law in practice, identify a nation's strengths and weaknesses in comparison to other countries, and track changes over time. RLI consist of 9 factors, each range between 0-1 and a high index indicates a better performance. (Agrast et al. 2010)

The intention with RLI is similar to the one with EI, since it intends to assess a nation's adherence to the rule of law in practice. Therefore, the RLI scores can both confirm other results and indicate that they might be inaccurate. Note that RLI scores are not available for all countries.

G 18 References

Agrast, M., Botero, J. & Ponce, A., 2010. *WJP Rule of Law Index.* Available at: http://www.worldjusticeproject.org/rule-of-law-index/.

FAO, IUCN and UNEP, 2011. *ECOLEX - the gateway to environmental law.* Available at: http://www.ecolex.org/start.php [Accessed April 5, 2011].

Global Integrity, 2009. *Global Integrity Report.* Available at: http://report.globalintegrity.org/.

The Economist Intelligence Unit, 2010. *Democracy index 2010, Democracy in retreat.* Available at: http://graphics.eiu.com/PDF/Democracy_Index_2010_web.pdf [Accessed August 28, 2010].

Transparency International, 2010. *Corruption Perception Index 2010.* Available at: http://www.transparency.org/policy_research/surveys_indices/cpi/2010.

Appendix H Environmental impact assessments

H 1 Introduction

In order to sell biofuels to the EU RED market, biofuel (or feedstock) producers need to consider the RED sustainability requirements already in the planning stage of new projects, due to the restrictions on land conversion included in the Renewable Energy Directive [2009/28/EC] sustainability requirements.

The Environmental Impact Assessment[77] (EIA) is a valuable legal mechanism that can provide insight in how countries manage sustainability challenges in areas relevant for biofuels production aimed for export to EU.

Therefore, EIAs have been studied to evaluate how sustainability is dealt with in a selection of biofuels projects.

An underlying reason to study legal and voluntary mechanisms such as EIAs is to understand inhowfar governments tend to develop policies in response to foreign sustainability concerns, and also how well prepared they are to do so.

Finally, if biofuel project EIAs would be found that show (increasing) interest for the Directive's sustainability requirements, this would signal that the Directive has been effective already in its early stages, even before complete implementation.

This Appendix is a shortened version of a full report that is available online[78].

H 2 Aim and objectives

The overall aim of this study is

- To analyze the coverage, comprehensiveness and reliability of EIAs for biofuel projects, in order to determine the usefulness of EIAs as tools to supply information for assessments verifying the sustainability of biofuels, from an RED perspective.

Three thesises underly this study:

- If the RED sustainability criteria would be considered already in the planning stage of biofuel projects, these projects would have a higher likelihood of meeting these RED criteria, and consequently more "RED-eligible" biofuels would be produced;

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[77] There are several different types of Impact Assessments. In order to avoid confusion from the use of too many similar terms, Impact Assessments as well as Impact Assessment reports are most often referred to as EIAs in this report. An introduction to EIAs, including the terminology, is provided in the full report.

[78] Englund O, Berndes G, Johnson H and Ostwald M, 2011, Environmental impact assessment: suitable for suppoting assessments of biofuel sustainability? Technical report for the EU biofuel Baseline project. Gothenburg, Chalmers University of Technology. Available at: http://publications.lib.chalmers.se/records/fulltext/local_146738.pdf

- There is a need for ways to determine the sustainability of biofuels, so that only biofuels complying with the RED sustainability criteria are used for meeting the set biofuels targets. EIAs can provide useful information for studies that evaluate RED eligibility of biofuel projects and in this way help to assess some of the features considered in the RED;
- EIAs can be used as tools for collecting information for biofuel sustainability assessments only if they can be considered as sufficiently comprehensive and reliable.

The following objectives are laid out in order to fulfill the aim:

- Systematically analyze the coverage and comprehensiveness of a number of EIAs for bioenergy projects, with regard to the sustainability criteria and other considerations in the RED.
- Identify signs of EU biofuel policy considerations in EIAs for bioenergy projects.
- Assess the sufficiency and reliability of EIAs and EIA systems.

H 3 Limitations to the study

This EIA analysis only investigates the coverage and comprehensiveness of the EIAs and refers only to the ways that the issues are handled in the EIAs. The quality of the EIAs is assessed only in terms of quantification of impacts, i.e., whether they include quantitatively described impacts. Investigating the degree of correctness, or any other grading of the quality of the analyzed EIAs, is outside the scope of the study.

The limited number of EIAs included in the analysis is the most crucial factor determining the reliability of the results. Using a larger selection of EIAs would make the results more reliable. The EIA analysis can be extended to include more EIAs when available, in order to increase reliability and potentially draw additional conclusions.

H 4 Methodology

The methodology is described in the full report, see footnote 78.

H 5 Results and analysis

The EIA analysis includes 19 impact assessments from different biofuel projects. Table 78 provides an overview of the projects; their geographical locations are illustrated in Figure 102.

Table 78. Overview of biofuel projects.

	America	Africa	Asia, Oceania & Europe
Sugarcane plantations and ethanol plant	**Brazil** – Ituiutaba	**Kenya** - Tana River	
	Brazil - Itumbiara	**Tanzania** - Bagamoyo	
	Brazil - Campina Verde	Sierra Leone - Bombali	
Oil Palm plantations and biodiesel plant		**Tanzania** -Mngeta	
Jatropha plantations and biodiesel plant		**Kenya** - Bungale	
Oil palm plantations			**Malaysia** - Saribas
			Malaysia - Tawau
Eucalyptus plantations	**Uruguay** - Tacuarembó/Durazno		**China** - Guangxi
Ethanol plant	**Jamaica** - St. Catherine		**The Philippines** - Negros Occidental
	USA - Jasper County, Indiana		
	USA - Stevens County, Kansas		
Biodiesel plant	**USA** - Oahu, Hawaii		**Australia** - Darwin
			Australia - Wagga Wagga

Figure 102. Geographical location of biofuel projects .

EIA comprehensiveness – analysis of results

Detailed results from the EIA analysis are presented in chapter 3.1 of the full report (available online), using symbols to visualize how each EIA performs in relation to the RED features. In this chapter, the symbols are transformed into numerical values in order to plot the results in graphs. This allows for an easier way to identify general similarities and differences between EIAs for the different project types. In addition, by looking at how the results for each EIA differ from the average result for similar EIAs, it becomes possible to identify patterns with higher certainty.

One graph is presented for each RED-topic including results for all EIAs grouped corresponding to the project type for which the EIAs were conducted.

One additional chart is presented with results for features specifically related to the RED sustainability criteria. The reason for this is to attempt to estimate the probability that EIAs in general are sufficiently comprehensive in how the covered features are treated to provide information for an assessment verifying RED-sustainable biofuels.

Instructions for interpretation

The numerical values plotted in the graphs correspond to the levels of compliance with the Baseline EIA. The graphs can be further interpreted with help of the example in Figure 103.

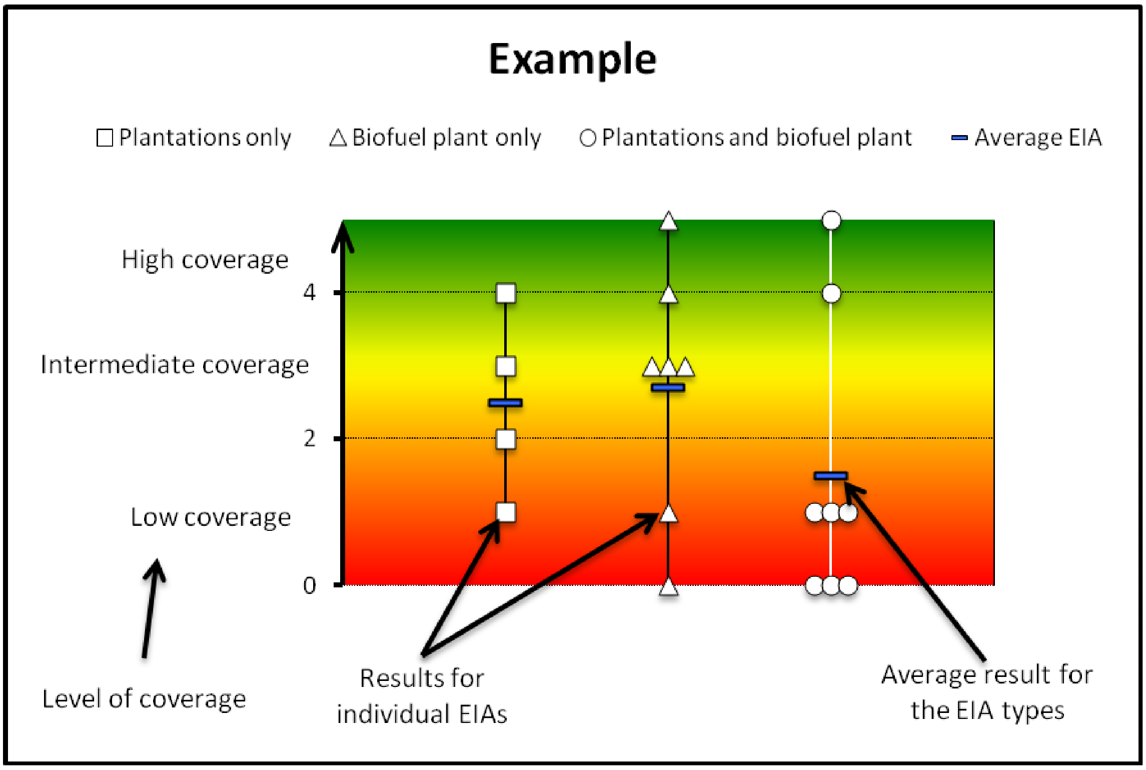


Figure 103. Example of results graph.

In the graphs, coverage is derined as follows:

- Level 0: Feature not discussed;
- Level 1: Feature briefly or indirectly discussed;
- Level 2: Feature discussed;
- Level 3: Impact identified, no measures proposed;
- Level 4: Impact identified, measures proposed;
- Level 5: Feature (or corresponding impact) deliberately avoided, or planned (in cases where there is a required action), or would not occur (if proposed measures are implemented)

Social sustainability

Figure 104 shows all results related to social sustainability for the different project types.

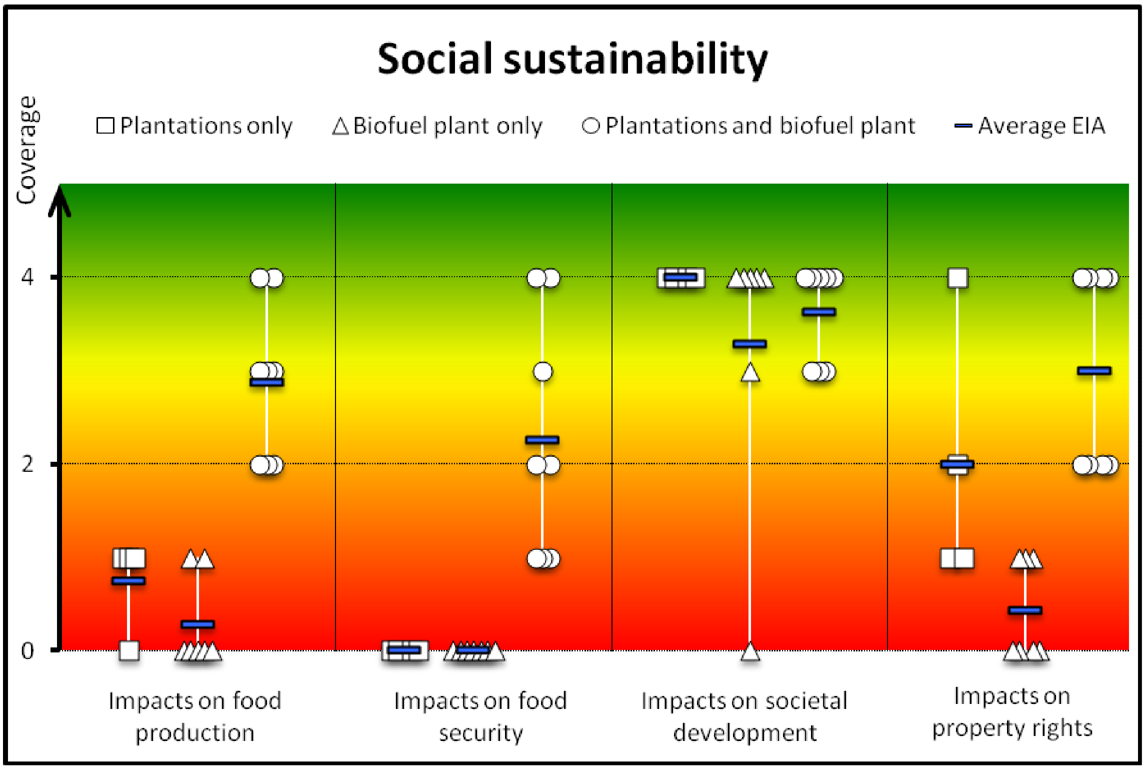


Figure 104. Results related to social sustainability.

- *Impacts on food production* seem to have a low coverage in both "plantation" and "biofuel plant" EIAs (high certainty). In "plantations and biofuel plant" EIAs, the average is an intermediate coverage.
- *Impacts on food security* seem to have a low coverage in both "plantation" and "biofuel plant" EIAs (high certainty). In "plantations and biofuel plant" EIAs, the average is intermediate-to-low coverage.
- *Impacts on societal development* seem to be highly covered in "plantation" EIAs (high certainty). In "biofuel plant" EIAs, the average is an intermediate coverage and in "plantations and biofuel plant" EIAs it seems to have an intermediate-to-high coverage (high certainty). It should be noted that large emphasis is placed on the positive impacts on societal development in the assessed EIAs. For

example, 18 of the 19 EIAs identified positive impacts related to societal development (primarily employment opportunities), while 13 of the 19 EIAs identified one or more negative impacts.

- *Impacts on property rights* seems to have a low coverage in both "plantation" EIAs on average, and in "biofuel plant" EIAs (high certainty). In "plantations and biofuel plant" EIAs, the average is an intermediate coverage.

Biodiversity

Figure 105 shows the results related to biodiversity for the different project types.

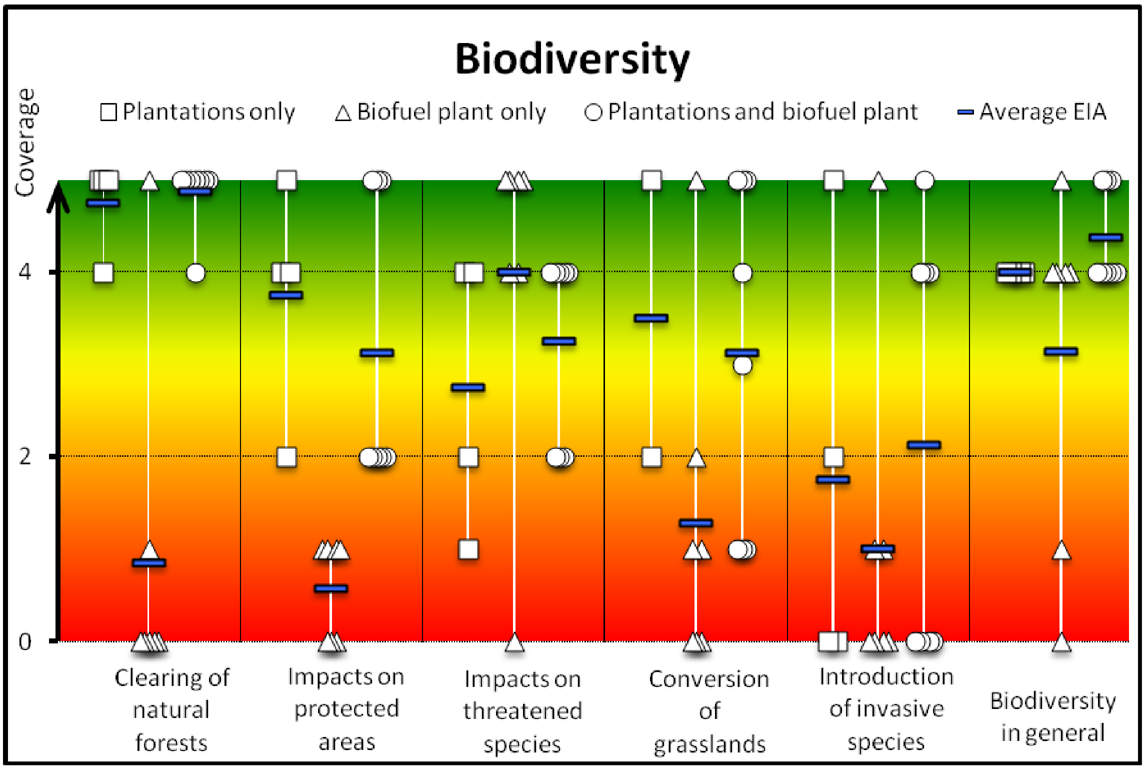


Figure 105. Results related to biodiversity.

- *Clearing of natural forests* seems to be highly covered in both "plantation" and "plantations and biofuel plant" EIAs (both with high certainty). In "biofuel plant" EIAs it seems to have a low coverage (high certainty).
- A similar pattern is found when looking at *impacts on areas designated for nature protection purposes*. This feature has an average of intermediate-to-high coverage in "plantation" EIAs and an average of intermediate coverage in "plantations and biofuel plant" EIAs but both with less certainty. In "biofuel plant" EIAs it seems to have a low coverage (high certainty).
- *Impacts on rare, threatened and endangered species* has an average of intermediate coverage in both "plantation" and "plantation and biofuel plant" EIAs. Interestingly it seems to be highly covered in "biofuel plant" EIAs (high certainty), but it should be noted that these considerations in most cases seem to be restricted to impacts related to construction of facilities and discharge of effluents.

- *Conversion of grasslands* has an average of intermediate-to-high coverage in "plantation" EIAs and an average of intermediate coverage in "plantations and biofuel plant" EIAs. In "biofuel plant" EIAs it seems to have a low coverage, on average, although results varied broadly.
- *Introduction of invasive species* seems to have a low coverage in both "biofuel plant" EIAs and "plantation" EIAs (high certainty). In "plantation and biofuel plant" EIAs it has an average of intermediate-to-low coverage.
- *Biodiversity in general* seems to be highly covered in both "plantation" and "plantations and biofuel plant" EIAs (high certainty). In "biofuel plant" EIAs it has an average of intermediate coverage. It should be noted though that biodiversity most often is only considered with respect to species diversity and not other features of biodiversity, such as genetic, functional or ecosystem diversity. Therefore, even though it seems to be relatively highly covered, it is reasonable to assume that biodiversity is a feature generally not sufficiently discussed in EIAs.

GHG emissions

Figure 106 shows the results related to GHG emissions for the different project types.

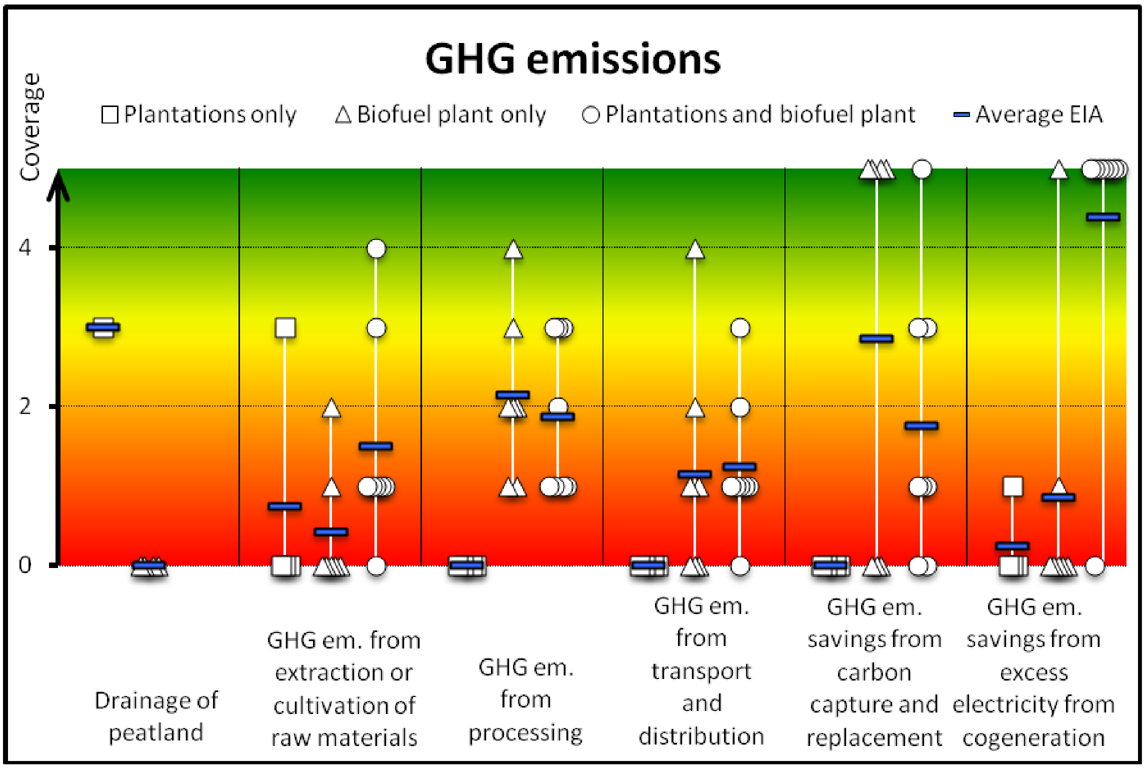


Figure 106. Results related to GHG emissions.

- *Drainage of peatlands.* For "plantation" EIAs, this feature was only relevant for one EIA, for the Lower Saribas Agricultural Development Project (ADB 1996). In this project, drainage of low-lying peat swamps was a deliberate action in order to be able to establish oil palm plantations. Several impacts related to drainage of peatlands were identified in the corresponding EIA, including peat oxidation.

However, resulting GHG emissions were not identified as an impact. For "biofuel plant" EIAs, this feature is relevant for four of the seven EIAs in that category. None of these discussed drainage of peatlands as a feature. For "plantation and biofuel plant" EIAs, this feature was not relevant for any of the EIAs to consider. The only reasonable conclusion to draw from this discussion is that drainage of peatlands seems to have a low coverage in "biofuel plant" EIAs (high certainty).

- *GHG emissions from extraction or cultivation of raw materials* seems to have a low coverage in all EIA types; "plantation" EIAs (high certainty), "biofuel plant" EIAs (high certainty) and "plantation and biofuel plant" EIAs on average.
- *GHG emissions from processing* seems to have a low coverage in both plantation EIAs (high certainty) and "plantation and biofuel plant" EIAs on average. In "biofuel plant" EIAs, it has an average of low-to-intermediate coverage. It is interesting to note that not even EIAs for projects focused on processing seem to cover GHG emissions.
- *GHG emissions from transport and distribution* seems to have a low coverage in all types of EIAs; "plantation" EIAs (high certainty), "biofuel plant" EIAs on average and "plantations and biofuel plant" EIAs on average.
- *GHG emissions savings from carbon capture and replacement* seems to have a low coverage in both "plantation" (high certainty) and "plantations and biofuel plant" EIAs on average. In "biofuel plant" EIAs it has an average of intermediate coverage. Besides the "plantation" EIAs, there is a big variation regarding whether EIAs consider carbon capture and replacement to be an opportunity or not.
- *GHG emissions savings from excess electricity from co-generation* seems to have a low coverage in both "plantation" and "biofuel plant" EIAs (high certainty). In "plantations and biofuel plant" EIAs it seems to be highly covered (high certainty).

The overall low score for "plantation" EIAs indicates that EIAs for projects including only feedstock production in general may give little consideration to features related to processing.

The low score for "biofuel plant" EIAs regarding GHG emissions from extraction and cultivation of raw materials indicates that EIAs for projects considering only biofuel processing in general may give little consideration to features related to feedstock production.

The significant difference between "biofuel plant" and "plantation and biofuel plant" EIAs regarding possibilities of co-generation is rather interesting. Since feedstock production tends to be outside the scope of EIAs for "biofuel plant" projects, it is possible that alternative uses for the feedstock, such as cogeneration, are less likely to be identified. In this sense, EIAs for "plantation and biofuel plant" projects can be more likely to see a "bigger picture" and identify possibilities that other EIAs do not.

Carbon stock

Figure 107 shows the results related to carbon stock for the different project types.

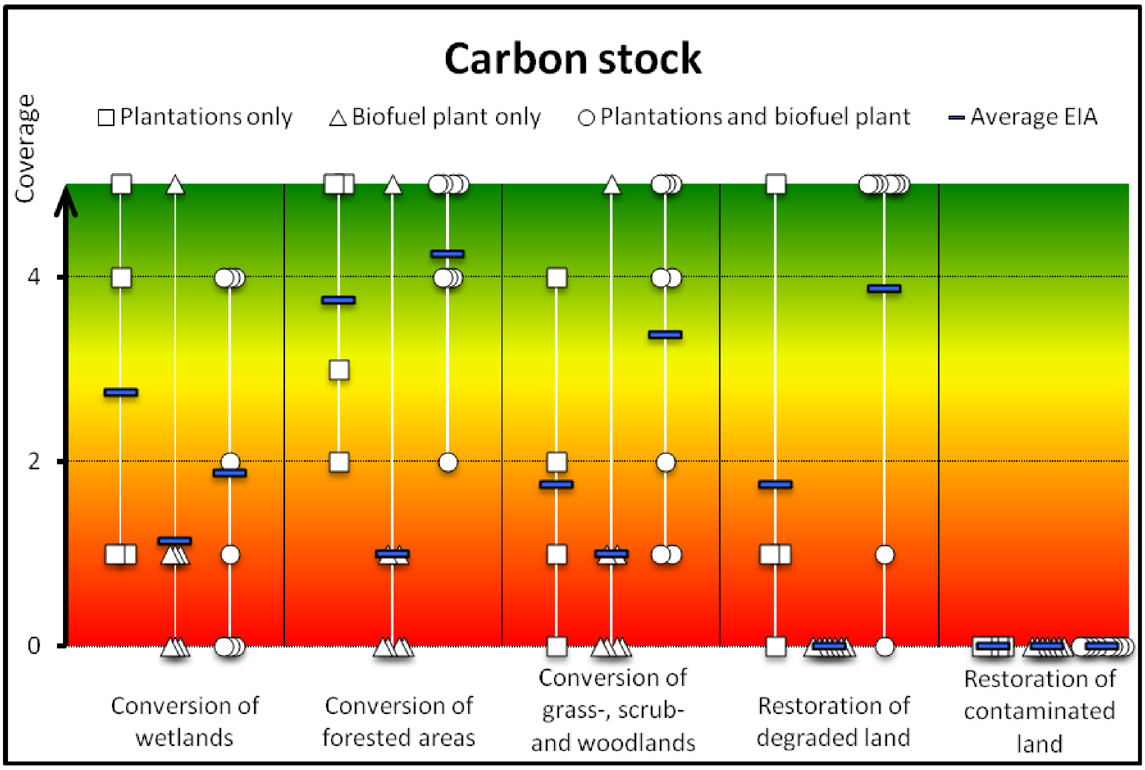


Figure 107. Results related to carbon stock.

- *Conversion of wetlands* seems to have an intermediate coverage in "plantation" EIAs on average and low coverage in both "biofuel plant" EIAs (high certainty) and "plantation and biofuel plant" EIAs on average.
- *Conversion of forested areas* seems to be intermediate-to-highly covered in "plantation" EIAs on average and highly covered in "plantations and biofuel plant" EIAs (high certainty). In "biofuel plant" EIAs it seems to have a low coverage (high certainty).
- *Conversion of grass- scrub- and woodlands* seems to have a low coverage in both "plantation" and "biofuel plant" EIAs (high certainty). In "plantations and biofuel plant" EIAs it has an average of intermediate-to-high coverage.
- *Restoration of degraded land* seems to have a low coverage in both "plantation" and "biofuel plant" EIAs (high certainty). In "plantations and biofuel plant" EIAs, on the other hand, it seems to be seen as more of an opportunity since the coverage is intermediate-to-high on average.
- *Restoration of contaminated land* seems to have a low coverage in all three types of EIAs (high certainty). Actually, no signs of interest in this feature could be found in any of the 19 EIAs.

Air, water and soil

Figure 108 shows the results related to air, water and soil for the different project types.

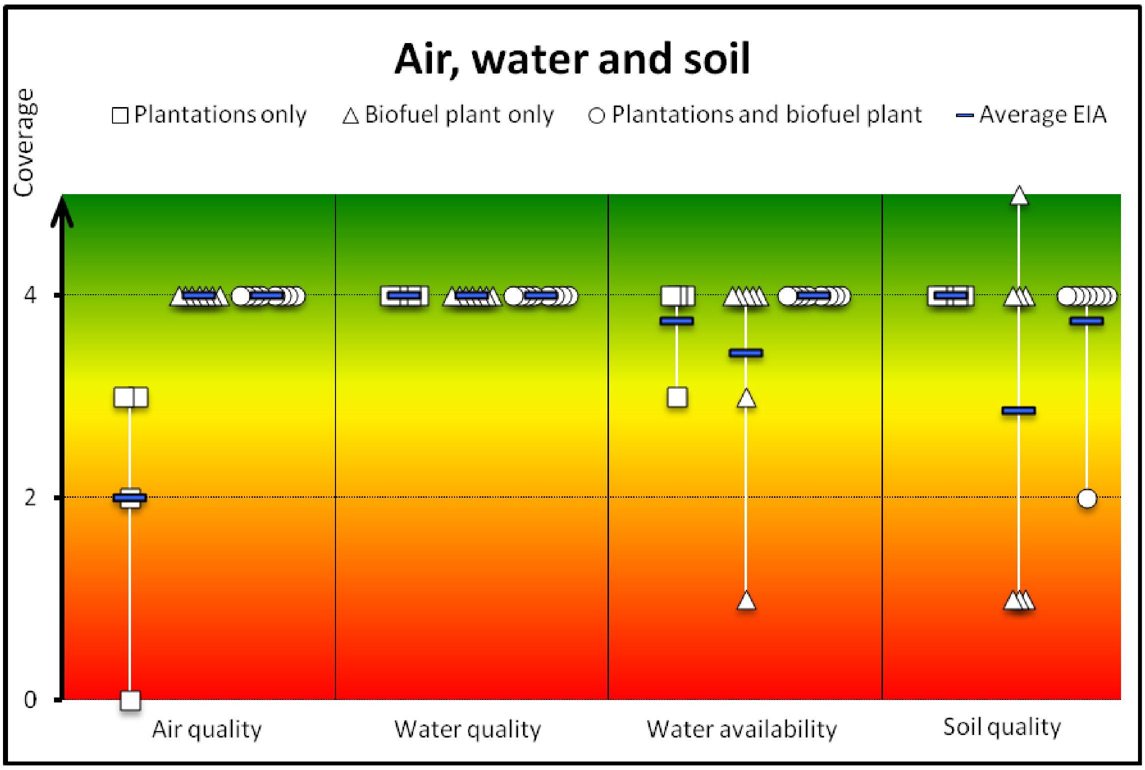


Figure 108. Results related to air, water and soil.

- *Air quality* seems to be highly covered in both "biofuel plant" and "plantation and biofuel plant" EIAs (high certainty). In "plantation" EIAs it has an average of low coverage. This can be explained with the finding that impacts on air quality in EIAs typically relate to airborne emissions from processing facilities. Since projects only including plantations normally do not include processing facilities, it is relevant to assume that this feature becomes less natural to address in the corresponding EIAs.
- *Water quality* seems to be highly covered in all types of EIAs (high certainty).
- *Water availability* seems to be highly covered in "plantation and biofuel plant" EIAs (high certainty) and intermediate-to-highly covered in "plantation" EIAs (high certainty). In "biofuel plant" EIAs it has an average of intermediate coverage.
- *Soil quality* seems to be highly covered in "plantation" EIAs (high certainty) and intermediate-to-highly covered in "plantation and biofuel plant" EIAs (high certainty). In "biofuel plant" EIAs it has an average of intermediate coverage. It should be noted that EIAs for "biofuel plant" projects typically only relate this feature to effluents from processing facilities, whereas EIAs for the other type of projects typically also address soil fertility.

Impacts related to air, water and soil seem to be rather highly covered in all types of EIAs. It should be noted that "biofuel plant" EIAs generally do not consider impacts from feedstock production and "plantation" EIAs generally do not consider impacts from biofuel processing. "Plantation and biofuel plant" EIAs on the other hand generally consider impacts from both feedstock production and biofuel processing.

Ecosystem services

Figure 109 shows the results related to ecosystem services for the different project types.

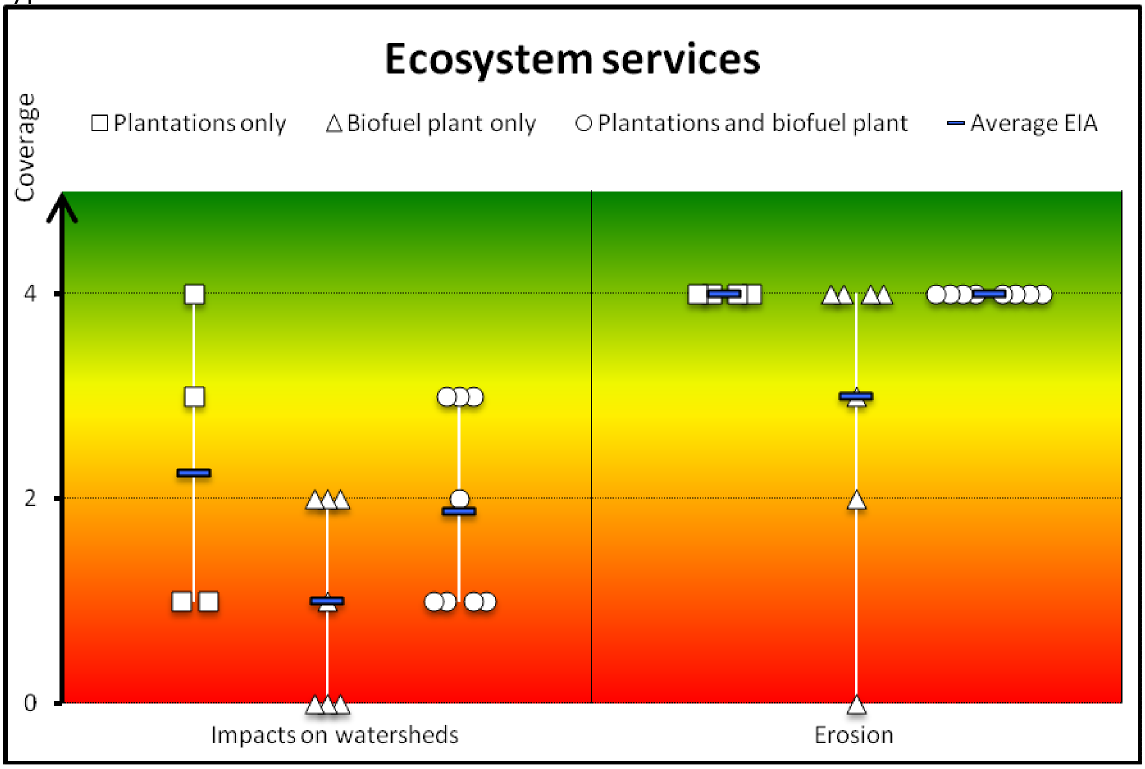


Figure 109. Results related to ecosystem services.

- *Impacts on watersheds* seem to have an intermediate-to-low coverage in "plantation" EIAs on average and low coverage in both "biofuel plant" EIAs (high certainty) and "plantation and biofuel plant" EIAs on average.
- *Erosion* seems to be highly covered in both "plantation" and "plantations and biofuel plant" EIAs (high certainty). In "biofuel plant EIAs it has an average of intermediate coverage. It should also be noted that only one out of seven EIAs for "biofuel plant" projects relates this feature to feedstock production. The other six EIAs only relate this feature to the construction of facilities.

Since "biofuel plant" EIAs seem have a low coverage of impacts on watersheds and since they in general only seem to consider erosion a feature related to construction of facilities, it could be assumed that projects including only biofuel processing in general may give little consideration to features related to feedstock production.

Land use

Figure 110 shows the results related to land-use for the different project types.

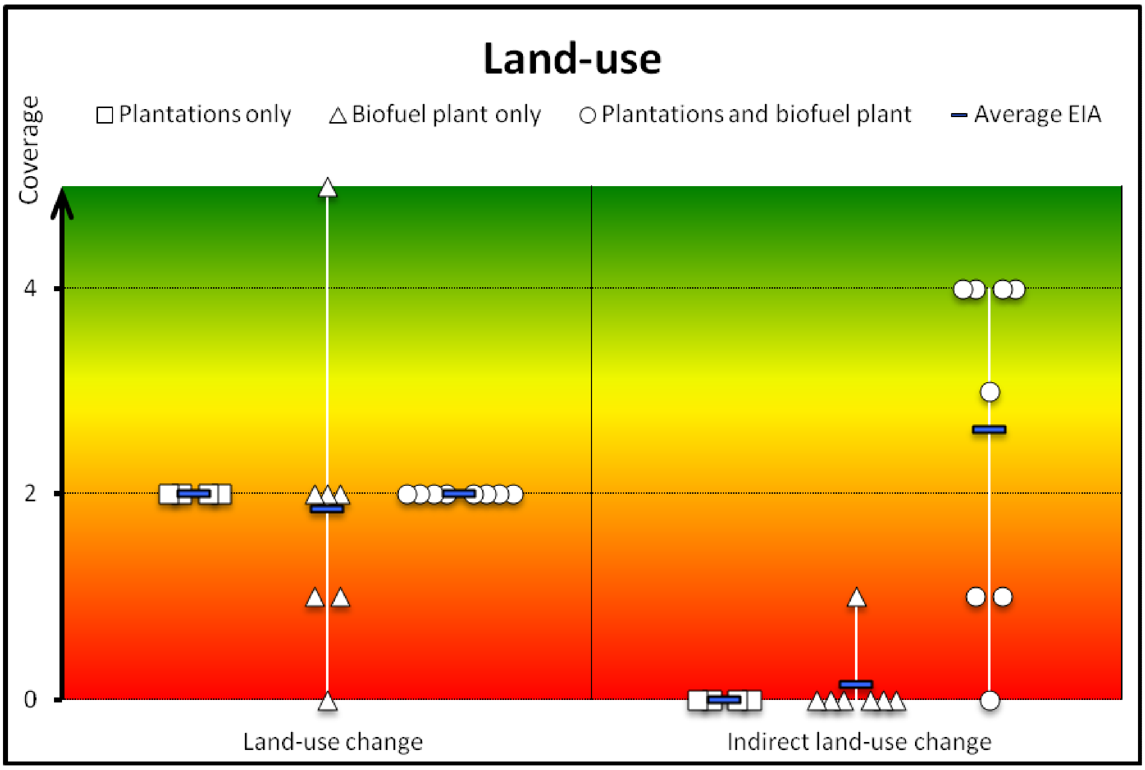


Figure 110. Results related to land-use.

Land-use change cannot be discussed in the same way as other features. EIAs handled this feature very differently and it was only possible to use the compliance levels 0, 1, 2 and 5 in the analysis. Besides the finding that EIA consultants seem to have very different ideas of what is relevant to discuss in relation to land-use change, it is possible to conclude that this feature seems to be rather highly covered in "plantation" and "plantation and biofuel plant" EIAs, even though they do so with varying approaches and levels of effort.

Indirect land-use change seems to have a low coverage in both "plantation" EIAs and "biofuel plant" EIAs (high certainty). In "plantations and biofuel plant" EIAs it has an average of low-to-intermediate coverage. It is relevant to add that very few EIA consultants seem to have proper knowledge about ILUC and therefore their efforts to address it become rather pointless. In addition, ILUC is currently (2011) a "hot potato" in both the scientific and the political world, resulting in a difficulty to address it without taking a stand.

EU biofuel policy development

Figure 111 *s*hows the results related to EU biofuel policy development for the different project types.

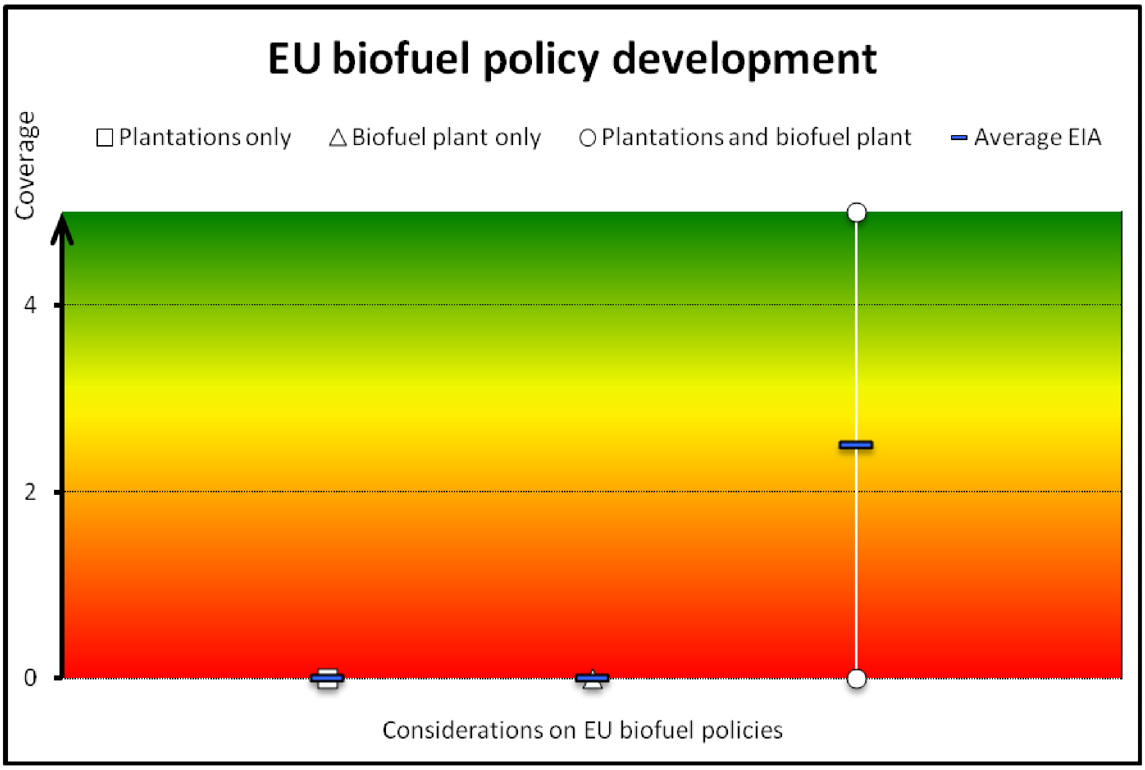


Figure 111. Results related to EU biofuel policy development.

Only one "plantation" EIA and one "biofuel plant" EIA was completed after 2008. Neither of these two included any considerations on EU biofuel policy development.

Two of the "plantation and biofuel plant" EIAs were completed after 2008. One of these two, the Addax Bioenergy project in Bombali district, Sierra Leone (Coastal & Environmental Services 2009), includes rather ambitious considerations on the RED.

In the ESHIA report, the sustainability criteria are cited in the introduction and returned to throughout the report. It should be noted though that Article 17 §5, restricting the use of peatland for production of biofuel feedstock, is left out. It has not been possible to determine the reason for this, but since peatland is not reported to exist in Sierra Leone (FAO et al. 2009; USDA 2005) it is unlikely that it is a deliberate action.

Besides that the impacts are discussed in relation to the RED criteria, several of the impacts related to carbon stock and GHG emissions are quantified according to the rules set out in Annex V of the RED. This approach actually makes it possible to use the EIA to provide information for an assessment of the project's level of compliance with the RED criteria, providing that the EIA and the EIA system can be regarded as sufficiently reliable.

RED sustainability criteria

Figure 112 shows the results related to the RED sustainability criteria for the different project types.

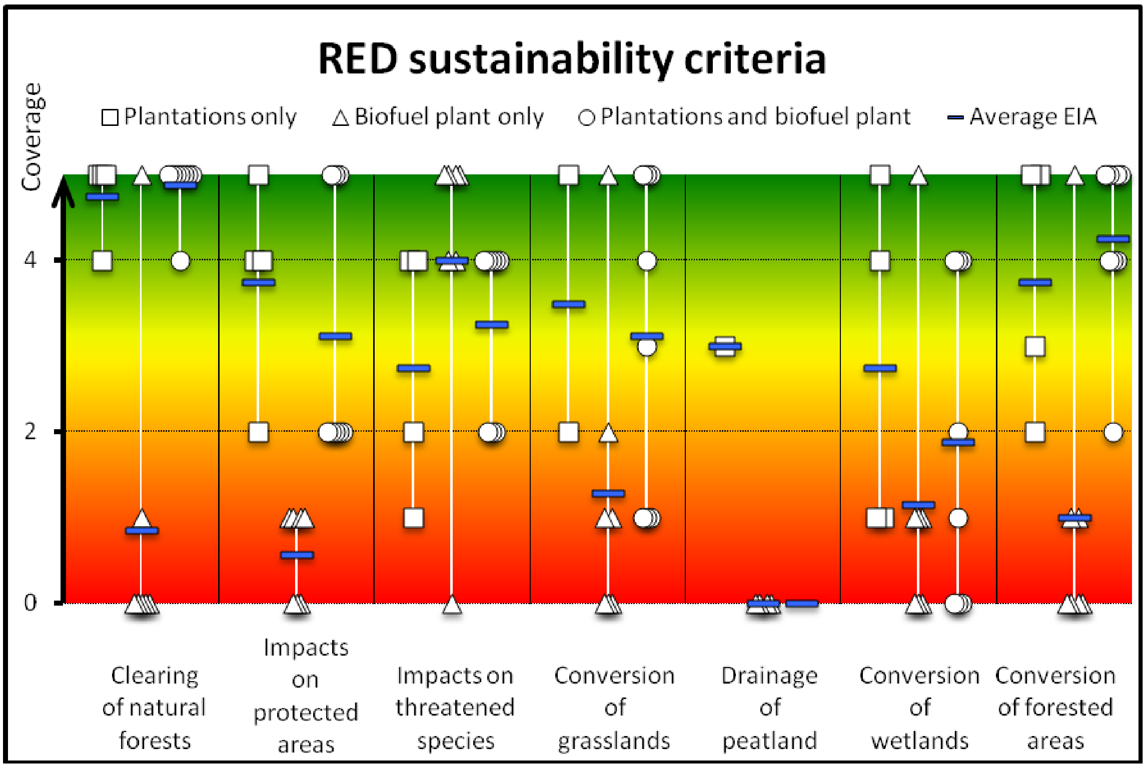


Figure 112. Results related to RED sustainability criteria.

By taking a closer look at these findings, it may become possible to determine whether or not EIAs in general are likely to be sufficiently comprehensive to provide information to support an assessment verifying RED-sustainable biofuels.

In the result charts, the "coverage" is connected to the amount of relevant information in the EIAs. The higher coverage of a feature, the greater amount of information is likely to exist. Thus, the probability that EIAs can be suitable for providing information to an assessment verifying RED-sustainable biofuels increases with the coverage. In Table 79, on the next page, this has been estimated based on the findings with higher certainty for the features specifically related to the RED sustainability criteria.

Table 79. Probability that EIAs are sufficiently comprehensive to provide information for an assessment where the level of compliance with each of the RED sustainability criteria should be determined, for the three project types.

RED sustainability criteria	Estimated probability		
	Plantation	**Biofuel plant**	**Plantations and biofuel plant**
Clearing of natural forests (Article 17:3a)	High	Low	High
Impacts on areas designated for nature protection purposes (Article 17:3bi)	1)	Low	1)
Impacts on rare, threatened and endangered species (Article 17:3bii)	1)	High	1)
Conversion of grasslands (Article 17:3c)	1)	1)	1)
Drainage of peatland (Article 17:5)	1)	Low	1)
Conversion of wetlands (Article 17:4a)	1)	Low	1)
Conversion of forested areas (Article 17:4bc)	1)	Low	High

1) Too large variation between EIAs to determine probability.

"Plantation" projects

For "plantation" projects, EIAs are likely to be sufficiently comprehensive to provide information about the RED sustainability criterion 17:3a (*clearing of natural forests*). For the rest of the criteria it is not possible to draw clear conclusions since the features related to these criteria are handled very differently in the EIAs.

"Biofuel plant" projects

For "biofuel plant" projects, EIAs are likely to be sufficiently comprehensive to provide information about the RED criterion 14:3bii (*Impacts on rare, threatened and endangered species*).

On the other hand, they are not likely to provide relevant information about the RED sustainability criterion 17:3a (*clearing of natural forests*), 17:3bi (*Impacts on areas designated for nature protection purposes*), 17:4a (*Conversion of wetlands*), 17:4bc (*Conversion of forested areas*) and 17:5 (*Drainage of peatlands*).

Regarding RED criterion 17:3c, it is not possible to draw clear conclusions since the features related to these criteria are handled very differently in the EIAs

"Plantation and biofuel plant" projects

For "plantation and biofuel plant" projects, EIAs are likely to be sufficiently comprehensive to provide information about the RED criterion 17:3a (*clearing of natural forests*) and 17:4bc (*Conversion of forested areas*).

For the rest of the criteria it is not possible to draw clear conclusions since the features related to these criteria are handled very differently in the EIAs.

In addition, since "plantation and biofuel plant" EIAs seem to consider impacts from both feedstock production and biofuel processing, unlike most "plantation" and "biofuel plant" EIAs, they are likely to be more comprehensive and thus more likely to be useful sources of information.

EIA sufficiency and reliability

The comprehensiveness analysis, as presented in above only indicates whether or not EIAs in general can be sufficiently comprehensive to provide information for an assessment verifying RED-sustainable biofuels. For EIAs to *function* as such tools, it is important that they are also sufficiently reliable. Therefore it is important to analyze possible limitations of EIAs, in order to identify potential boundaries that would rule out an EIA as a sufficient and reliable tool.

Target countries

In this section, we discuss the sufficiency and reliability of EIAs and EIA systems in the target countries as presented in Table 80.

Table 80. Target countries

North- and South America	Africa	Asia and Europe
Argentina	Ethiopia	India
Bolivia	Malawi	Indonesia
Brazil	Mozambique	Malaysia
Canada	Nigeria	Pakistan
Guatemala	South Africa	Russia
Peru	Sudan	Ukraine
USA	Tanzania	
	Uganda	

Issues of concern

First it is relevant to identify and discuss specific problems with EIAs in the target countries. Table 81 and Table 82 include quotes from research studies about EIA in the individual target countries that represent recurring issues. The issues are divided into two types, *legal and institutional issues* and *operational issues.* Note that the issues should be seen as general problems with EIA systems. For country-specific analyses, please follow the references.

It is not the purpose of this study to thoroughly discuss each of the issues of concern. However, by discussing the cause of the issues, it becomes possible to discuss general problems and thus to further investigate the sufficiency and reliability of EIAs in the target countries.

The causes of the legal and institutional issues in Table 81 include:
- Insufficient legislation;
- Insufficient enforcement;
- Insufficient capacity;
- Insufficient transparency.

The capacity is connected to the enforcement since insufficient capacity weakens the potential to enforce legislation. Therefore, capacity constraints are considered to be part of the enforcement problems and will not be discussed separately. The sufficiency of EIA legislation and EIA enforcement in the target countries are discussed in this appendix while transparency is not included.

Table 81. Quoted EIA issues of concern: Legal and institutional[1].

Institutional and legal issues
The EPA did not have any influence on the implementation of the project
Lack of human, political and financial capacity to support the EIA system, including enforcement tools such as a monitoring system
Lack of awareness of EIA legislation, even among those officials who are important in the EIA process
Missing regulation for how to treat public complaints
EIA reports are confidential, "never" made available to the public, nor discussed in public hearing sessions or media
Lack of mandatory post-decision monitoring
No ministry exists with environment as the sole responsibility. Environmental affairs are taken care of, "indirectly and inefficiently"
Lack of local, adequately competent, practitioners
Consultants lack experience. No systems to accredit consultants
A lack of trust of NGOs from central government as well as the private sector
Lack of feedback to the project proponents from government or donors on the draft EIS
Non-accountability of EIA professionals
Lack of coordination and poorly defined decision-making process
Finding personnel with sufficient knowledge of the environmental issues as well as free of conflicts of interest has been difficult
A key problem of enforcement is corruption, due to a lack of accountable and transparent institutions
Weak coordination between EIA practitioners, developers, financial institutions and government; a financial institution may give loans before government officials have issued a clearance
Entanglement of government responsibilities
EIA is too centralized, limiting local awareness and participation of local authorities, NGOs etc
EIA process regarded as being too bureaucratic and time-consuming
A legal basis for enforcement of EIA legislation was missing
Specific guidelines exist, but are not used in practice
An investment permit may be issued even though a screening has not been done
An investment permit may be issued without EIA, even though EIA legislation demands it
Absence of processes to enforce the delivery of EIS documents
EIA guidelines are not legally binding
Capacity constraints, both centrally and locally, due to difficulties in finding experienced practitioners willing to work on (lower) public sector salaries
Centrally placed personnel also worked on enforcement processes locally
Public opinion is deemed to be overridden by political will and interest
Enforcement of EIA in the public sector has been low, as government agencies "do not respect" environmental authorities and have consequently refused to carry out EIA
No procedures for enforcement, follow-up or monitoring
By law, biofuel projects are requested to present an EIA, however, this is not done in practice. It is sufficient for the project developer to present permits from the province in which the project is located
Little public involvement in the legislative making process
Overlapping or contradicting legislation creates loopholes for biofuel projects

1) Sources: (Nadeem & Hameed 2006; Morgera et al. 2009; Lopez & Laan 2008; Gallardo & Bond 2010; Gebremeskel & Tesfaye 2008; Sandham & Pretorius 2008; Ecaat 2004; Debeke & Akilu 2008; Devlin 2007; Memon 2003; Glasson 2000; Paliwal 2006; Ogunba 2004; Mwebasa et al. 2009; Nadeem & Hameed 2008; Ruffeis et al. 2010; Tamrat 2010; Spong & Walmsley 2009; Damtie & Bayou 2008; Ali 2007; Mccarthy & Zen 2009; Andersson et al. 2005; Mhango 2005).

The causes of operational issues in Table 82 also include insufficient legislation, enforcement and transparency, at least to some extent. However, from the perspective of this study, the most important thing to discuss when it comes to EIA quality is in which ways that poor EIA quality affects the reliability of the EIA. This is subject to a complementary study under development [Chalmers 2011] and not included in the present report.

Table 82. Quoted EIA issues of concern: Operational[1)]

Operational issues
In the scoping process, when analyzing alternatives, only a no-option alternative is put forward
EIA studies are often carried out after the project has started
Limited or no public participation or stakeholder consultation
EIA failed to include effects on the public
Terms of references were, if not excluded altogether, often generic or even directly copied from the EIA guidelines
Impact analysis was mostly made on impacts during construction, not from when the project was operational
The use of "scientific" or technical methods was mostly missing
Impact prediction and signification was not well-performed
Management plans were weak on including indicators to monitor impacts
Environmental audit not performed
Low quality of EIA reports
Impacts identified are more often qualitative than quantitative
Not enough time to perform all the steps in the EIA process
Screening and scoping processes are not well-defined
EIAs for sites with very different environmental characteristics are often very similar, as consultants "copy and paste" data.
Lack of baseline data for air, water and soil conditions. Consultants often used secondary data due to time constraints.
Lack of quantitative methods to predict impacts
Due to the project-level scope of an EIA, important issues are not considered. Neither are cumulative or indirect impacts
Low amount of produced EIAs

1) Sources, see footnote under Table 81.

Sufficiency of EIA legislation

As discussed in chapter 3.4.2, insufficient EIA legislation seems to be causing problems with EIAs in the target countries. Therefore, it is relevant to further investigate the installed EIA legislation.

Some companies see EIAs as tools to demonstrate their commitment to environmental issues (Equilibrium Research 2009), but to many companies it seems like EIAs are things that "they have to do" in order to get an approval for their project. Therefore, to make sure that all biofuel projects *must* carry out an EIA prior to project initiation, sufficient legislation is necessary.

Table 83 provides an overview of existing EIA legislation and requirements for biofuel projects in the target countries. "Existing EIA legislation" refers to legislation requiring an EIA to be conducted for projects that intend to alter the existing landscape. "EIA required for biofuel projects" refers to legislation requiring an EIA to be conducted for biofuel projects. In cases where it is not obvious whether or not

EIAs are required for biofuel projects, or if inconsistent legislation exists, the term "Unclear" has been used.

Table 83. Overview of EIA legislation and related biofuel requirements for the target countries.

	Country	Existing EIA legislation	EIA required for biofuel projects	EIAs found for analysis
America	Argentina	Yes	Yes	0
	Bolivia	Yes	1)	0
	Brazil	Yes	Yes	3
	Canada	1)	1)	0
	Guatemala	Yes	1)	0
	Peru	Yes	1)	0
	USA	Yes	Yes	3
Africa	Ethiopia	Yes	Yes	0
	Malawi	Yes	Yes	0
	Mozambique	Yes	Unclear	0
	Nigeria	Yes	No	0
	South Africa	1)	1)	0
	Sudan	Yes	1)	0
	Tanzania	Yes	Yes	2
	Uganda	Yes	1)	0
Asia and Europe	India	Yes	No	0
	Indonesia	Yes	1)	0
	Malaysia	Yes	Unclear	2
	Pakistan	Yes	Yes	0
	Russia	1)	1)	0
	Ukraine	Yes	1)	0

1) Not enough information has been found.

The overview shows that EIAs generally are required for projects that intend to alter the existing landscape. However, biofuel projects do not automatically alter the landscape (e.g., biofuel projects on previously cultivated land or on converted grasslands), so additional EIA requirements are necessary for all biofuel projects to be included in the national EIA system. These requirements could only be found in seven of the 18 target countries. This means that:

1. EIA legislation exists in most target countries;
2. Biofuel projects are not covered by EIA legislation per se.

The first finding is positive. Since EIA legislation already exists in the assessed target countries, EIA systems should be in place and 'EIA' should be a familiar concept for decision-makers.

The second finding is negative. Since biofuel projects are not totally covered by EIA legislation, it is unlikely that EIAs are carried out for all biofuel projects.

When combining the two findings, it becomes clear that even though EIA legislation exists, it is insufficient from a biofuels perspective. However, since the concept of 'EIA' seems to be familiar to the decision-makers it might make an improvement of EIA legislation easier to realize.

Sufficient EIA legislation is, however, not the sole key to EIA success. Even though the legislation itself might be impeccable, it is of little use unless it is sufficiently enforced.

Sufficiency of EIA enforcement

As discussed above, insufficient enforcement of EIA legislation seems to be causing problems with EIAs in the target countries. Enforcement of legislation is therefore another key to EIA success. In order for all biofuel projects to carry out an EIA according to the requirements in the legislation, it is important that EIA legislation is sufficiently enforced. If we assume that enforcement of EIA legislation can be reflected by the enforcement of other types of legislation, we can discuss the enforcement potential of the target countries by looking at general enforcement problems.

In Table 84, the enforcement capacity of the target countries is presented. This table provides an overview of the countries' capacity to enforce legislation in general and thus, according the above assumption, the capacity to enforce EIA legislation.

Table 84. Enforcement capacity for target countries. Red indicates Low capacity to enforce legislation, Yellow indicates Intermediate capacity to enforce legislation and Green indicates High capacity to enforce legislation.

		Corruption index	Integrity index	Democracy index	Enforcement capacity
America	Argentina	2.9	7.0	6.8	5.6
	Bolivia	2.8	1)	5.9	2)
	Brazil	3.7	7.6	7.1	6.1
	Canada	8.9	8.0	9.1	8.7
	Guatemala	3.2	6.4	6.1	5.2
	Peru	3.5	6.9	6.4	5.6
	USA	7.1	8.5	8.2	7.9
Africa	Ethiopia	2.7	5.6	3.7	4.0
	Malawi	3.4	7.3	5.8	5.5
	Mozambique	2.7	5.9	4.9	4.5
	Nigeria	2.4	6.4	3.5	4.1
	South Africa	4.5	7.9	7.8	6.7
	Sudan	1.6	5.9	2.4	3.3
	Tanzania	2.7	6.0	5.6	4.8
	Uganda	2.5	6.9	5.1	4.8
Asia and Europe	India	3.3	7.0	7.3	5.9
	Indonesia	2.8	7.4	6.5	5.6
	Malaysia	4.4	1)	6.2	2)
	Pakistan	2.3	7.2	4.6	4.7
	Russia	2.1	6.9	4.3	4.4
	Ukraine	2.4	5.8	6.3	4.8

1) GII score missing.
2) Classification is mathematically certain even though GII score is missing.

The results illustrate that the target countries in general seem to have rather low capacity to enforce EIA legislation. This tells us that even though EIA legislation could be improved to such an extent that it could be considered sufficient, it might not be sufficiently enforced.

H 6 Conclusions

The aim of this study was to analyze the comprehensiveness and reliability of EIAs for biofuel projects, in order to determine the usefulness of EIAs as tools for collecting information for studies intended to assess the sustainability of biofuels, from an RED perspective.

EIA coverage

In order to evaluate how sustainability in biofuel projects is dealt with the coverage of 30 features, defined as relevant for the RED, was determined in 19 EIA reports (EIRs) for bioenergy projects. Large variations in coverage between individual EIRs were found for most of the features (see Table 86). However, 12 features were sufficiently similarly considered for the coverage to be determined with an adequate accuracy. These features are summarised in Table 85.

Notable differences between EIRs for different types of projects were found. EIRs for projects including both plantation establishment and the construction of a biofuel plant had better coverage than EIRs for projects including either the plantations or the biofuel plant. As might be expected, EIAs for "plantation projects" generally leave out features related to biofuel processing, and EIAs for "biofuel plant" projects generally leave out features related to feedstock production.

Table 85. Coverage of RED features in EIAs.

High coverage	Low coverage
Impacts on societal development [1)]	Impacts on food production [1)]
General impacts on biodiversity (species diversity)	Impacts on food security [1)]
Air quality [1)]	Introduction of invasive species
Water quality [1)]	GHG emissions from extraction or cultivation of raw materials [1)]
Soil quality [1)]	GHG emissions from transport and distribution [1)]
Erosion [1)]	Conversion of grass, scrub and woodlands

1) Coincides with findings by Gallardo and Bond (2010).

Supporting much of our findings, (Gallardo & Bond 2010) assessed 32 EIRs for sugarcane projects in Brazil and concluded that "water and soil pollution" and "air emissions" were universally considered in EIAs, and "soil erosion" and "jobs" were extensively covered, but "energy balance and GHG" and "food security" were less considered.

Table 86. EIA coverage of the 30 RED features

RED topics	Features	EIA coverage		
		Plantation	Biofuel plant	Plantation & plant
Social sustainability	Impacts on food production	Low	Low	[1)]
	Impacts on food security	Low	Low	[1)]
	Impacts on societal development	High	[1)]	Intermediate-to-high
	Impacts on property rights	[1)]	Low	[1)]
Biodiversity	Clearing of natural forests	High	Low	High
	Impacts on areas designated for nature protection purposes	[1)]	Low	[1)]
	Impacts on rare threatened and endangered species	[1)]	High	[1)]
	Conversion of grasslands	[1)]	[1)]	[1)]

	Introduction of invasive species	Low	Low	1)
	Impacts on biodiversity (general)	High	1)	High
GHG emissions	Drainage of peatlands	1)	Low	1)
	GHG emissions from extraction or cultivation of raw materials	Low	Low	1)
	GHG emissions from processing	Low	1)	1)
	GHG emissions from transport and distribution	Low	Low	Low
	GHG emission savings from carbon capture and replacement	Low	1)	1)
	GHG emission savings from excess electricity from co-generation	Low	Low	High
Carbon stock	Conversion of wetlands	1)	Low	1)
	Conversion of forested areas	1)	Low	High
	Conversion of grass-, scrub- and woodlands	Low	Low	1)
	Restoration of degraded land	Low	Low	1)
	Restoration of contaminated land	Low	Low	Low
Air, water and soil	Air quality	1)	High	High
	Water quality	High	High	High
	Water availability	Intermediate-to-high	1)	High
	Soil quality	High	1)	High
Ecosystem services	Impacts on watersheds	1)	Low	1)
	Erosion	High	1)	High
Land-use	Land-use change	1,2)	1,2)	1,2)
	Indirect land-use change	Low 2)	Low 2)	1,2)

1) Too large variation among EIAs to determine coverage
2) Not possible to discuss in the same way as other features

EIRs as sources for an RED-sustainability assessment

Overall, this study concludes that EIRs do not offer a complete coverage of the features related to the RED sustainability criteria. Therefore, complementary sources of information are needed for an RED sustainability assessment. However, EIRs are likely to provide useful information about some of the criteria, depending on the type of project assessed.

EIAs for "plantation and biofuel plant" projects seem to consider impacts from both feedstock production and biofuel processing, while EIAs for "plantation projects" naturally fail to consider features related to feedstock-to-biofuel processing, and EIAs for "biofuel plant" projects often fail to consider features related to the feedstock production. Therefore, EIRs for "plantation and biofuel plant" projects are considered to have the best potential to provide useful information.

Table 86 shows the probability that EIRs (for the three project types) are sufficiently comprehensive to provide information of acceptable quality for a RED sustainability assessment. As can be seen, in several instances there was too large variation in coverage among the 19 EIRs to determine probability.

For "plantation" projects, EIRs are likely to be sufficiently comprehensive to provide information about *clearing of natural forests*.

For "biofuel plant" projects, EIRs are likely to be sufficiently comprehensive to provide information about *impacts on rare, threatened and endangered species*. On the other hand, they are unlikely to provide sufficient information about *clearing of natural forests*, *impacts on areas designated for nature protection purposes*, *conversion of wetlands*, *conversion of forested areas* and *drainage of peatlands*.

For "plantation and biofuel plant" projects, EIRs are likely to be sufficiently comprehensive to provide information about *clearing of natural forests* and *conversion of forested areas*.

Availability of EIRs

As seen in Table 87, several target countries seem to have insufficient EIA requirements. In addition, several target countries seem to have difficulties in enforcing legislation and regulation. This means that even if EIA legislation was sufficiently improved, it should not be taken for granted that EIAs are being conducted for the majority of biofuel projects. Therefore, RED sustainability assessments should not expect EIRs to be available to support information for all projects.

Table 87. Requirements by law that EIAs need to be conducted for biofuel projects and estimated enforcement potential, for each target country.

Region	Country	EIA required for biofuel projects	Enforcement potential
America	Argentina	Yes	Intermediate
	Bolivia	1)	Low
	Brazil	Yes	Intermediate
	Canada	1)	High
	Guatemala	1)	Low
	Peru	1)	Intermediate
	USA	Yes	High
Africa	Ethiopia	Yes	Low
	Malawi	Yes	Intermediate
	Mozambique	Unclear	0
	Nigeria	No	Low
	South Africa	1)	Intermediate
	Sudan	1)	Low
	Tanzania	Yes	Low
	Uganda	1)	Low
Asia and Europe	India	No	Intermediate
	Indonesia	1)	Intermediate
	Malaysia	Unclear	Intermediate
	Pakistan	Yes	Low
	Russia	1)	Low
	Ukraine	1)	Low

1) Not enough information has been found to determine whether or not EIAs are required for biofuel projects by law

Since quantitatively described impacts in EIRs seem scarce, a thesis is that the general EIA quality might not be sufficient for EIRs to be regarded as suitable sources of information. Several findings in existing literature (see *Table 15 and 16)* support this. In addition, quantifications of some impacts are necessary for calculating greenhouse gas savings. Therefore EIRs in general seem not to suffice as the sole source of information for that purpose.

It is important to clarify that this does not rule out EIRs as information sources. It rather means that it needs to be carefully investigated whether or not an EIR should be used as an information source for each individual RED sustainability assessment.

Signs of increasing interest for including European notions on sustainability

Among the assessed, one "plantation" EIR and one "biofuel plant" EIR was completed after 2008. Neither of these included any considerations on the EU biofuel policy development. Two of the "plantation and biofuel plant" EIRs were completed after 2008. One of these, the Addax Bioenergy project in Bombali district, Sierra

Leone (Coastal & Environmental Services 2009), includes rather ambitious considerations on the RED.

In the ESHIA report for the Addax Bioenergy project, the RED sustainability criteria are cited in the introduction and referred to throughout the report. Besides that the impacts are discussed in relation to the RED criteria, several of the impacts related to carbon stock and GHG emissions are quantified according to the rules set out in Annex V of the RED. This approach makes it possible to use the EIR as an information source for an assessment of the project's level of compliance with the RED criteria, including greenhouse gas savings, provided that the EIR can be regarded as sufficiently reliable. According to the CEO of Addax Bioenergy, this was a natural approach when planning the project in order to understand whether or not it would become profitable (Sandström 2011).

Concluding remarks

Considering the RED-criteria in the scoping process of an EIA would make the EIA a better source of information, since it would then cover all the features that need to be assessed in an RED sustainability assessment. During this study, we noted that the approach of considering the RED criteria already in the planning stage of a project has been adopted in one EIA, the Addax Bioenergy project mentioned above. It cannot be concluded at this point whether this EIA is an exception or a sign of emerging interest in considering RED requirements in EIAs. Even so, considering the RED requirements was considered important and profitable by those responsible for this EIA (Sandström 2011), if this approach proves successful more companies targeting the EU-RED market might follow. This would entail an increased coverage of RED features in EIAs and thus improve the usefulness of EIAs as information sources for RED sustainability assessments.

H 7 References

ADB, 1996. Summary Environmental Impact Assessment of the Lower Saribas Agricultural Development Project in Malaysia.

Ali, O.M.M., 2007. POLICY AND INSTITUTIONAL REFORMS FOR AN EFFECTIVE EIA SYSTEM IN SUDAN. *Journal of Environmental Assessment Policy and Management*, 9(1), p.67-82.

Andersson, J., Slunge, D. & Berlekom, M., 2005. Tanzania – Environmental policy brief. Document financed by the Swedish International Development Agency, SIDA. Available at: http://www.hgu.gu.se/files/nationalekonomi/eeu/helpdesk/env%20policy%20brief%20tanzania.pdf [Accessed September 13, 2010].

Coastal & Environmental Services, 2009. Sugar cane to ethanol project, Sierra Leone, Draft ESHIA.

Damtie, M. & Bayou, M., 2008. Overview of Environmental Impact Assessment in Ethiopia: Gaps and Challenges. Available at: http://www.melca-ethiopia.org/EIA.html [Accessed September 13, 2010].

Debeke, Y. & Akilu, N., 2008. Alarm bell for biofuel development in Ethiopia: the case of Babille elephant sanctuary, in Agrofuel development in Ethiopa: rhetoric, reality and recommendations, Forum for Environment, Ethiopia. Available at: www.boell-ethiopia.org/downloads/Binder1.pdf [Accessed September 13, 2010].

Devlin, J., F, 2007. Comparisons of EA practices in Bolivia, Mozambique, Ukraine and Vietnam, Prepared for the Canadian International Development Agency. Available at: : http://www.uoguelph.ca/~jdevlin/CIDA-Report-Impact-of-EA-Four-Countries-YESA.pdf [Accessed September 7, 2010].

Ecaat, J., 2004. A review of the application of environmental impact assessment (EIA) in Uganda: A report prepared for the United Nations Economic Commission for Africa. Available at: http://www.uneca.org/sdd/documents/ReportEIAUgandaFinal.pdf [Accessed September 13, 2010].

Equilibrium Research, 2009. The potential environmental and social impacts of a plantation project in Uruguay. With tools for planning and monitoring.

FAO et al., 2009. Harmonized World Soil Database (version 1.1). Available at: http://www.iiasa.ac.at/Research/LUC/External-World-soil-database/HTML/index.html?sb=1.

Gallardo, A.L.C.F. & Bond, A., 2010. Capturing the implications of land use change in Brazil through environmental assessment: Time for a strategic approach? *Environmental Impact Assessment Review*. Available at: http://linkinghub.elsevier.com/retrieve/pii/S0195925510000880.

Gebremeskel, L. & Tesfaye, M., 2008. A preliminary assessment of socioeconomic and environmental issues pertaining to liquid biofuel development in Ethiopia, in Agrofuel development in Ethiopa: rhetoric, reality and recommendations, Forum for Environment, Ethiopia. Available at: www.boell-ethiopia.org/downloads/Binder1.pdf [Accessed September 13, 2010].

Glasson, J., 2000. EIA in Brazil a procedures–practice gap. A comparative study with reference to the European Union, and especially the UK. *Environmental Impact Assessment Review*, 20(2), p.191-225.

Global Integrity, 2009. Global Integrity Report 2009. Available at: http://report.globalintegrity.org/globalindex/results.cfm [Accessed August 27, 2010].

Johnsson, 2010. Unpublished research document: Inventory of EIA legislation and problems in a set of countries that can be potentially large suppliers of biofuels to the EU.

Kenya Ministry of Agriculture, 1980. Exploratory Soil Map of Kenya. Appendix 1 to Report no. E1. Available at: http://eusoils.jrc.ec.europa.eu/esdb_archive/eudasm/africa/lists/cke.htm [Accessed June 2, 2010].

Lopez, G.P. & Laan, T., 2008. Biofuels – at what cost? Government support for biodiesel in Malaysia. Available at: www.iisd.org/pdf/2008/biofuels_subsidies_malaysia.pdf [Accessed September 13, 2010].

Malaysia Department of Agriculture, 1968. Soil Map of Sarawak.

Mccarthy, J. & Zen, Z., 2009. Regulating the Oil Palm Boom: Assessing the Effectiveness of Environmental Governance Approaches to Agro-industrial Pollution in Indonesia. *Law & Policy*. Available at: http://doi.wiley.com/10.1111/j.1467-9930.2009.00312.x.

Memon, A., 2003. Devolution of environmental regulation: EIA in Malaysia, in UNEP EIA Training Resource Manual: Case studies from developing countries. Available at: http://www.unep.ch/etu/publications/13%29%2045%20to%2061%20doc.pdf [Accessed September 13, 2010].

Mhango, S., 2005. The quality of environmental impact assessment in Malawi: a retrospective analysis. *Development Southern Africa*, 22(3), p.383-408.

Morgera, E., Kulovesi, K. & Gobena, A., 2009. *Case studies on bioenergy policy and law: options for sustainability*, Rome: Food and Agriculture Organization of the United Nations. Available at: http://www.fao.org/docrep/012/i1285e/i1285e00.pdf [Accessed September 13, 2010].

Mwebasa, R., Mwanlka, P. & Wonndemagegnehu, W., 2009. Environmental crimes in Ethiopia. Available at: www.issafrica.org/uploads/EnvironCrimesEthioJul08.pdf [Accessed September 13, 2010].

Nadeem, O. & Hameed, R., 2006. A critical review of the adequacy of EIA reports – Evidence from Pakistan. *World Academy of Science, Engineering and Technology*, 23, p.64-70.

Nadeem, O. & Hameed, R., 2008. Evaluation of environmental impact assessment system in Pakistan. *Environmental Impact Assessment Review*, 28(8), p.562-571.

Ogunba, O., 2004. EIA systems in Nigeria: evolution, current practice and shortcomings. *Environmental Impact Assessment Review*, 24(6), p.643-660.

Paliwal, R., 2006. EIA practice in India and its evaluation using SWOT analysis. *Environmental Impact Assessment Review*, 26(5), p.492-510.

Ruffeis, D. et al., 2010. Evaluation of the environmental policy and impact assessment process in Ethiopia. *Impact Assessment and Project Appraisal*, 28(1), p.29-40.

Sandham, L. & Pretorius, H., 2008. A review of EIA report quality in the North West province of South Africa. *Environmental Impact Assessment Review*, 28(4-5), p.229-240.

Sandström, J., 2011. Discussion about the ESHIA for the Addax Bioenergy project in Bombali district, Sierra Leone.

Spong, P.-J. & Walmsley, B., 2009. Handbook on Environmental Assessment Legislation in the SADC Region. Available at: http://www.saiea.com/dbsa_handbook_update09/dbsaFrameSet.html [Accessed September 13, 2010].

Surveys and Mapping Division of Tanzania, 1977. Provisional soils map of Tanzania. Available at: http://eusoils.jrc.ec.europa.eu/esdb_archive/EuDASM/Africa/lists/ctz.htm [Accessed May 28, 2010].

Tamrat, I., 2010. Governance of large scale agricultural investments in Africa: the case of Ethiopia, paper presented at the World Bank Conference on Land Policy and Administration. Available at: http://web.worldbank.org/WBSITE/EXTERNAL/TOPICS/EXTARD/0,,contentMDK:22537817~pagePK:148956~piPK:216618~theSitePK:336682,00.html.

The Economist, 2008. The Economist Intelligence Unit's Index of Democracy 2008. Available at: http://graphics.eiu.com/PDF/Democracy%20Index%202008.pdf [Accessed August 28, 2010].

The Philippines Department of Agriculture, 1975. General Soil Map of the Philippines. Available at: http://eusoils.jrc.ec.europa.eu/esdb_archive/EuDASM/Asia/lists/cph.htm [Accessed June 1, 2010].

Transparency International, 2009. Corruption Perception Index 2009. Available at: http://www.transparency.org/policy_research/surveys_indices/cpi/2009/cpi_2009_table [Accessed August 27, 2010].

USDA, 1985. National Cooperative Soil Survey Classification of 1967. Reviewed 1985.

USDA, 2005. Natural Resources Conservation Service (NRCS): Global Soil Regions Map. Available at: http://soils.usda.gov/use/worldsoils/mapindex/order.html [Accessed May 31, 2010].

Appendices to Chapter 4 (Environmental & social impacts)

Appendix I Country profiles: Land use patterns, production systems & local environmental impacts

In the following section several country profiles are presented, providing in detail information on land use patterns, production systems and local environmental impacts. In the first section the applied approach is set out.

I 1 Methodology

Each country profile includes a table summarising the following for the selected crops:

- Total harvested area
  In order to allow for high data consistency and comparability, FAOSTAT was the primary source of information for all countries. For Jatropha, which is not covered by FAOSTAT, data from GEXI (2008) was used.
- Cropland used for producing domestic biofuels
  Production data from Agra CEAS and Ecofys was used to determine the amounts of biofuels, which was domestically produced in 2008, for different crops in each country. The amounts of domestically produced crop-specific biofuels were recalculated to corresponding areas of cropland, using the following equation:

  Equation 1: Calculation of cropland area corresponding to domestic production of biofuels

$$\frac{\text{Crop specific biofuel production}}{\text{Overall conversion efficiency} * \text{Crop yields (national average)}},$$

$$\frac{t\ biofuels}{\frac{t\ biofuels}{t\ crop} * \frac{t\ crop}{ha}}$$

The reason for calculating with *overall* conversion efficiency and not conversion efficiency *with allocation*[79] was that the main focus of this study is on *actual* land-use. Therefore, actual areas used for cultivation of crops for biofuel production was desired. Using conversion efficiencies *with allocation* would, for most crops, result in smaller areas of land than what is actually used for producing the feedstock. This means that, for some crops, potential by-products may also be produced on the same areas as given by Equation 1.

- Cropland used for producing biofuels or –feedstock for biofuels on the EU market in 2008.
  Trade data from Agra CEAS and Carlo Hamelinck (Ecofys) was used to determine the amounts and origin of feedstock used to produce biofuels for the EU market in 2008. The amounts of specified feedstock originating from each country were recalculated to corresponding areas of cropland, using a similar methodology as described by Equation 1. Note that this concerns the "direct land use" which via a

[79] Allocation, when used, has been on the basis of RED allocation principles (i.e. using lower heating value)

mass balance of fuels and feedstocks connects between the EU biofuels consumption and the production of specific crops in specific countries. Further see Chapter 2 and Appendix C.

For countries producing biofuels or –feedstock for the EU market in 2008, more detailed agricultural land-use charts were constructed. These charts specify the total land-use in the respective countries for 2008, including:

1. Non-agricultural land
2. Pastures
3. Permanent crops
4. Annual crops

Crops used as feedstock for EU biofuels were described as a distinctive part of the total area under permanent- or annual crops. For each such crop, the following was specified:

5. Area used for domestic production of biofuels in 2008
6. Area used for domestic production of biofuels, which was traded to the EU in 2008
7. Area used for cultivation of feedstock, which was traded and processed (outside the country) into biofuels for the EU market in 2008
8. Area used for non-biofuel purposes

For "1-4" above, FAOSTAT data was used. "5-7" was calculated using a similar methodology as described by Equation 1. "8" was calculated by subtracting (5+6+7) from the total crop-specific harvested area, as defined by FAOSTAT.

- <u>Historical developments</u>
  In order to illustrate the developments between 1990 and 2008 with regard to cultivation of the selected crops, charts showing annual levels of production, harvested area and national average yields were constructed for each country. FAOSTAT data was used for the purpose of consistency and comparability. This provided the basis for understanding past land-use dynamics in each country.
  In order to further describe the findings from the charts (above), a review was made of relevant literature. In all cases, attempts have been made to spatially identify and describe potential expansion, as well as currently important regions for cultivation of the different crops.

- <u>Land-use dynamics from future production increases</u>
  In an attempt to describe the effects of potential production increases in a near future, various sources of information were used. For all countries, a review of relevant literature (e.g. journal articles and ILUC reports) was made. For some countries, suitability maps were found and used as a basis for understanding the risk of direct competition with other land-uses. Additional sources of information include local expert consultations, questionnaires and in-house experience.

- <u>Local environmental impacts and production system characteristics</u>

In many cases, biofuel related literature focuses on the effects from processing of feedstock into biofuels. Production of feedstock is often neglected, as if the supply of feedstock to biofuel plants is taken for granted. With rapid developments of large-scale biofuel projects, and corresponding land-use changes, the biofuel feedstock production phase, and the environmental issues related to it, needs more attention. Therefore, the focus of this assessment has been on assessing local environmental impacts from the feedstock production phase.

The types of environmental impacts from biofuel feedstock production will depend on the production models employed, the governance conditions in place and the biophysical properties of the environment. Hence, the production model is one important variable to determine the environmental impacts of biofuel production. Therefore, this task was extended to also include production system characteristics.

The information has been arranged on a country level. In the end of each country profile there is one table presenting production system characteristics and one presenting *documented* environmental impacts for the selected biofuel crops.

- Quantifying environmental impacts

  In order to quantify the environmental impacts attributable to (a) production of domestic biofuels and (b) EU demands for biofuels or biofuels feedstock, the share of the total crop-specific area that was used for (a) production of domestic biofuels and (b) production of feedstock used for production of EU biofuels, has been calculated for selected crops in all selected countries. Since crop cultivation for EU biofuels are regarded as having the same characteristics as crop cultivation for other purposes, local environmental impacts are also the same and the importance of (a) domestic biofuel production or (b) EU biofuel demands is proportional to the share of the total cropland that is used for (a) and (b) purposes, respectively. Since production of certain crop-biofuel combinations generates by-products that substitutes for other crop production, the net area requirement for those crops are lower than the actual area used for cultivation of feedstock for EU biofuels. For that reason, RED allocation principles have been used. Calculations have been made using FAOSTAT data for land-use and yields, and trade data developed for this project by Agra CEAS and Ecofys. Calculations were made using the same principle as described by Equation 1.

- Land-use patterns

  The extent to which crop production increases were obtained based on cropland expansion during 1990-2008 was determined by calculating (1) how large the total production would have been in 2008 if no yield increases had occurred, and (2) how large the total production would have been in 2008 if no expansion had occurred. The contribution of expansion as means of increasing production was then estimated by dividing (1) with the sum of (1) and (2). The same method was used for the period 2004-2008.

I 2 REGIONAL PROFILE - EUROPEAN UNION

This chapter describes local environmental impacts from cultivation of selected biofuel crops in the EU.

Selected biofuel crops include wheat, rapeseed and sugarbeet. As seen in Table 88, 1.4% of the total area under wheat cultivation and 8.6% of the total area under sugarbeet cultivation was used for producing ethanol fuel in 2008, while about half of the total area under rapeseed cultivation was used for producing biodiesel.

Table 88. Area used for production of EU's selected biofuel crops, including area used for domestic biofuel production

Crop	Total harvested area in 2008 (kha)	Cropland used for biofuel feedstock production in 2008	
		kha	% of total
Wheat	26,491	360	1.4%
Rapeseed	6,129	3,171	51.7%
Sugarbeet	1,531	131	8.6%

The conditions for agriculture differ a lot between different member states and the main conclusions presented are average estimations for the EU region.

Most biofuel crops in the EU are ordinary agricultural crops and the cultivation is more or less the same, regardless of whether the crop is grown for food or biofuel purposes. In this summary, sugarbeet, rapeseed and wheat have been selected as the main crops for biofuel purposes in the EU.

Compared to most other regions in the world, agriculture within the EU is intensive. This is certainly the case with the main crops described in this summary. The share of total cropland that is cultivated with sugarbeet, rapeseed and wheat is 1%, 6% and 24 % respectively. Yields for the selected crops compared to average EU yields are presented in Figure 113 and distribution of production between member states is illustrated in Figure 114. Note that not all countries presented in the two figures actually produce biofuels; the figures concern general agriculture.

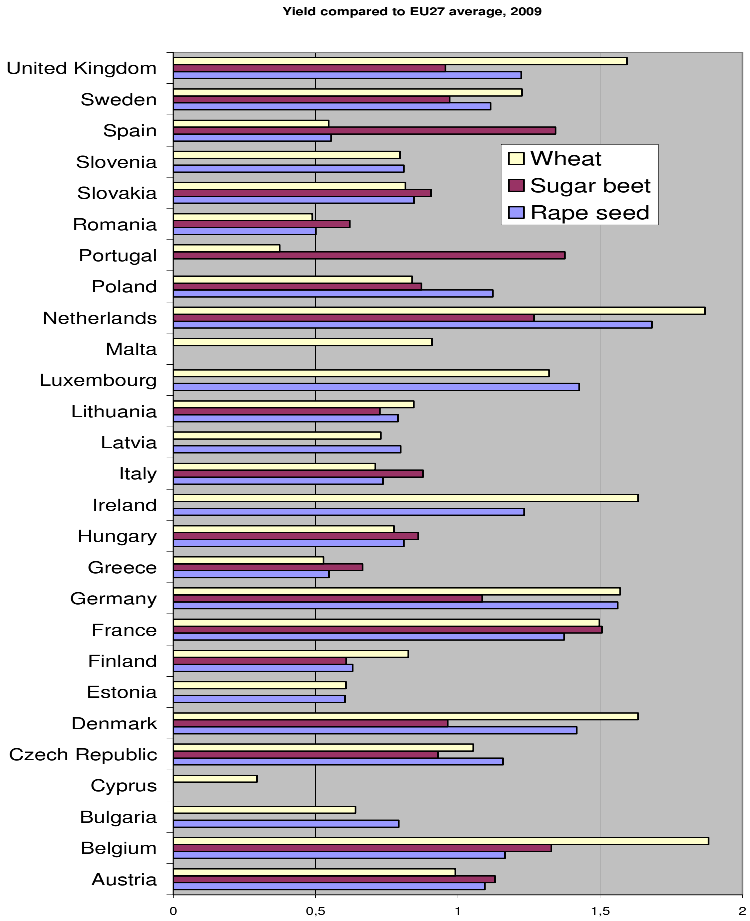


Figure 113. Yield compared to average yield (2009 set to 1). The difference can be explained by intensity differences and due to different natural given conditions as soil type and climate.

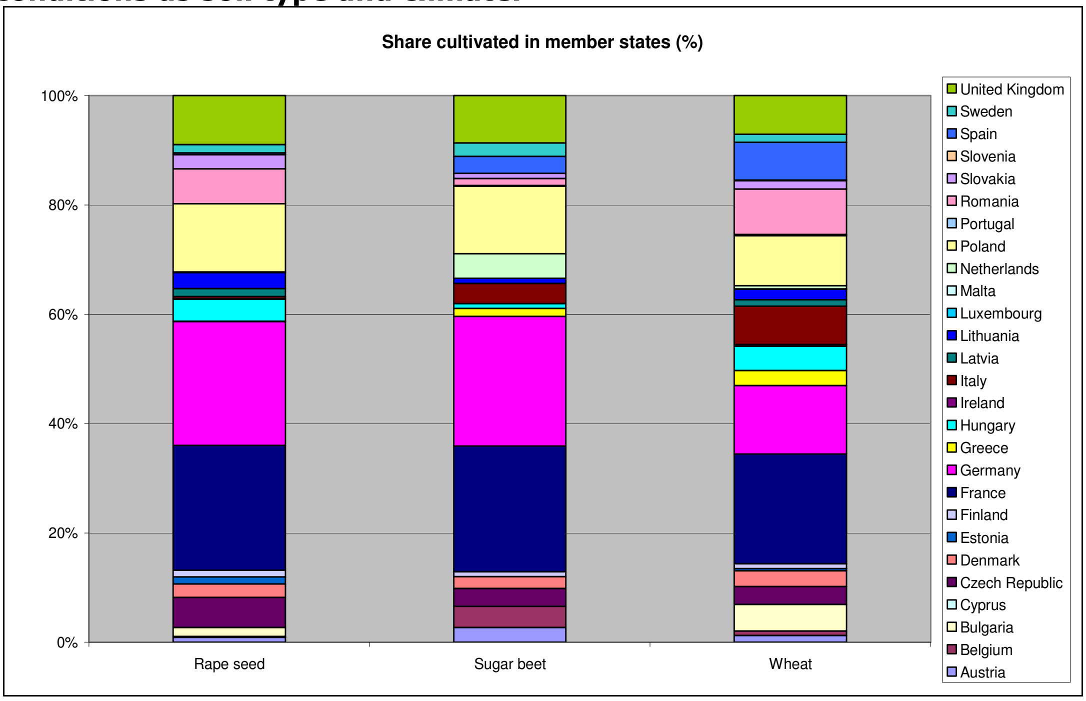


Figure 114. Distribution of rapeseed, sugarbeet and wheat between EU member states in 2009

Table 89 presents a grouping of member states based on the area under intensive cropping compared to total area under cultivation. It also shows how large share of the total EU area under cultivation that each group constitutes. Several of the new member states fall into the group with the lowest share of intensive agriculture.

Table 89. Grouping of member states based on the area under intensive cropping compared to total area under cultivation, and share of the total EU area under cultivation that each group constitutes

Member states	Est. share of national cultivated area under intensive cropping (%)	Share of total EU area under cultivation that each group constitutes (%)
Belgium, Czech rep, Denmark, Germany, the Netherlands, Finland, Sweden, UK	70	31
Greece, Spain, France Austria, Portugal, Ireland, Italy	50	45
Estonia, Hungary, Lithuania, Latvia, Poland, Slovenia, Slovakia	40	23

Production system characteristics and observed local environmental impacts

Production system characteristics for wheat, rapeseed and sugarbeet in the EU are summarised in Table 90.

Table 90. Production system characteristics for wheat, rapeseed and sugarbeet in the EU

System component	Wheat	Rapeseed	Sugarbeet
Large scale	Dominating	Dominating	Dominating
Small scale			
Mechanized farming system			
Manual farming system			
Tillage	Some parts non-tillage systems		Dominating
Reduced or no tillage	Some parts where soil conditions are suitable		
Irrigated			Parts of Southern Europe
Rain-fed			
Mono-cropping			
Multi-cropping			
Crop rotation	Rape seed the year before wheat is appropriate	Needed	Needed but not with maize or rapeseed
Mineral fertilizer used			
Chemical pesticides used	Dominating	Dominating	Dominating

GMO seeds *			
Land preparation with fire			
By-products (from harvesting)	Straw	Straw	Crop residues can be harvested

* Many EU-states are very restrictive regarding GMO-crops. No data found.

Observed local environmental impacts from wheat, rapeseed and sugarbeet production in the EU are summarised in Table 91.

Table 91. Observed local environmental impacts from wheat, rapeseed and sugarbeet production in the EU

Environmental impact	Wheat	Rapeseed	Sugarbeet
Deforestation			
Loss of agro-biodiversity			
Loss of biodiversity			
Air pollution			
Water pollution			
GMO contamination	*	*	*
Eutrophication			
Soil fertility decline	Not if proper soil management is practised	Not if proper soil management is practised	Not if proper soil management is practised
Erosion	No large scale	No large scale	No large scale

* many EU-states are very restrictive regarding GMO-crops. However, no information found.
Legend: Red = occurring; green = not occurring; white = occurrence unknown due to lack of information

In an approach to describe local impacts from cultivation of the main biofuel crops in a more detailed way, Table 92 shows a ranking of wheat, rapeseed and sugarbeet, based on the risk of them causing certain environmental pressures. To allow for comparisons, the same ranking for maize and “other cereals” is presented in Table 93. The tables are based on EEA studies.

Table 92. Ranking of wheat, rapeseed and sugarbeet based on the risk of them causing certain environmental pressures

Environmental pressure	Wheat		Rapeseed		Sugarbeet	
	Rank	Reason	Rank	Reason	Rank	Reason
Erosion	A	Winter wheat provide good soil cover	B	Row crop, but dense soil cover	C	Row crop, sown late, thus bare soil into late spring
Soil compaction	A	Intensive rooting system, harvest in dry weather	A	Deep end dense root system	C	Heavy machinery and harvested mass lead to soil compaction
Nutrient leaching	A	Higher fertiliser demand but good uptake	B/C	High demand, leaching risk depends on use of harvest residues	B/C	High fertiliser demand and soil erosion risk
Pesticide pollution to soils and water	B	Generally high number of pesticides treatments	C	Various pesticide treatments	B	Various pesticide treatments
Water abstraction	B	Highest water demand of all cereals	n/a	n/a	A/C	Often irrigated in southern Europe
Link to farmland biodiversity	B/C	Mostly high input use, dense crop	B/C	High pesticide use, some pollen offer but very dense crop	A/B	Often pesticide use, but can provide nesting habitat and shelter in autumn
Diversity of crop types	C	Most common cereal	A/B	Common	B	Common in intensive areas but not self tolerant

A=low risk, B= medium risk, C= high risk n/a=non applicable

Table 93. Ranking of maize and "other cereals" based on the risk of them causing certain environmental pressures

Environmental pressure	Maize		Other cereals	
	Rank	Reason	Rank	Reason
Erosion	C	Soil uncovered over long period, row crop	A	Winter cereals provide good soil cover
Soil compaction	B	Poorly developed root system, average machine use	A	Intensive rooting system, harvest in dry weather
Nutrient leaching	C	High demand and often highly fertilised	A	Moderate demand and good uptake
Pesticide pollution to soils and water	C	High pesticide use	A	Moderate number of pesticide treatments
Water abstraction	A/B	High water efficiency (C4) but often irrigated	A	Moderate water demands
Link to farmland biodiversity	C	High pesticide use, low weed diversity, some shelter in autumn	B	Medium use of inputs, can have open structure; nesting habitat when spring crop
Diversity of crop types	B/C	Is dominant crop in some regions; self tolerance	B	Very common

A=low risk, B= medium risk, C= high risk n/a=non applicable

Local environmental impacts allocated to EU biofuel demands

The share of the total wheat area that was harvested for EU biofuel production was 1.4% in 2008. However, the net area requirement is lower since wheat biofuel production generates by-products that substitutes for other crop production: using RED allocation principles the area allocated to biofuels corresponded to 0.8% of the total wheat area in 2008. Since wheat cultivation for EU biofuels has the same characteristics as wheat cultivation for other purposes, local environmental impacts are also the same and the importance of EU biofuel demand is proportional to the share of the total wheat area used for EU biofuel production (0.8%).

The share of the total rapeseed area that was harvested for EU biofuel production was 52% in 2008. However, the net area requirement is lower since rapeseed biofuel production generates by-products that substitutes for other crop production: using RED allocation principles the area allocated to biofuels corresponded to 30% of the total rapeseed area in 2008. Since rapeseed cultivation for EU biofuels has the same characteristics as rapeseed cultivation for other purposes, local environmental impacts are also the same and the importance of EU biofuel demand is proportional to the share of the total rapeseed area used for EU biofuel production (30%).

The share of the total sugarbeet area that was harvested for EU biofuel production was 8.6% in 2008. However, the net area requirement is lower since sugarbeet biofuel production generates by-products that substitutes for other crop production: using RED allocation principles the area allocated to biofuels corresponded to 6.1% of the total sugarbeet area in 2008. Since sugarbeet cultivation for EU biofuels has the same characteristics as sugarbeet cultivation for other purposes, local environmental impacts are also the same and the importance of EU biofuel demand is proportional to the share of the total sugarbeet area used for EU biofuel production (6.1%).

I 3 Brazil

Selected biofuel crops for Brazil include sugarcane, soybean and oil palm. As seen in Table 94, more than half of the total area under sugarcane cultivation in 2008 was used for domestic ethanol production but only a small share ended up on the EU market. About 10% of the soybean area in 2008 was used for biodiesel production, although co-products such as animal feed are likely to be produced along with the biodiesel and this reduces the land requirements for producing animal feed elsewhere (not necessarily close though). About 4% of the total soybean area was used for producing soybean as feedstock for biodiesel production targeting the EU market during the same year (mostly Brazilian-produced biodiesel was exported but also some soybean was exported as feedstock for domestic biodiesel production in EU). No data on domestic biodiesel from oil palm in 2008 has been found, although small amounts of palm oil as feedstock for EU biofuels have been traced to Brazil.

Table 94. Area used for production of Brazil's selected biofuel crops, including areas used for domestic biofuel production and feedstock for biofuels on the EU market in 2008

Crop	Total harvested area in 2008 (kha)	Cropland used for domestic biofuel production in 2008		Cropland used for production of feedstock for EU biofuels in 2008	
		kha	% of total	kha	% of total
Sugarcane	8,140	4,266	52.4%	91	1.1%
Soybean	21,057	2,090	9.9%	782	3.7%
Oil palm	66	No data	No data	0.2	0.3%

Source: FAOSTAT (land data); Agra CEAS and Ecofys (biofuel production and trade data).

Sugarcane

As seen in Figure 115, pastures constitute the largest share of Brazil's total agricultural area and permanent crops are uncommon in relation to annual crops, which are dominating the cultivated land. Sugarcane cultivation constitutes more than 13% of the total land under annual/semi-annual crops making it an important crop in Brazil's agriculture, particularly in the state of Sao Paolo. Ethanol production is a main application for sugarcane, although not for the EU market.

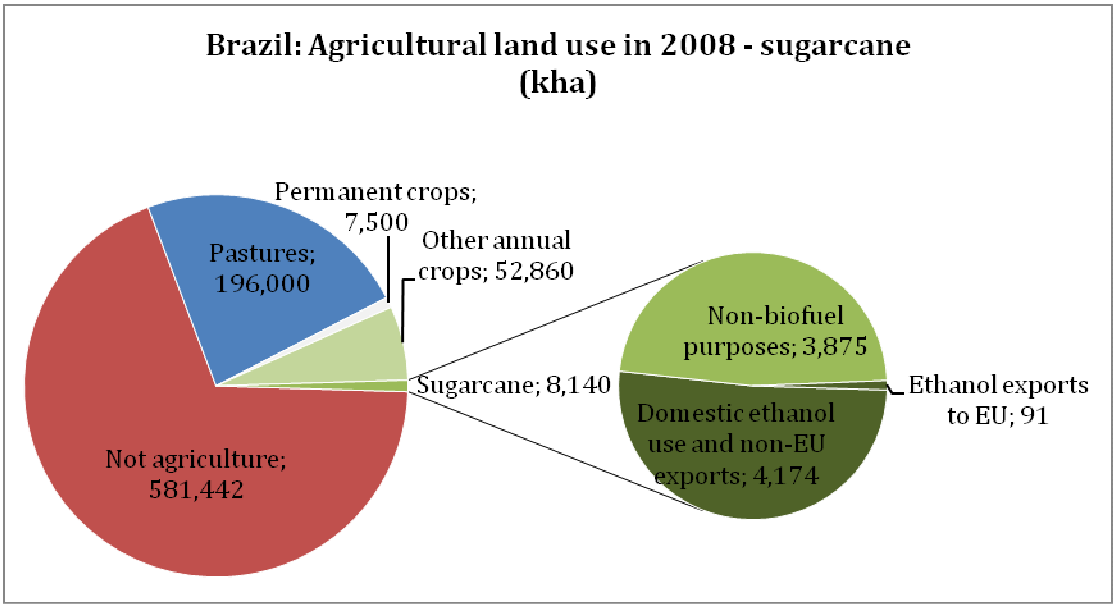


Figure 115. Agricultural land use in Brazil in 2008, focused on sugarcane production

Historical developments

There has been a steady increase in the area dedicated to Sugarcane production. During the period 2002-2009, the sugarcane area in the State of São Paulo increased from 2.7 to almost 5 million ha (SPIEA 2010a). There is also expansion outside this state. The Midwest region is a new area of expansion for sugarcane cultivation, especially the State of Goiás, which experienced a 345% increase in the sugarcane production between the 1998/99 and 2008/09 harvests to contribute about 5% of the national production. The eastern part of Mato Grosso do Sul and the southeast of Minas Gerais – also in the Cerrado area – follow this trend of sugarcane expansion to new areas (UNICA 2011).

In 2008/09, about 564 million ton of sugarcane was harvested on 7.115 million ha of land, and about 60% of the sugarcane was used to produce ethanol. The north and northeast contributed about 10 % of total production; the remaining came from the central-southern part of Brazil, with about 60% from the State of São Paulo (IBGE 2009a). Sugarcane is the dominating crop in this state where it occupies an area almost twice as large as the aggregated area of the next five largest crops (IBGE 2009b).

About 27.2 billion liters of ethanol was produced in 2008. About 17% (4.6 billion liters) was exported and about 13% of the total ethanol exports (0.6 billion liters) were going to EU countries.

Recent decades' sugarcane expansion appears not to have contributed much to direct deforestation in the traditional agricultural region where most of the expansion took place (Sparovek et al. 2009). The amount of forests on farmland in this area is below the minimum stated in law and the situation did not change over the studied period. Sugarcane expansion resulted in a significant reduction of pastures and cattle heads. Modelling studies have illustrated how CO_2 emissions from direct and indirect land-use change associated with expansion of sugarcane can significantly reduce the GHG savings from displacing gasoline with sugarcane ethanol (see e.g. Fargione et al. 2008; Gibbs et al. 2008; Lapola et al. 2010). However, it has not been possible to quantify such emission with high confidence due to lack of empirical data and limited knowledge about underlying processes, especially when it comes to indirect emissions. Even so, results indicate that a possible migration of cattle production, caused by sugarcane expansion on pastures, reached further than to the municipalities surrounding the municipalities that experienced significant expansion of sugarcane (Sparovek et al. 2009).

Occurring at much smaller rates, expansion of sugarcane in regions such as the Amazon and the Northeast region was related to direct deforestation and competition with food crops (Sparovek et al. 2009). These regions are not expected to experience substantial increases of sugarcane in the near future, but mitigating measures are warranted.

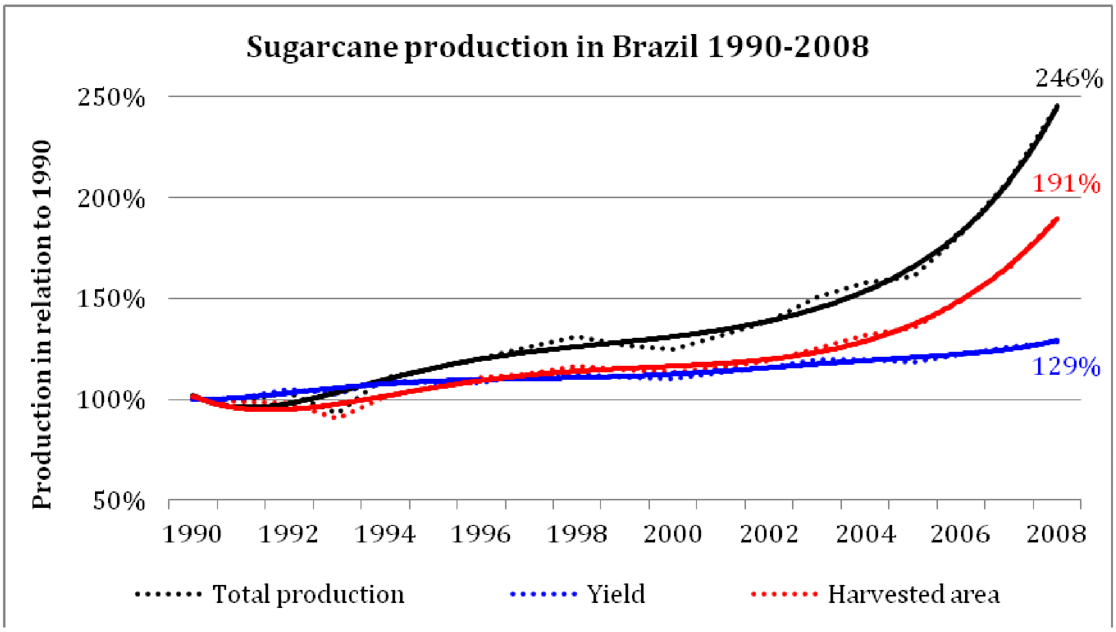


Figure 116. Change in sugarcane production, yields and harvested area in Brazil, 1990-2008

Land-use dynamics from future production increases

It has been projected that the sugarcane area will increase further and both increasing domestic demand and increasing import demand are expected to drive this projected increase. Presently (2011) the Brazilian ethanol exports to EU is down to a low level and to a large extent displaced by subsidised corn ethanol that has become in surplus in the U.S due to the 2008 financial crisis. The financial crisis in 2008 also caught the Brazilian sugarcane sector with a high debt situation due to the high investments in the construction of new mills and expansion of the existing ones. The mills could not find money to run the plants during the crushing season and had to sell the stocks of ethanol and sugar at very low prices, making things even worse. Due to the shortage of money the mills had to reduce the fertilizer and herbicide applications as well as the renewal of older cane fields, which will lead to lower yields for two or three subsequent crops.

Investors from outside the sector and those in better financial shape reduced the speed of construction of new mills and waited to see if they could get a better deal buying plants from groups in financial trouble. This also reduced the speed of construction of greenfield facilities.

Contributing to that Brazilian ethanol exports are presently low, a government policy – intended to help the auto industry overcome the crisis in good shape – to facilitate credit to the car buyers has resulted in a large growth of the flex-fuel vehicle (FFV) fleet during the past two years. This has in turn resulted in rapidly increasing domestic ethanol demand since around 70% of FFVs run on ethanol (this percentage varies depending on the relative prices of ethanol/gasoline). Recent years' weather has also played a role. Too much rain in the second half of 2009 reduced the cane sugar content and shortened the harvesting period; less cane was crushed and this cane contained less sugar than usual. 2010 was drier than the average and that has reduced the expectation of cane yields for the 2011 season. The international sugar prices have also been very high, mainly due to bad cane performance in India.

Nevertheless, the longer-term trend is towards increasing ethanol production and reduced production costs of sugarcane ethanol. The land use consequences of future expansion will depend on several factors, including: (i) the recent revision of the Forest Act[80], which is the most important legal framework for regulating conservation and restoration on private land; (ii) development of international mechanisms such as REDD and various certification schemes, sustainability standards and other systems influencing land use; and (iii) whether Brazil become successful in developing alternative expansion strategies for its agriculture, where especially important is to stimulate productivity improvements in meat/diary production to make room for cropland expansion that does not require the conversion of forests and other natural ecosystems.

The Brazilian sugarcane agro-ecological zoning (ZAE-Cana project) that was recently established to guide the sugarcane expansion – includes several components:

- The identification of areas without any environmental constraints that are already degraded or under human use that have potential for sugarcane cultivation.
- The exclusion of the biomes of Amazon, Pantanal and Upper Paraguay River Basin for sugarcane expansion.
- The indication of degraded land or pasture areas as preferable areas for sugarcane expansion, minimizing any competition with food production.

[80] In May 2011 the revised Forest Act (or Forest Code) has passed the Brazilian parliament. The revision includes for example a reduction in the area to be reserved for forest on large areas. Furthermore amnesty for all cuttings before 2008 is another much debated aspect of the recent revision.

Specific areas were also excluded from the agro-ecological zoning for sugarcane: protected areas, indigenous reserves and areas with high conservation value for biodiversity.

It remains to see whether the agro-ecological zoning approach become successful in mitigating negative outcomes of the future sugarcane expansion. The version of the zoning approach that was approved by the government (Decreto 6961/09, which is not a law) does not include any kind of clear prohibition of sugarcane expansion. The zoning report was approved as a general guideline that could be considered in future public credit concessions. Assessments of the compliance of Brazilian agriculture with the existing legislation show a large deficit in protection of natural vegetation on private farmland (Sparovek et al. 2010).

Soybean

As already described, pastures constitute the largest share of Brazil's total agricultural area and permanent crops are uncommon in relation to annual crops, which are dominating the cultivated land. Soybean cultivation constituted about 35% of the total land under annual crops in 2008, making it a very important crop in Brazil's agriculture. As seen in Figure 117, biodiesel production is a rather important application for soybean, although no biodiesel was traded to the EU in 2008. However, significant amounts of land can be associated with exports of feedstock for EU biofuels. As already noted, co-products such as animal feed are likely to be produced together with the biodiesel.

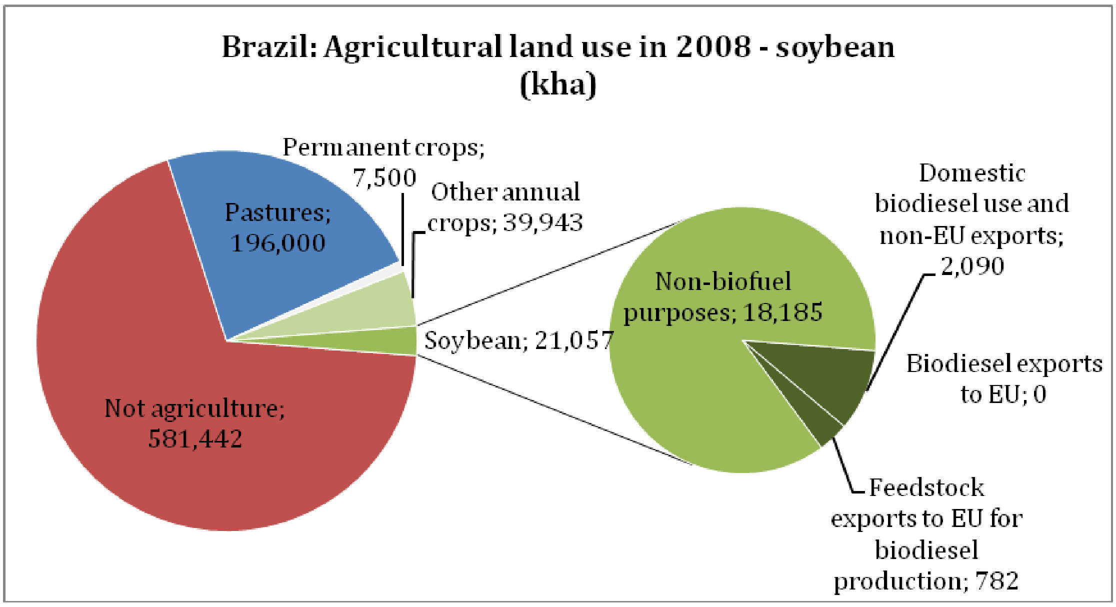


Figure 117. Agricultural land use in Brazil in 2008, focused on soybean production

Historical developments

Soybean plantations occupy some 35% of Brazil's cultivated land and it is the most important crop in terms of harvested area (FAOstat 2011). Agronomic advances have made it possible to cultivate the soils in the Cerrado biome and this has –

together with infrastructure development efforts – contributed to that a significant part of the Cerrado is now converted into agriculture land. Increasing soy demand has been one important driver behind this expansion.

The cultivation of soy as biofuel feedstock has increased as a consequence of national biodiesel programs. This program has a significant social component but also environment and fuel security considerations provide rationale for the program. There is a debate over the extent to which deforestation is a result of the soy expansion (e.g., Fearnside 2005). Some studies report that soy can be a significant cause of deforestation (Morton *et al* 2006), but it appears that recent evidence point to that deforestation is primarily driven by the expansion of cattle ranching, and that soybean is expanding into land previously under pasture, causing little new deforestation (Mueller 2003, Brandao *et al* 2005, Brown *et al* 2005, Greenpeace-Brazil 2009). However, there are indications that there can exist in some places an indirect link between soybean expansion and deforestation; in the State of Mato Grosso, an increase in soybeans occurred in regions previously used for pasture, which may have displaced pastures further north into the forested areas, causing indirect deforestation there (Barona et al. 2010).

As in Argentina and USA (the other two major soy producers) GM soybean cultivation dominates and – as in Argentina – mostly no-till cultivation is employed. The problems associated glyphosate-resistant weed species associated with glyphosate-tolerant soybeans will likely lead to increased occurrence of multi-herbicide-tolerant GM soybeans and increased use of older, less environmentally friendly herbicides (Meyer & Cederberg 2010).

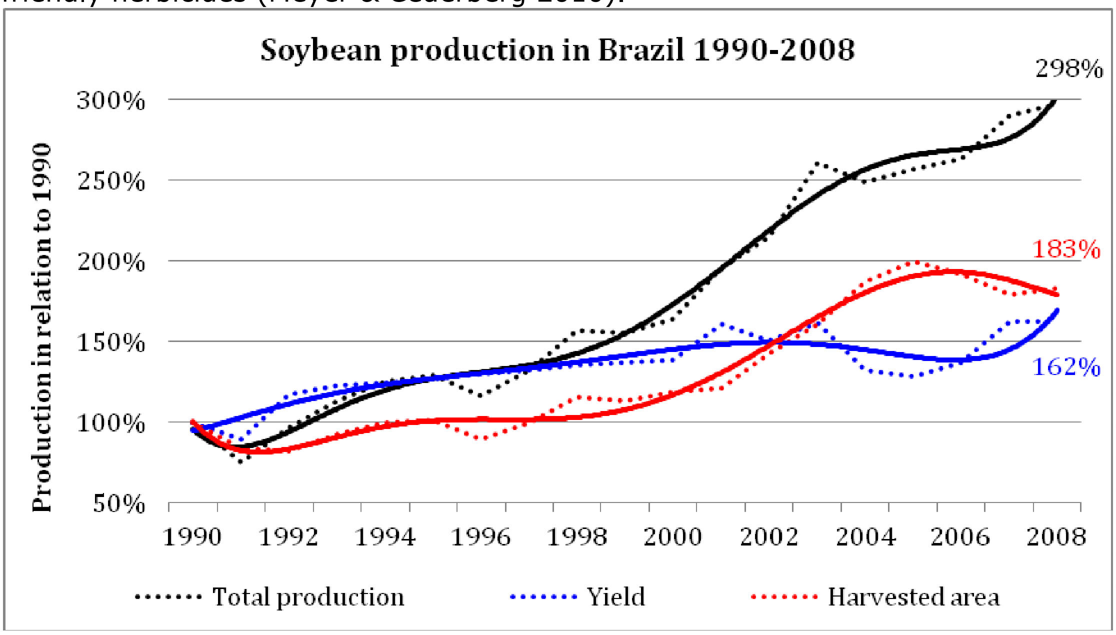


Figure 118. Change in soybean production, yields and harvested area in Brazil, 1990-2008

Land-use dynamics from future production increases

As for sugarcane, future expansion of soy will depend on (i) the recent revision of the Forest Act; (ii) development of international mechanisms such as REDD and various certification schemes and sustainability standards; and (iii) the productivity development in agriculture (notably cattle production) since this determines the agriculture expansion pressure at a given level of demand growth.

More research is needed to improve the understanding of the indirect effects of possible future soybean expansion. Besides that soybean expansion on pastures can induce pasture expansion elsewhere, there may exist other indirect links. For example, Fearnside (2005) suggests that soybean establishment induce infrastructure improvements, which in turn stimulates crop expansion. Nepstad *et al* (2006) report that growth of the soy industry has driven up land prices in the Amazon, allowing cattle ranchers to sell their land at high capital gains and purchase new land further north where pasture expansion leads to deforestation.

Oil Palm

Historical developments

Brazil currently has about 70,000 hectares of oil palm plantations, i.e., a relatively small area compared to other agricultural crops. Brazil is producing both for the domestic and international markets. Most of Brazil's oil palm plantations are located in the state of Para, out of which the company Agropalma accounts for 80%. Deforestation occurred in the 1980's, in the initial phase of establishing Agropalma's oil palm plantations. Currently it is mandatory for new plantations to be limited to grasslands and other degraded land, or the company will loose its environmental permit.

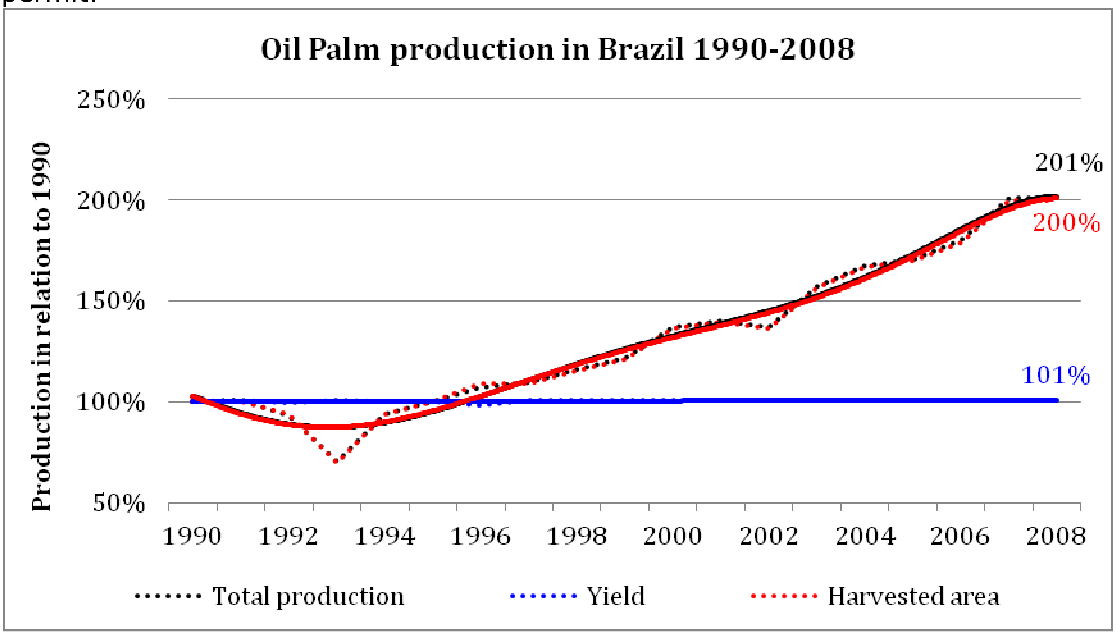


Figure 119: Change in oil palm production, yields and harvested area in Brazil, 1990-2008

Land-use dynamics from future production increases

Oil palm is expected to increase substantially in Brazil. In the long run, the aim is to reach one million hectares of oil palm. Brazil is producing both for the domestic and international markets. In 2008, Brazil signed a deal with Malaysia's Land Development Authority FELDA to establish 100,000 hectares (250,000 acres) of oil palm plantations on forestland in the state of Amazonas.

In May 2010, the Brazilian government launched The Program for the Sustainable Production of Palm Oil, which is designed to stimulate utilization of degraded lands and prohibit the expansion of production in forest areas. A component of the program is the proposed bill outlining new agro-ecological zoning rules for palm oil, coordinated by the Brazilian Agricultural Research Corporation (Embrapa). According to these zoning rules, the cultivation of palm oil will be restricted to land that is already occupied by humans, with an emphasis on degraded or low productivity areas. Removal of native vegetation for palm production is strictly forbidden. It is also forbidden to use protected areas such as national parks, indigenous areas and conservation units. Given these restrictions, the total area suitable for the production of palm oil amounts to about 31.8 million hectares.

There is concern that the plan for large-scale oil palm plantations on degraded land in Amazonas will effectively reduce the amount of forest/trees that landowners are required to keep on their property from 80% coverage to 50% (see also the separate section on the Brazilian Forest Act).

Production system characteristics and local environmental impacts

Production system characteristics for sugarcane, soybean and oil palm in Brazil are summarised in Table 95.

Table 95. Production system characteristics for sugarcane, soybean and oil palm in Brazil

System component	Sugarcane	Soybean	Oil Palm
Large scale	73%	Dominating production system	Dominant
Small scale	27% (less than 150 ha)	15-20% of production, partly mechanised partly manual production systems	3-4 %, "Social Fuel Seal" provides tax incentives to involve smallholders
Mechanized farming system			Land preparation
Manual farming system	Planting, agrochemical application or harvesting can be manual		Harvesting
Tillage	Dominant	50%	
Reduced and no tillage	Increasingly used	50%	Perennial crop
Irrigated	Very limited scale	Very limited scale	
Rain fed			
Mono-cropping			Dominant
Multi-cropping			(e.g. with maize and cassawa)
Crop rotation	Horticulture crops, legume crops and cereals may be grown between the sugarcane cycles of 5-8 years	E.g. corn, millet, sorghum, or cotton	Perennial crop
Mineral fertilizer used		Soybean is a nitrogen fixer. Therefore, no or little nitrogen is needed to add	
Chemical pesticides used		Particularly herbicides	
GMO seeds for sowing	Varieties under development, planned to be available commercially 2015		
Land preparation with fire	Pre-harvest burning when manual harvest is employed		
By-products (from harvesting)	Tops and leaves from mechanical harvesting are left on the field		

Legend: Blue = occurring; orange = not occurring; white = occurrence unknown due to lack of information

Sources: (Dros, 2004; FAO, 2010; Flaskerud, 2003; Goldemberg et al., 2008; Martinelli and Filoso, 2008; Ortega et al., 2004; Proforest, 2010; Vermeulen, 2006)

Observed local environmental impacts from sugarcane, soybean and oil palm production in Brazil are summarised in Table 96.

Table 96. Observed local environmental impacts from sugarcane, soybean and oil palm production in Brazil

Environmental impact	Sugarcane	Soybean	Oil Palm
Deforestation			
Loss of agro-biodiversity			
Loss of biodiversity			
Air pollution			
Water pollution			
GMO contamination			
Eutrophication			
Soil fertility decline			
Erosion		Especially when conventional tillage is practiced	

Legend: Red = occurring; green = not occurring; white = occurrence unknown due to lack of information
Sources: (Dros, 2004; FAO, 2010; Flaskerud, 2003; Goldemberg et al., 2008; Martinelli and Filoso, 2008; Ortega et al., 2004; Proforest, 2010; Vermeulen, 2006)

Local environmental impacts allocated to domestic biofuel production

The share of the total sugarcane area that was harvested for domestic biofuel production was 52.4% in 2008. Since sugarcane cultivation for domestic biofuels has the same characteristics as sugarcane cultivation for other purposes, local environmental impacts are also the same and the importance of domestic biofuel production is proportional to the share of the total sugarcane area used for production of domestic biofuels (52.4%). It should be noted that sugarcane for production of domestic biofuels in 2008 was cultivated on 4266 kha, which is a significant amount of land.

The share of the total soybean area that was harvested for domestic biofuel production was 9.9% in 2008. However, the net area requirement is lower since soybean biofuel production generates by-products that substitutes for other crop production: using RED allocation principles the area allocated to biofuels corresponded to 3.3% of the total soybean area in 2008. Since soybean cultivation for domestic biofuels has the same characteristics as soybean cultivation for other purposes, local environmental impacts are also the same and the importance of domestic biofuel production is proportional to the share of the total soybean area used for production of domestic biofuels (3.3%). It should be noted that soybeans for production of domestic biofuels in 2008 was cultivated on 1445 kha, which is a significant amount of land. It should be noted that soybean for production of domestic biofuels in 2008 was cultivated on 2090 kha, which is a significant amount of land.

Since no production of domestic biofuels from oil palm has been identified for 2008; no local environmental impacts from cultivation of oil palm can be allocated to domestic biofuel production in Brazil.

Local environmental impacts allocated to EU biofuel demands

The share of the total sugarcane area that was harvested for EU biofuel production was 1.1% in 2008. Since sugarcane cultivation for EU biofuel production has the same characteristics as sugarcane cultivation for other purposes, local environmental impacts are also the same and the importance of EU biofuel demand is proportional to the share of the total sugarcane area used for EU biofuel production (1.1%).

The share of the total soybean area that was harvested for EU biofuel production was 3.7% in 2008. However, the net area requirement is lower since soybean biofuel production generates by-products that substitutes for other crop production: using RED allocation principles the area allocated to biofuels corresponded to 1.2% of the total soybean area in 2008. Since soybean cultivation for EU biofuels has the same characteristics as soybean cultivation for other purposes, local environmental impacts are also the same and the importance of EU biofuel demand is proportional to the share of the total soybean area used for EU biofuel production (1.2%). It should be noted that soybeans used for EU biofuel production in 2008 was cultivated on 1137 kha, which is a significant amount of land.

Since only very small fractions (0.3%) of the total oil palm area in Brazil was used for production of feedstock for EU biofuels in 2008; no local environmental impacts from cultivation of oil palm in Brazil can be allocated to EU biofuel demands.

References

Barona, E., Ramankutty, N., Hyman, G. and Coomes, O., 2010. The role of pasture and soybean in deforestation of the Brazilian Amazon. *Environmental Research Letters*, 5(2), pp.024002

Brandao, A., Castro de Rezende, G. and Da Costa Marques, R., 2005. *Agricultural Growth in the Period 1999–2004, Outburst in Soybeans Area and Environmental Impacts in Brazil*. IPEA Discussion Paper No. 1062. Available at: http://ssrn.com/abstract=660442 Accessed on May 30, 2011.

Brown, J., Jepson W. and Price, K., 2004. Expansion of mechanized agriculture and land-cover change in Southern Rondônia, Brazil. *Journal of Latin American Geography*, 3(1), pp.96–102.

FAOstat, 2011. Available at http://faostat.fao.org/ Accessed on May 14, 2011.

Fearnside, P.M., 2005. Deforestation in Brazilian Amazonia: history, rates and consequences. *Conservation Biology*, 19(3), pp.680-688.

Fargione, J., Hill, J., Tilman, D., Polasky, S. and Hawthorne, P., 2008. Land clearing and the biofuel carbon debt. *Science*, 319(5867), pp.1235–1238.

Gibbs, H.K., Johnston, M., Foley, J., Holloway, T., Monfreda, C., Ramankutty, N. and Zaks, D., 2008. Carbon payback times for crop-based biofuel expansion in the tropics: The effects of changing yield and technology. *Environmental Research Letters*, 3(3):034001

Greenpeace-Brazil, 2009. *Amazon Cattle Footprint. Mato Grosso: State of Destruction*. Available at www.greenpeace.org/international/press/reports/amazon-cattle-footprint-mato Accessed on May 30, 2011.

IBGE, 2009a. *Municipal Agricultural Production – 2008*. Available at: http://www.ibge.gov.br/english/presidencia/noticias/noticia_impressao.php?id_noticia=1479 Accessed on September 30, 2010.

IBGE, 2009b. Available at: http://www.sidra.ibge.gov.br Accessed on April 11, 2011.

Lapola, D.M., Schaldach, R., Alcamo, J., Bondeau, A., Koch, J., Koelking, C. and Priess, J.A., 2010. Indirect land-use changes can overcome carbon savings from biofuels in Brazil. *Proceedings of the National Academy of Sciences of the USA*, 107(8), pp.3388-3393.

Meyer, D. and Cederberg, C. (2010) Pesticide use and glyphosate- resistant weeds – a case study of Brazilian soybean production. SIK report 809, 2010

Morton, D., DeFries, R., Shimabukuro, Y., Anderson, L., Arai, E., Espiritu-Santo, F., Freitas, R. and Morisette J., 2006. Cropland expansion changes deforestation dynamics in the southern Brazilian Amazon. *Proc. Natl Acad. Sci. USA*, 103(39), pp.14637–14641.

Mueller, C., 2003. *Expansion and Modernization of Agriculture in the Cerrado – The Case of Soybeans in Brazil's Center-West*. Available at: http://e-groups.unb.br/face/eco/cpe/TD/306nov2003CMueller.pdf Accessed on May 30, 2011.

Nepstad, D., Stickler, C. and Almeida O., 2006. Globalization of the Amazon soy and beef industries: opportunities for conservation. *Conservation Biology*, 20(6) pp.1595–1603.

Sparovek, G., Barretto, A., Berndes, G., Martins, S. and Maule, R., 2009. Environmental, land-use and economic implications of Brazilian sugarcane expansion 1996–2006. *Mitigation and Adaptation Strategies for Global Change,* 14(3), pp.285–298.

Sparovek, G., Berndes, G., Klug, I. and Barretto, A., 2010. Brazilian agriculture and environmental legislation: status and future challenges. *Environmental Science and Technology*, 44(16), pp.6046–6053.

SPIEA, 2010a. Available at: http://www.iea.sp.gov.br/out/banco/menu.php Accessed on September 2, 2010.

SPIEA, 2010b. Available at: http://www.iea.sp.gov.br/out/verTexto.php?codTexto=7448 Accessed on September 2, 2010.

UNICA, 2011. Available at: http://english.unica.com.br/dadosCotacao/estatistica/ Accessed on April 12, 2011.

Personal communication on future outlook:

Manoel Regis Lima Verde Leal, CTBE - Bioethanol Technology Center, Arnaldo Walter, Faculdade de Engenharia Mecanica – UNICAMP, Campinas University, Brazil

I 4 Argentina

Soybean is the selected biofuel crop for Argentina. As seen in Table 97, about 9% of the total area under soybean cultivation in 2008 was used for domestic biodiesel production and 3.3% of the total area was used for production of biofuel feedstock for the EU market. It should be noted that co-products are produced along with the biodiesel, including a protein-rich press cake that is suitable for animal feeding. This reduces the land requirements for producing animal feed elsewhere (not necessarily in the same area though).

Table 97. Area used for production of Argentina's selected biofuel crops, including areas used for domestic biofuel production and feedstock for biofuels on the EU market in 2008

Crop	Total harvested area in 2008 (kha)	Cropland used for domestic biofuel production in 2008		Cropland used for production of feedstock for EU biofuels in 2008	
		kha	% of total	kha	% of total
Soybean	16,387	1,445	8.8%	542	3.3%

Source: FAOSTAT (land data); Agra CEAS and Ecofys (biofuel production and trade data).

Argentina is the 2nd largest country in Latin America (after Brazil) and agriculture land covers about half of the land area (about 274 Mha in total). Roughly one-quarter of agriculture land is arable land and the rest is pastureland. The arid region in Argentina – most of Patagonia to the south of Rio Colorado – has relatively little agricultural activity. Most of Argentina's agricultural production takes place on the fertile plains in the central and northeast parts of the country (the Argentine part of the Pampas).

In the last 1-2 decades, agriculture in Argentina has undergone substantial changes with very large increases in grain and soybean production as well as exports of cereals and oil seeds. There have also been increases in poultry and beef production and exports. As in many countries, increasing the agriculture output was achieved though both agriculture expansion on natural lands and intensification to increase yields, with negative consequences of high fertilizer and other chemical input. But there has been a development towards lower risks of pollution and soil erosion due to adoption of less aggressive pesticides and no-till practices (Viglizzo et al. 2010). Important crops in Argentina are sunflower, maize, wheat and soybean. Agriculture products make up a very substantial part of Argentina's export revenues.

Soybean

As seen in Figure 120, pastures constitute the largest share of the total agricultural land in Argentina. Permanent crops are uncommon, making cultivated land dominated by annual crops in general and soybean in particular. Soybean cultivation in 2008 constituted more than 50% of the total area under annual crops, making it the most important crop in Argentina's agriculture. Biodiesel production is a rather important application for soybean, and a significant share of the total production was exported to the EU in 2008. In addition, an almost equal amount of land as can be associated with the production of biodiesel for the EU market was used for production of exported feedstock for EU biodiesel. As already noted, co-products such as animal feed are likely to be produced together with the biodiesel.

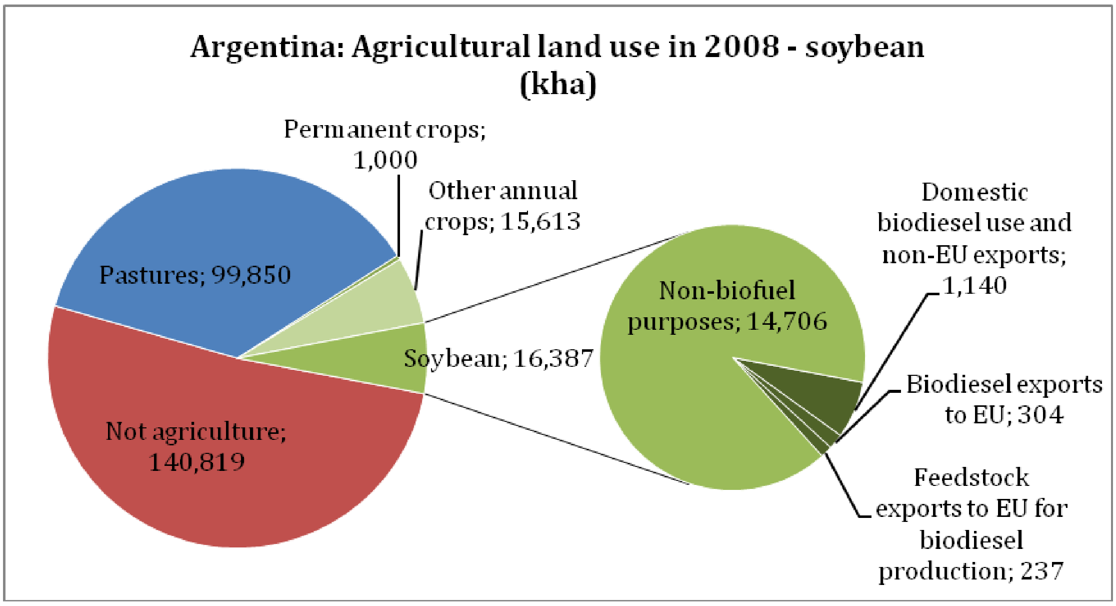


Figure 120. Agricultural land use in Argentina in 2008, focused on soybean production

Soy is the most important crop cultivated in Argentina and accounts for more than 50% of the area cultivated with grains in 2008 (Panichelli et al., 2009). Traditionally, soybean has mainly been produced in the Pampas region, including the provinces of Buenos Aires, La Pampa, Santa Fe, Entre Ríos and Córdoba. Until late 90:s rice and cotton destined for the Brazilian market were important crops in northern agriculture regions but due to reduced profitability rice and cotton areas have been replaced with soybean. USA, Brazil and Argentina together contribute to almost 80% of world soybean production and dominate the world exports of soybeans and soymeal.

Soybean is also considered to be among the most promising crops in Argentina for biofuel production (Mathews and Goldsztein 2008).

Historical developments

There has been a rapid growth in soybean production in Argentina (see the figure below). Direct seeding and no-till cropping systems have become the dominant production system (see Table 1 below). Farmers consider no-till cultivation as beneficial since it makes it possible to cultivate lower quality soils and generally results in improved yield stability. It also improves water use efficiency (lower soil evaporation and improved water infiltration capacity), reduces the erosion risk, and increases the soil C content (or slows soil C losses when croplands are established on land with high soil C content.

There has also been a very rapid increase in the use of GM soybean and Argentina today produces almost exclusively GM soybeans. In 2009, 91%, 99% and 71% of total soybean acreage were grown with GM glyphosate-tolerant cultivars in USA, Argentina, and Brazil, respectively (Meyer and Cederberg 2010). The high adoption rate was due to the easier and cheaper weed control enabling earlier seeding and no-tillage. However, glyphosate-resistant weed species associated with glyphosate-tolerant soybeans has become a concern. Reports indicate 30 000 infested sites on up to around 4.6 Mha in USA in 2010.The development in Brazil and Argentina is less analysed than in USA (see Section "Observed local environmental impacts" below).

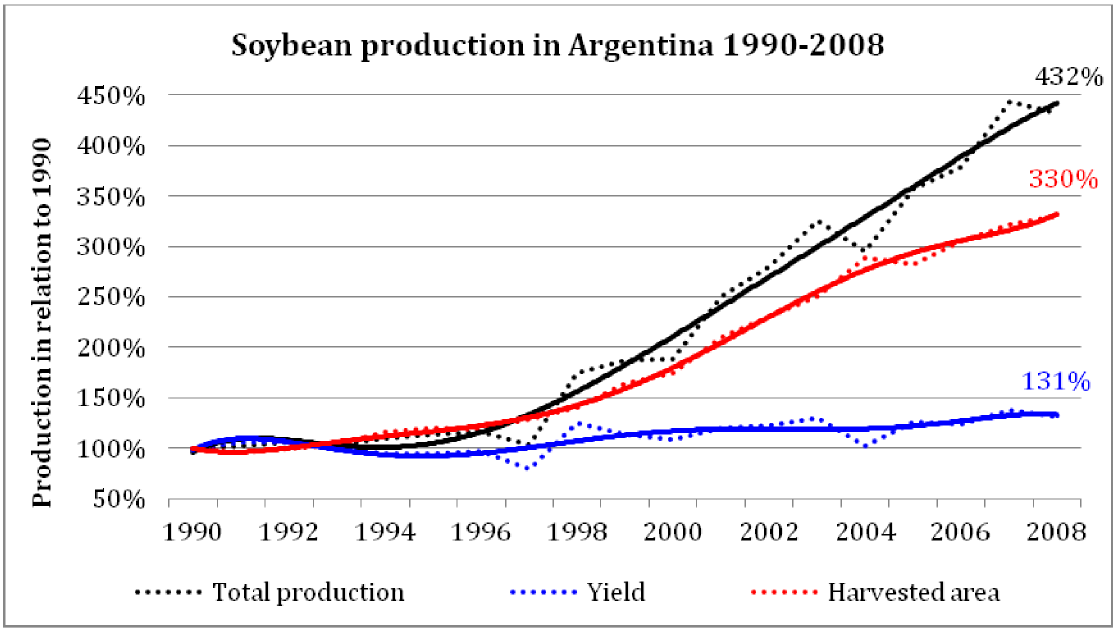


Figure 121. Change in soybean production, yields and harvested area in Argentina, 1990-2008

Land-use dynamics from future production increases

As noted, soy is traditionally cultivated in the Pampas region. Recent years, soybean production has been extended to less fertile areas in the northeast and -west of Argentina (Berkum *et al.* 2006) driving livestock production into less fertile lands (Dobson W.D. 2003). The transition from a traditional crop-livestock rotational model to a model entirely based on crops (started in the mid 1970s), shifted the agriculture frontier towards traditional cattle ranching areas and deforestation to make place for pasture. Under this land use regime, soybean expansion can be expected to take place on both pastureland and at the expense of forests. Further development of relevant legal frameworks, including both revision of existing regulation, new measures and strengthened enforcement, may counter this.

Assessments (e.g., Van Dam et al 2009) indicate a substantial potential for expanding cultivation for bioenergy without causing far reaching deforestation of food competition, but regional land-use planning may be required to ensure that expansion reflects a balance between various stakeholder groups, including those concerned about nature conservation. Further development of agriculture practices – including soil- and climate adapted crop rotations, and balanced increases in fertilization – may contribute to the sustainability of production. Biodiversity conservation strategies for the agricultural frontier areas may help protect natural vegetation.

Production system characteristics and local environmental impacts

Production system characteristics for soybean in Argentina are summarised in Table 98. As already noted, no-till farming dominates and almost all soybean producers in Argentina uses GM glyphosate-tolerant cultivars. Soybean is commonly rotated with other crops such as wheat, maize, rice, sorghum and sugarcane and Argentinian soybean cultivation employing no-till often include wheat and maize.

Table 98. Production system characteristics for soybean in Argentina

System component	Soybean
Large scale	80%
Small scale	20%
Mechanized farming system	
Manual farming system	
Tillage	18 %
Reduced and no tillage	72 %
Irrigated	
Rain fed	
Mono-cropping	
Multi-cropping	
Crop rotation	51%, especially rotation with wheat and in smaller part rotation with corn and sunflower
Mineral fertilizer used	soybean is a biological nitrogen fixer and no or little nitrogen is therefore needed to add
Chemical pesticides used	especially herbicides
GMO seeds for sowing	dominating seed for sowing, 98% of soy production) Modified for herbicide resistance
Land preparation with fire	
By-products (from harvesting)	

Legend: Blue = occurring; orange = not occurring; white = occurrence unknown due to lack of information
Sources: (Dros, 2004; Panichelli et al., 2009; Proforest, 2010; Tomei et al., 2010)

A recent LCA study (Panichelli et al., 2009) compared Argentinean soy biodiesel with soy biodiesel in Brazil and USA, rapeseed biodiesel in EU and Switzerland, and palm oil biodiesel in Malaysia. It was found that Argentinean soy biodiesel had the highest non-renewable energy use and global warming potential. It also had the highest aquatic ecotoxicity and human toxicity. A comparison with a fossil low-sulphur diesel option showed that the Argentinian soy biodiesel had higher impact when considering land use competition, terrestrial and aquatic ecotoxicity, human toxicity, eutrophication and acidification, and global warming potential. The fossil option had higher impact only for the category non-renewable energy use.

The most significant contributor to the environmental impact of Argentinian soy biodiesel varied depending on impact category. Deforestation for soybean cultivation, nitrate leaching during soybean cultivation, and pesticide use in feedstock production were among the major factors. Avoiding deforestation was emphasized as the main option for improving the environmental performances Argentinian soy biodiesel where the use of marginal and set-aside agricultural land was recommended an option for further consideration. Further implementation of crops' successions, soybean inoculation, reduced tillage and less toxic pesticides were other options pointed out as important for improving the environmental performance.

Related to the problem of glyphosate-resistant weeds, new GM crops that are resistant to more herbicides than only glyphosate can be expected (e.g., crops with genes that confer resistance to herbicides with other mode of actions than glyphosate, for example 2,4-D and dicamba). Multi-herbicide-tolerant GM soybeans are proposed as potentially inducing strong growth of herbicide use in U.S. soybean cultivation in the coming years and Argentina might experience a similar development. Since there has not been much development of new herbicides, a significant proportion of the projected increase will be of older, less environmentally friendly herbicides (Meyer and Cederberg 2010).

Observed local environmental impacts from soybean production in Argentina are summarised in Table 99. It should be noted that even though lacking information prevented linking soy cultivation with biodiversity losses, such links are likely given the link with deforestation.

Table 99: Observed local environmental impacts from soybean production in Argentina

Environmental impact	Soybean
Deforestation	
Loss of agro-biodiversity	
Loss of biodiversity	
Air pollution	
Water pollution	
GMO contamination	
Eutrophication	
Soil fertility decline	
Erosion	

Legend: Red = occurring; green = not occurring; white = occurrence unknown due to lack of information
Sources: (Dros, 2004; Panichelli et al., 2009; Proforest, 2010; Tomei et al., 2010)

Local environmental impacts allocated to domestic biofuel production

The share of the total soybean area that was harvested for domestic biofuel production was 8.8% in 2008. However, the net area requirement is lower since soybean biofuel production generates by-products that substitutes for other crop production: using RED allocation principles the area allocated to biofuels corresponded to 2.9% of the total soybean area in 2008. Since soybean cultivation for domestic biofuels has the same characteristics as soybean cultivation for other purposes, local environmental impacts are also the same and the importance of domestic biofuel production is proportional to the share of the total soybean area used for production of domestic biofuels (2.9%). It should be noted that soybeans for production of domestic biofuels in 2008 was cultivated on 1445 kha, which is a significant amount of land.

Local environmental impacts allocated to EU biofuel demands

The share of the total soybean area that was harvested for EU biofuel production was 3.3% in 2008. However, the net area requirement is lower since soybean biofuel production generates by-products that substitutes for other crop production: using RED allocation principles the area allocated to biofuels corresponded to 1.1% of the total soybean area in 2008. Since soybean cultivation for EU biofuels has the same characteristics as soybean cultivation for other purposes, local environmental impacts are also the same and the importance of EU biofuel demand is proportional to the share of the total soybean area used for EU biofuel production (1.1%).

References

Dros, J.M., 2004. Managing the Soy Boom: Two scenarios of soy production expansion in South America. Amsterdam: A I D E nvironment, Commissioned by WWF.

Mathews, J. and Goldsztein, H., 2008. Capturing latecomer advantages in the adoption of biofuels: The case of Argentina. *Energy Policy*, 37(1), pp.326-337.

Meyer, D. and Cederberg, C., 2010. *Pesticide use and glyphosate- resistant weeds – a case study of Brazilian soybean production*. SIK report 809. Available at: http://www.sik.se/archive/pdf-filer-katalog/SR809.pdf Accessed on May 23, 2011.

Panichelli, L., Dauriat, A. and Gnansounou, E., 2009. Life cycle assessment of soybean-based biodiesel in Argentina for export, *International Journal of Life Cycle Assessment*, 14(2), pp.144–159.

Proforest, 2010. *Agricultural production models and methods for UK biofuels*. Oxford: Renewable Fuels Agency Research Programme. Available at: http://www.proforest.net/objects/publications/agricultural-production-models-and-methods-for-uk-biofuels Accessed on May 23, 2011.

Tomei, J., Semino, S., Paul, H., Joensen, L., Monti, M., and Jelsøe, E., 2010. Soy production and certification: the case of Argentinean soy-based biodiesel. *Mitigation and Adaptation Strategies for Global Change*, 15(4), pp.371–394.

Viglizzo, E. F., Frank, F. C., Carreño, L. V., Jobbágy, E. G., Pereyra, H., Clatt, J., Pincén, D. and Ricard, M. F., 2011. Ecological and environmental footprint of 50 years of agricultural expansion in Argentina. *Global Change Biology*, 17(2), pp.959–973.

I 5 Bolivia

Selected biofuel crops for Bolivia include sugarcane and soybean. As seen in Table 100, about 18% of the total area under sugarcane cultivation in 2008 was used for domestic ethanol production and about 7% of the total area was used for production of fuel ethanol for the EU market. No domestic production of soybean biodiesel in 2008 was identified, although small amounts of biodiesel feedstock for the EU market.

Table 100. Area used for production of Bolivia's selected biofuel crops, including areas used for domestic biofuel production and feedstock for biofuels on the EU market in 2008

Crop	Total harvested area in 2008 (kha)	Cropland used for domestic biofuel production in 2008		Cropland used for production of feedstock for EU biofuels in 2008	
		kha	% of total	kha	% of total
Sugarcane	160	28	17.8%	11	6.8%
Soybean	786	-	-	1.2	0.2%

Source: FAOSTAT (land data); Agra CEAS and Ecofys (biofuel production and trade data).

Sugarcane

As seen in Figure 122, pastures constitute the largest share of Bolivia's total agricultural area. Permanent crops are uncommon, making cultivated land dominated by annual crops. Even though a rather large share of the total sugarcane production can be associated with ethanol production, sugarcane plays a rather small role in Bolivia's agriculture.

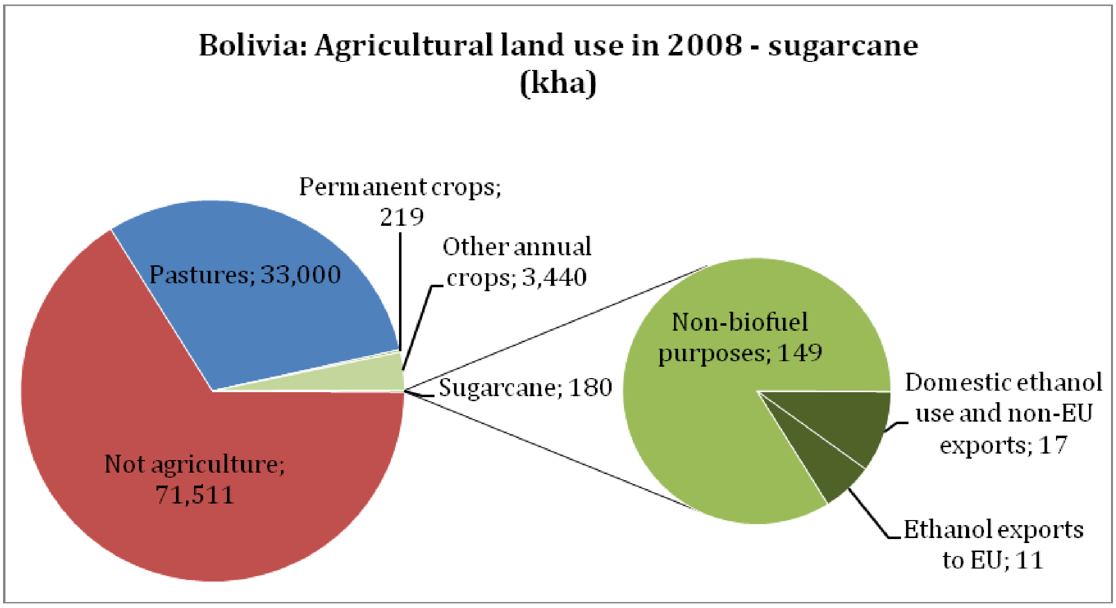


Figure 122. Agricultural land use in Bolivia in 2008, focused on sugarcane production.

Historical developments

Between 1990 and 2008, sugarcane production in Bolivia increased with 81%. As seen in Figure 123, the production increase has been made possible entirely by an increased harvested area (+91%), while average yields in 2008 were lower than in 1990 (-6%).

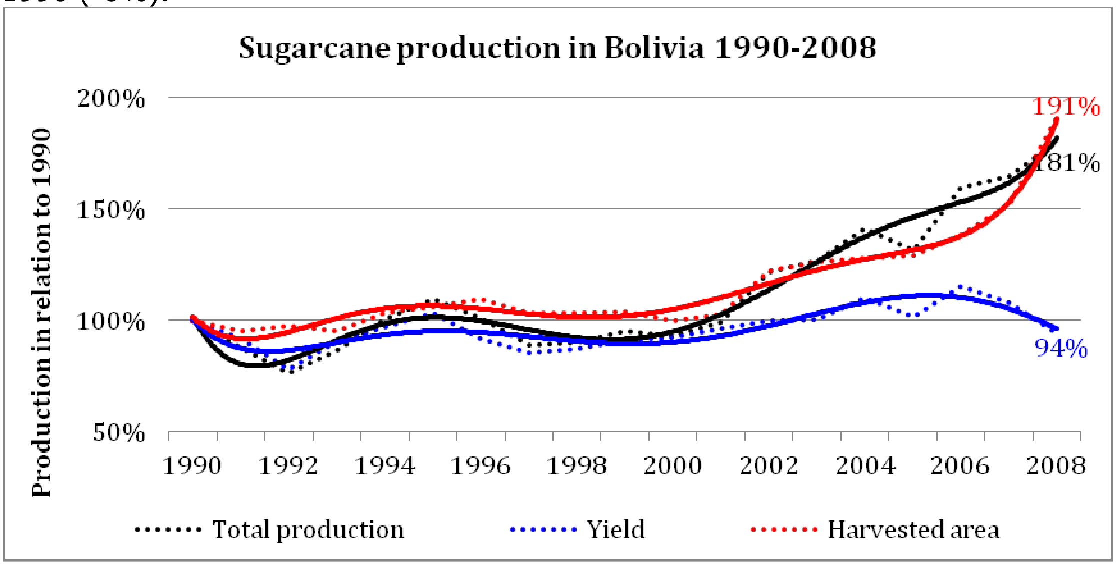


Figure 123. Change in sugarcane production, yields and harvested area in Bolivia, 1990-2008

Sugarcane cultivation started in the end of the 16th century in the department of Santa Cruz with local varieties, called *Listada* and *Cayaña*. Industrial sugarcane production started in Bolivia in 1941 as close to 3,000 hectares of sugarcane fields were established in the department of Santa Cruz. Currently, "almost all" of the sugarcane is produced in Santa Cruz, more specifically in nine municipalities: Andrés Ibáñez, La Guardia, El Tomo, Cotoca, Warnes, Portachuelo, Montero, Mineros, and General Saavedra. These municipalities are located in the eastern parts of Santa

Cruz, close to the departmental capital Santa Cruz de la Sierra (Burgos Lino 2007; Mendoza 2010 in Boliviabella 2010)

Land-use dynamics from future production increases

As discussed in the soybean section, Santa Cruz, Beni, and smaller parts of La Paz, Tarija and Chuquisaca (i.e. the eastern and northern parts of Bolivia) have fewer environmental constraints (FAO 200-) and are thus most suitable for sugarcane cultivation than the other departments. It is likely that sugarcane would mainly expand close to the current main production areas, i.e. in the eastern parts of the Santa Cruz. Nevertheless, sugarcane and –mill establishments in other provinces of Santa Cruz as well as other departments suitable for sugarcane cultivation may also occur. For example, one 11-20 kha sugarcane project is currently being discussed in the northern parts of La Paz (Malky Harb and Ledezma Columba 2010).

Given the abundance of undeveloped land (see the soybean section), expansion of sugarcane is likely to be at the expense of natural vegetation. Depending on where the expansion would occur, it would cause conversion of deciduous or evergreen broadleaf forests or savannahs. Hackenberg (2011) supports this, reporting that expansion of sugarcane is unlikely to occur on existing cropland or pastures but most likely on natural vegetation, such as grasslands and woodlands (savannahs).

As for soybean, sugarcane yields are lower than the regional average (55% of the average in Latin America). This is due to poor management, bad seed quality and dependence on just one variety (*Norte Argentino*). There is therefore a potential to significantly increase production by improving agricultural practices and introducing other varieties. For this purpose, a project for introducing new varieties was initiated in 2004 by the Centre for Sugarcane Research and Technology Transfer (CITTCA) (Soruco et al. 2007). Hackenberg (2011) also stresses the need for irrigation.

Soybean

Soybean is Bolivia's primary commercial crop and the most important field crop in the country, constituting 52% of total cropland and 59% of total crop production. About 85% is processed and exported and about 15% is used domestically. Soybean products make up an estimated 19 percent of total Bolivian exports and are by far the largest agricultural export. (USDA 2005a; Dros 2004)

According to Bolivia's National Institute of Statistics (NIS), 99% of the soybean production is from the department of Santa Cruz, with small acreages also in Tarija and Chuquisaca. Soybeans can be cultivated year-round, although the summer production is the most important, constituting 70-75% of the total annual production. Summer soy is planted in November/December and harvested in March/April, while winter soy is sown in June/July and harvested in October/November. Soybean yields in Bolivia were about 58% of the regional average in 2008 (FAOSTAT), even though soybean is cultivated on fertile soils. This is mainly due to low inputs (e.g. fertilizers, pesticides), less advanced technologies and less developed crop varieties (USDA 2005a; USDA 2005b).

Historical developments

Between 1990 and 2008, soybean production in Bolivia increased with 441%. As seen in Figure 124, the production increase has been made possible by an increased harvested area (+448%), while yields have remained rather unchanged during the period.

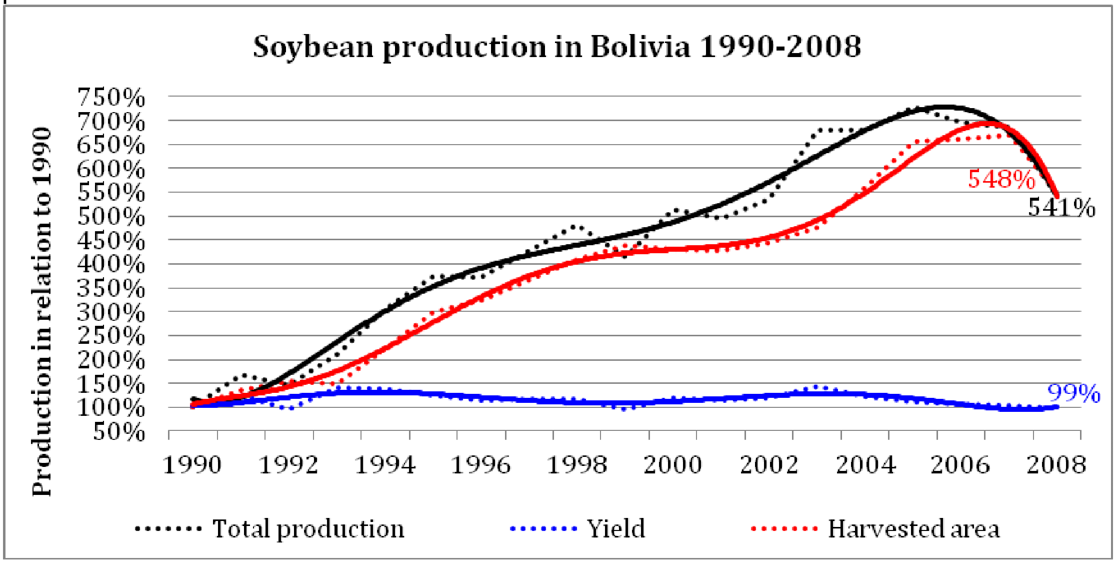


Figure 124. Change in soybean production, yields and harvested area in Bolivia, 1990-2008.

The expansion of soybean cultivation in Bolivia has been significant over the past 20 years. This was primarily achieved by clearing native savannah/woodland and forestland in the department of Santa Cruz. FAO reports that soybean initially gained interest in Santa Cruz in the 1970's, when international soybean prices escalated. By the 1980's, soybean had an entrenched production base and became Bolivia's most important oilseed crop (USDA 2005a).

Land-use dynamics from future production increases

The departments of Potosi, Oruro, Cochabamba and most of La Paz, Tarija and Chuquisaca (i.e. the western parts of Bolivia) are unsuitable for soybean production due to environmental constraints (dry and/or cold areas, low soil suitability, erratic rainfall and cold stress risk, steep slopes and mountains, severe and very severe land degradation) (FAO 200-). Santa Cruz, Beni, Pando and smaller parts of La Paz, Tarija and Chuquisaca (i.e. the eastern and northern parts of Bolivia) have fewer such environmental constraints (FAO 200-) and are thus more suitable for soybean cultivation. As Pando is highly undeveloped and almost entirely covered by broadleaf forests, soybean expansion is less likely to happen there. This coincides well with where soybean and other commercial crops are typically being produced; the fertile eastern lowlands.

The eastern lowlands are generally comprised by vast areas of pasture, savannah (woodlands) and forest, which could provide opportunities for future expansion (USDA 2005b). Soybeans are mainly produced in the savannah region of Santa Cruz, which still holds large areas of undeveloped land. Soybean is also produced at the forest frontier in Santa Cruz, being a historically significant driver of deforestation

(USDA 2005a, USDA 2005b, Müller et al. 2011). The most likely scenario in case of a future expansion of soybean production is that it expands on natural vegetation in the department of Santa Cruz, mainly on savannah woodlands but also on forestland. This is supported by Hackenberg (2011) who reports that expansion of soybean is unlikely to occur on existing cropland or pastures but most likely to occur on natural grasslands and woodlands.
Expansion may also occur in Beni and in the eastern parts of Chuquisaca and Tarija, although to a lesser extent. In Beni it would likely be at the expense of forests and in Chuquisaca and Tarija at the expense of savannahs.

As previously noted, average soybean yields in Bolivia were about 58% of the regional average in 2008 (FAOSTAT), even though soybean is cultivated on fertile soils. Therefore, there is a potential to significantly increase production by using more inputs and irrigation, and better agricultural practices and crop varieties (USDA 2005a; USDA 2005b; Hackenberg 2011).

Production system characteristics and local environmental impacts

Production system characteristics for sugarcane and soybean in Bolivia are summarised in Table 101.

Table 101. Production system characteristics for sugarcane and soybean in Bolivia

System component	Sugarcane	Soybean
Large scale	65% >50 ha	30% >50 ha
Small scale	35% <50 ha	70% <50 ha
Mechanized farming system		Dominant
Manual farming system	Harvesting and loading on trucks are often performed manually	
Tillage		
Reduced and no tillage		
Irrigated		
Rain fed		
Mono-cropping		
Multi-cropping		
Crop rotation		
Mineral fertilizer used		
Chemical pesticides used		
GMO seeds for sowing		
Land preparation with fire		
By-products (from harvesting)		

Legend: Blue = occurring; orange = not occurring; white = occurrence unknown due to lack of information

Sources: (Altieri, 2009; Blanco-Canqui and Lal, 2010; Kaimowitz et al., 1999; Baas, 2011; Müller et al., 2011; Pacheco, 2006; Dros, 2004; Burgos Lino 2007)

Mechanized production of soybean has caused extensive deforestation in the Santa Cruz region during the last 30 years (Müller et al. 2011). Observed local environmental impacts from sugarcane and soybean production in Bolivia are presented in Table 102. It should be noted that even though lacking information prevented linking sugarcane cultivation with biodiversity losses, such links are likely given the link with deforestation.

Table 102. Observed local environmental impacts from sugarcane and jatropha production in Bolivia

Environmental impact	Sugarcane	Soybean
Deforestation	[red]	[red]
Loss of agro-biodiversity		
Loss of biodiversity		[red]
Air pollution	[red]	[red]
Water pollution		[red]
GMO contamination		
Eutrophication		
Soil fertility decline		[red]
Erosion		[red]

Legend: Red = occurring; green = not occurring; white = occurrence unknown due to lack of information
Sources: (Altieri, 2009; Blanco-Canqui and Lal, 2010; Kaimowitz et al., 1999; Baas, 2011; Müller et al., 2011; Pacheco, 2006; Dros, 2004)

Local environmental impacts allocated to domestic biofuel production

The share of the total sugarcane area that was harvested for domestic biofuel production was 18.8% in 2008. Since sugarcane cultivation for domestic biofuels has the same characteristics as sugarcane cultivation for other purposes, local environmental impacts are also the same and the importance of domestic biofuel production is proportional to the share of the total sugarcane area used for production of domestic biofuels (18.8%).

Since no production of domestic biofuels from soybean has been identified for 2008; no local environmental impacts from cultivation of soybean can be allocated to domestic biofuel production in Bolivia.

Local environmental impacts allocated to EU biofuel demands

The share of the total sugarcane area that was harvested for EU biofuel production was 6.8% in 2008. Since sugarcane cultivation for EU biofuel production has the same characteristics as sugarcane cultivation for other purposes, local environmental impacts are also the same and the importance of EU biofuel demand is proportional to the share of the total sugarcane area used for EU biofuel production (6.8%).

Since no feedstock for EU biofuels in 2008 has been traced to soybean produced in Bolivia; no local environmental impacts from cultivation of soybean in Bolivia can be allocated to EU biofuel demands.

References

Altieri, M. A., 2009. The Ecological Impacts of Large-Scale Agrofuel Monoculture Production Systems in the Americas. *Bulletin of Science, Technology & Society,* 29(3), pp.236-244.

Baas, L., 2011. Children on Bolivian Sugar Cane Plantations. In G. K. Lieten, ed. *Hazardous Child Labour in Latin America*. Springer. Ch 10.

Blanco-Canqui, H. and Lal, R., 2010. No-Till Farming. In *Principles of Soil Conservation and Management*. Springer. Ch 8.

Boliviabella, 2010. *Santa Cruz produces 64% of Bolivia's food*. Available at: http://www.boliviabella.com/santa-cruz-produces-64-of-bolivias-food.html Accessed on June 17, 2011

Burgos Lino, G., 2007. *Agroenergy: Myths and Impacts in Latin America. Chapter 8, Bolivia: sugarcane production in Santa Cruz.* Pastoral Land Commission, Network for Social Justice and Human Rights. Available at: http://www.social.org.br/cartilha%20agroenergia%20ingles.pdf Accessed on June 17, 2011.

FAO, 200-. *FAO country profile: Bolivia. Misc. maps*. Available at: http://www.fao.org/countryprofiles/ Accessed on June 16, 2011.

Hackenberg, N., 2011. Expert consultation: Norbert Hackenberg, consultant for Winrock International for the EU Biofuel Baseline project.

Kaimowitz, D., Thiele, G. and Pacheco, P., 1999. The Effects of Structural Adjustment on Deforestation and Forest Degradation in Lowland Bolivia. *World Development*, 27(3), pp.505-520.

Malky Harb, A., F., Ledezma Columba, J., C., 2010. *Financial and economic feasibility of sugar cane production in northern La Paz*. Latin American and Carribean Environmental Economics Program (LACEEP). Working Paper Series No. 2010-WP13. Available at: http://www.laceep.org/images/stories/working_papers/2010-wp13_malky.pdf Accessed on June 17, 2011.

Mendoza, L., 2010. *En Santa Cruz se produce el 64% de los alimentos de Bolivia.* Available at: http://eju.tv/2010/04/en-santa-cruz-se-produce-el-64-de-los-alimentos-de-bolivia/ Accessed on June 17, 2011

Müller, R., Müller, D., Schierhorn, F. and Gerold, G., 2011. Spatiotemporal modelling of the expansion of mechanized agriculture in the Bolivian lowland forests. *Applied Geography,* 31(2), pp.631-640.

Pacheco, P., 2006. Agricultural expansion and deforestation in lowland Bolivia: the import substitution versus the structural adjustment model. *Land Use Policy,* 23(3), pp.205-225.

Soruco, O., Antelo Aguilar, S., Abelardo Enríquez, E. P., 2007. *Revealing success. What happened in nine applied technology innovation projects (PITAs)? Chapter 1: Sweet, lasting success.* Global Plant Clinic, CABI, Egham, UK. Available at: http://www.jefferybentley.com/RevealingSuccessFIT22.pdf Accessed on June 17, 2011

Stagnari, F., Ramazzotti, S. and Pisante, M., 2010. Conservation Agriculture: A Different Approach for Crop Production Through Sustainable Soil and water Management: A Review. *Sustainable Agriculture Reviews*, 1, pp.55-83.

Timilsina, G. R., and Shestha, A., 2010. How much hope should we have for biofuels? *Energy*, 36(4), pp.2055-2069.

USDA, 2005a. *Commodity Assessment Report. Bolivia: Agricultural Overview*. USDA Foreign Agriculture Service: Production Estimates and Crop Assessment Division. Available at: http://www.fas.usda.gov/pecad/highlights/2005/10/bolivia_12oct2005/ Accessed on June 16, 2011.

USDA, 2005b. *GAIN report BL5001: Bolivia Oilseeds and Products. Annual Soybean Report 2005.* USDA Foreign Agricultural Service: Global Agricultural Information Network (GAIN). Available at: http://www.fas.usda.gov/gainfiles/200503/146119282.pdf Accessed on June 16, 2011.

I 6 Guatemala

Selected biofuel crops for Guatemala include sugarcane and jatropha. As seen in Table 100, about 9% of the total area under sugarcane cultivation in 2008 was used for domestic ethanol production and about 1% of the total area was used for production of fuel ethanol for the EU market. Jatropha was cultivated on small amounts of land in 2008, although mainly for biodiesel purposes.

Table 103. Area used for production of Guatemala's selected biofuel crops, including areas used for domestic biofuel production and feedstock for biofuels on the EU market in 2008

Crop	Total harvested area in 2008 (kha)	Cropland used for domestic biofuel production in 2008		Cropland used for production of feedstock for EU biofuels in 2008	
		kha	% of total	kha	% of total
Sugarcane	287	26	9.1%	3	1.1%
Jatropha	0.7 [1)]	0.7	100%	-	-

1) Not including wild jatropha or jatropha used for fencing

Source: FAOSTAT (land data); Agra CEAS and Ecofys (biofuel production and trade data).

Sugarcane

As seen in Figure 125, cultivated land constitutes a slightly larger share of the total agricultural land than pastures. Permanent crops, such as banana and oil palm, are common, although slightly more land is used for the cultivation of annual crops. Sugarcane cultivation constitutes about 22% of the area under annual crops, making it an important crop in Guatemala's agriculture and ethanol production is a rather important application.

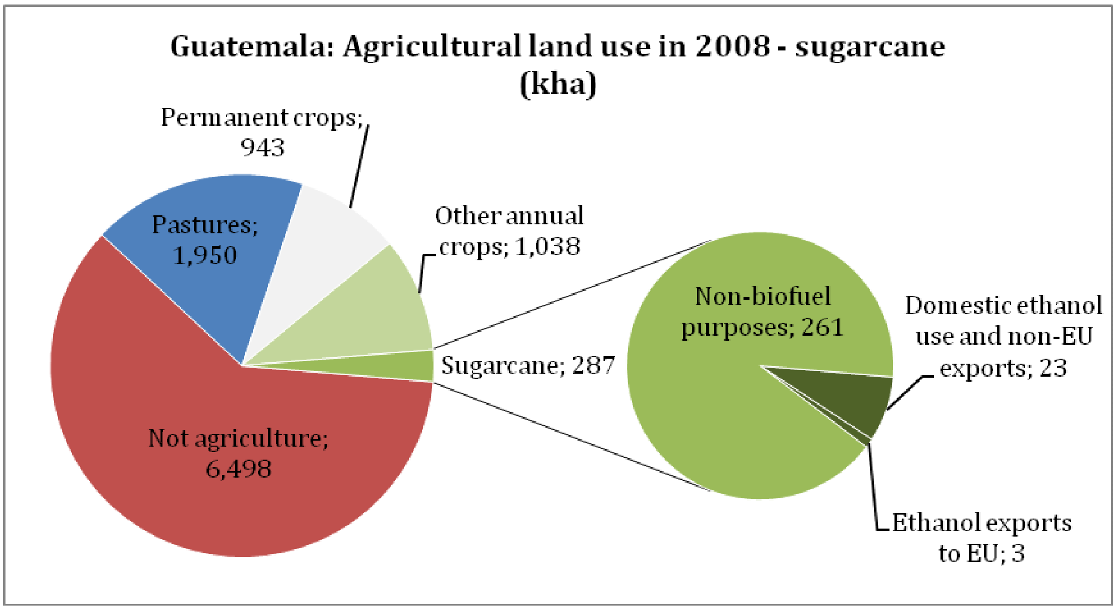


Figure 125. Agricultural land use in Guatemala in 2008, focused on sugarcane production.

Historical developments

Between 1990 and 2008, sugarcane production in Guatemala increased with 165%. As seen in Figure 126, the increase has been made possible by an increased harvested area (+156%), while yields have remained rather unchanged during the period. During this period, sugarcane has taken up an increasingly larger share of the total area under cultivation in Guatemala, from 8.7% in 1990 to 21.6% in 2008 (FAOSTAT).

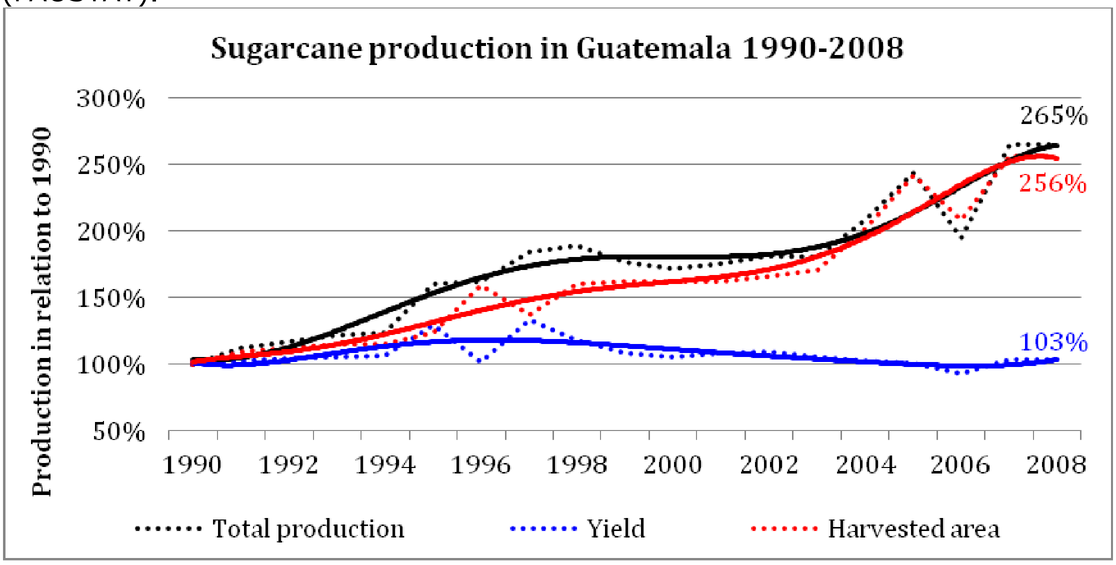


Figure 126. Change in sugarcane production, yields and harvested area in Guatemala, 1990-2008

The main sugarcane area is along the Pacific coast, in the southwestern part of the country. Besides one sugar mill that recently moved to the Atlantic lowlands on the eastern coast, 13 of the 14 sugar mills in the country are located near Puerto Quetzal at the Pacific coast (USDA 2009). The Global Mechanism (2009) reports that large forest areas have been converted to pastures and cultivation of crops, such as oil palm and sugar cane. However, no reports have been found on large-scale conversion of natural vegetation specifically due to sugarcane expansion. Instead, expansion of sugarcane since 1990 seems to have occurred mainly at the expense of pastures and other cash crops, such as cotton, soybean and maize (Fradejas 2009; Suarez 1996).

Guatemala is experiencing fast deforestation. 36.3% or about 3.94 million hectares of Guatemala is forested. Of this, 49.7 per cent is classified as primary forest, the most biodiverse form of forest. Between 1990 and 2005, Guatemala lost 17.1 per cent of its forest cover, or around 810,000 hectares (Mongabay 2010). While there is no general agreement on the causes of forest cover change, Assunção et al. (2007) reports that the conflict and competition that exist between the agriculture and forestry sectors and agricultural versus forestland use seems to be the main reason. Therefore, even though no evidence has been found for sugarcane expansion being a main cause of deforestation in Guatemala, deforestation is likely to have occurred as a direct or indirect effect from recent sugarcane expansion.

Land-use dynamics from future production increases

Little information has been found on potential effects from a sugarcane expansion in Guatemala. Since existing sugar mills are concentrated near Puerto Quetzal, expansion of sugarcane along the Pacific coast is likely to be preferable for the sugar and ethanol industry. Since much of the vegetation in this area has already been cleared for agriculture, such an expansion would be at the expense of competing crops, such as maize, beans, banana and cotton. Naturally, price developments for the competing crops determine which crops that would be most profitable to replace. This is supported by Duarte (2011) who reports that sugarcane is most likely to expand on existing cropland, and likely replacing cash crops such as maize and beans. He reports that sugarcane production in Guatemala is "extremely efficient" and that farmers can expect the biggest revenues from replacing their current crops with sugarcane. FAOSTAT data supports that sugarcane production in Guatemala is very efficient, with average sugarcane yields reported to be even higher than in Brazil. Whether replaced crops would be displaced to other areas has not been possible to determine.

Fradejas (2009) developed a suitability map for maize, sugarcane, oil palm and jatropha in Guatemala (Figure 127). Areas close to the Pacific coast are considered most suitable for sugarcane, supporting that sugarcane expansion is likely to occur in this area. Smaller areas in the central parts and close to the eastern coast are also considered suitable, as well as some small areas in the northern parts. Since most of the remaining forests in Guatemala are found in the northern and, to some extent, in the far eastern parts, sugarcane expansion in most areas considered suitable by Fradejas (2009) are not likely to be at the (direct) expense of natural vegetation. This is supported by Duarte (2011), who reports that sugarcane is unlikely to expand on natural vegetation. This since forests in most sugarcane areas (Pacific and Atlantic lowlands) have been cleared since many years to enable land for agriculture and pastures.

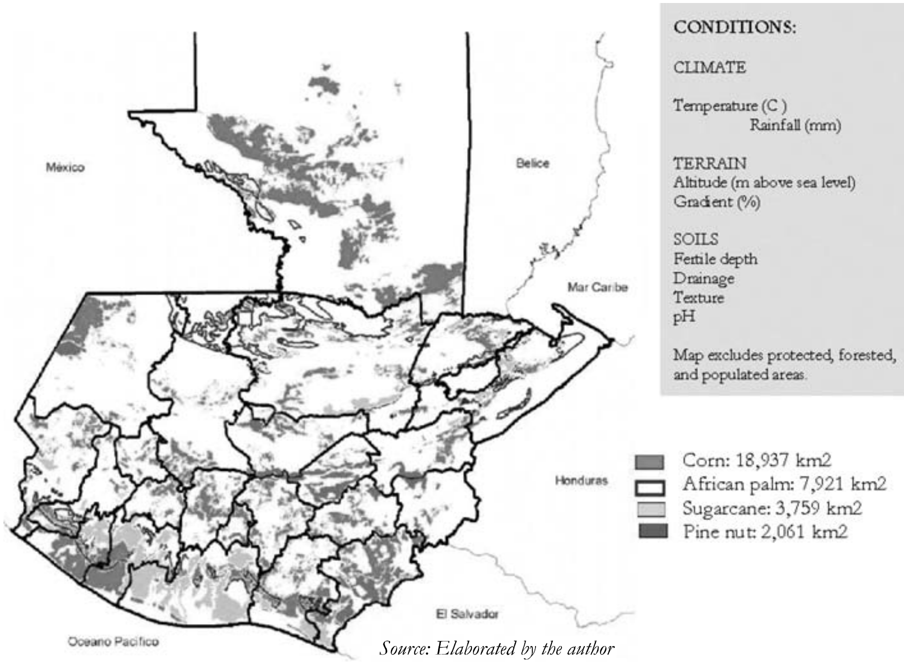


Figure 127. Areas suitable for maize, sugarcane, oil palm, and pine nut (Jatropha) in Guatemala. Source: (Fradejas 2009)

Sugarcane expansion on pastures is possible mainly in the Pacific or Atlantic lowlands or between the cultivated lowlands and the highlands. Highlands are typically unsuitable for sugarcane cultivation. Duarte (2011) reports that expansion on pastures is very likely to occur. As for replacement of crops, it has not been possible to determine whether replaced pastures would be displaced to other areas or not.

Jatropha

Jatropha is native to Guatemala and grows in many regions, where it has traditionally been used for fencing. Guatemala was among the first countries to cultivate Jatropha for commercial purposes, and is therefore more advanced in these activities than neighbouring countries. The first commercial attempts started in 2002 and have increased steadily, although the production scale is still small. Combined processing capacity of biodiesel from jatropha and recycled vegetables in 2009 was estimated at 15000 litres per day. In 2008, jatropha projects occupied 650 ha and supplied feedstock to five biodiesel plants with a total capacity of 7500 litres per day (USDA 2009; GEXI 2008).

Land-use dynamics from future production increases

The Ministry of Agriculture (MAGA) has identified 206 100 hectares of marginal and semi-marginal land that could be used for the cultivation of Jatropha. Primarily, MAGA is interested in promoting jatropha production in the northern region of the Peten, which is highly undeveloped (USDA 2009; Fradejas 2009).

As illustrated in Figure 128, jatropha production is possible primarily near the Pacific coast, but also in Petén in northern Guatemala. Due to competition with sugarcane plantations near the Pacific coast most of the current jatropha plantations have been placed in the north (GEXI 2008). It is unlikely that jatropha in a near future can be sufficiently profitable to compete with other crops in areas near the Pacific coast. Therefore, expansion in the northern parts is more likely to occur.

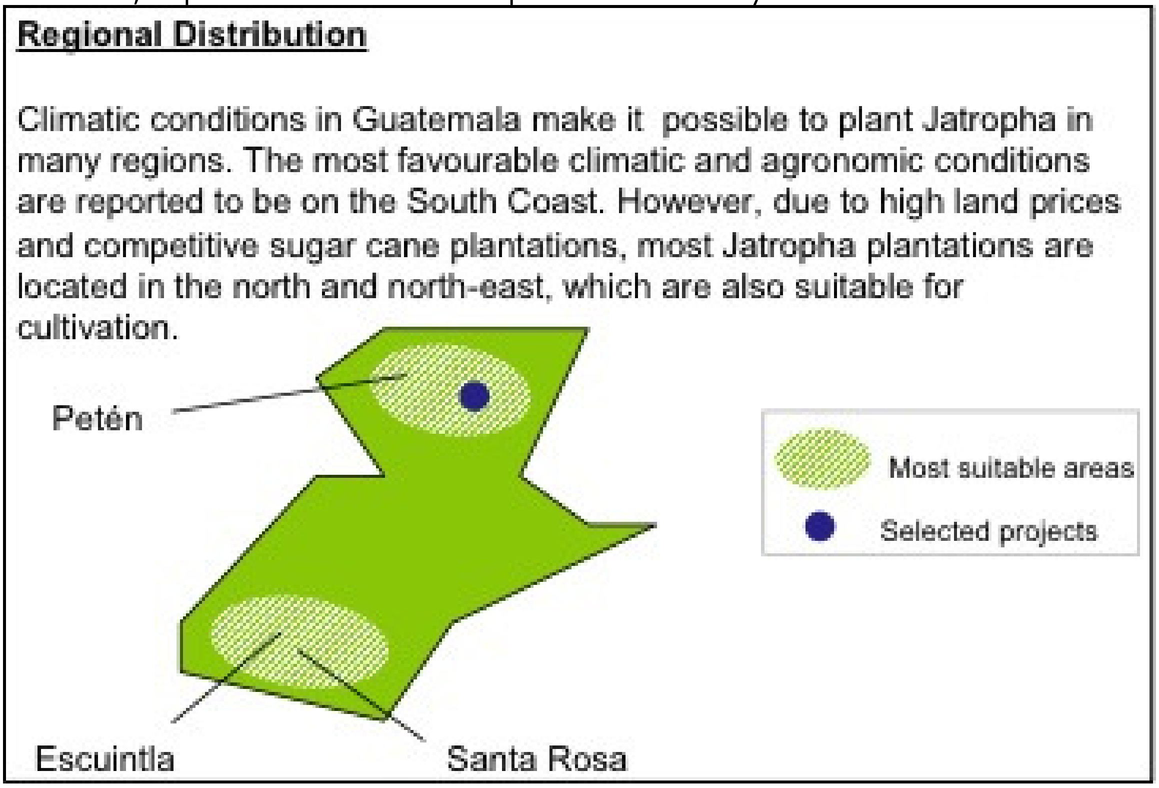


Figure 128. Regional distribution of suitable land for jatropha cultivation in Guatemala. Source: GEXI 2008.

Since jatropha production is promoted in undeveloped parts in northern Guatemala, it is unlikely to compete with existing cropland in a near future. Instead deforested and degraded marginal land is likely to be targeted. This is supported by Duarte (2011) who reports that jatropha expansion on pastures is very likely and expansion on existing cropland is unlikely. Since a criterion for assessing the suitability of land was to avoid deforestation, expansion on natural vegetation can be regarded as less likely. This is supported by Duarte (2011) who reports that this is an unlikely scenario.

However, since the northern parts of Guatemala contain most of the remaining natural forests, potential displacement of other activities onto natural vegetation (forestland) might occur. Which types of knock-on effects that could occur and the risk of them happening is very difficult to assess. It should be considered though that food production would have to increase as population increases. Therefore, as jatropha is expanding on land suitable for food crop cultivation (Fradejas 2009), new land might have to be claimed in case of a large-scale jatropha expansion, in order to secure the food supply.

Production system characteristics and local environmental impacts

Production system characteristics for sugarcane and jatropha in Guatemala are summarised in Table 104.

Table 104. Production system characteristics for sugarcane and jatropha in Guatemala

System component	Sugarcane	Jatropha
Large scale		
Small scale		
Mechanized farming system		
Manual farming system		
Tillage		
Reduced and no tillage		Perennial crop
Irrigated	60%	
Rain fed	40%	
Mono-cropping		
Multi-cropping		
Crop rotation		Perennial crop
Mineral fertilizer used		
Chemical pesticides used		
GMO seeds for sowing		
Land preparation with fire		
By-products (from harvesting)	Tops and leaves from mechanical harvesting are left on the field	

Legend: Blue = occurring; orange = not occurring; white = occurrence unknown due to lack of information

Sources: (FAO/PISCES, 2009; Fradejas, 2009; Morales, 2008; Murillo et al., 2003; WRM, 2010).

Observed local environmental impacts from sugarcane and jatropha production in Guatemala are summarised in Table 105.

Table 105. Observed local environmental impacts from sugarcane and jatropha production in Guatemala

Environmental impact	Sugarcane	Jatropha
Deforestation		
Loss of agro-biodiversity		
Loss of biodiversity		
Air pollution		
Water pollution		
GMO contamination		
Eutrophication		
Soil fertility decline		
Erosion		

Legend: Red = occurring; green = not occurring; white = occurrence unknown due to lack of information

Sources: (FAO/PISCES, 2009; Fradejas, 2009; Morales, 2008; Murillo et al., 2003; WRM, 2010).

Local environmental impacts allocated to domestic biofuel production

The share of the total sugarcane area that was harvested for domestic biofuel production was 9.1% in 2008. Since sugarcane cultivation for domestic biofuels has the same characteristics as sugarcane cultivation for other purposes, local environmental impacts are also the same and the importance of domestic biofuel production is proportional to the share of the total sugarcane area used for production of domestic biofuels (9.1%).

Regarding jatropha, the entire production in 2008 was used for biodiesel production in some sense. Therefore, all local environmental impacts from jatropha production can be allocated to domestic biodiesel production.

Local environmental impacts allocated to EU biofuel demands

The share of the total sugarcane area that was harvested for EU biofuel production was 1.1% in 2008. Since sugarcane cultivation for EU biofuel production has the same characteristics as sugarcane cultivation for other purposes, local environmental impacts are also the same and the importance of EU biofuel demand is proportional to the share of the total sugarcane area used for EU biofuel production (1.1%).

Since no feedstock for EU biofuels in 2008 has been traced to jatropha produced in Guatemala; no local environmental impacts from cultivation of jatropha in Guatemala can be allocated to EU biofuels demands.

References

Fradejas, A. A., 2009. Red Sugar Green Deserts. Chapter: The human right to food versus the new colonizers of agriculture in Guatemala - sugarcane and African palm. Available at: http://www.fao.org/docs/eims/upload/276609/monocultures.pdf Accessed on May 4, 2011.

Assunção L., de la Torre Ugarte, D., Moreira J. R. & Zarrilli, S., 2007. Prospects for a biofuels industry in Guatemala: Main findings and results of the mission undertaken by the UNCTAD Biofuels Initiative. United Nations Conference on Trade and Development. Available at: http://www.unctad.org/en/docs/ditcted200711_en.pdf Accessed on May 4, 2011.

Mongabay, 2010. *Mongabay website: Guatemala Forest Information and Data*. Available at: http://rainforests.mongabay.com/deforestation/2000/Guatemala.htm Accessed on May 6, 2011.

USDA, 2009. *Guatemala Biofuels Annual: Biodiesel and Ethanol*. Available at: http://gain.fas.usda.gov/Recent%20GAIN%20Publications/General%20Report_Guatemala_Guatemala_5-26-2009.pdf Accessed on May 6, 2011.

The Global Mechanism, 2009. *Increasing finance for sustainable land management: Guatemala.* Available at: http://global-mechanism.org/dynamic/documents/document_file/guatemala.pdf Accessed on May 6, 2011.

Suarez, N. R., 1996. *Sugar and Sweetener Situation and Outlook 1996: The Central American Sugar Industry.* Economic Research Service, U.S. Department of Agriculture, Washington, DC

Duarte, C., 2011. Expert consultation: Carlos Duarte, consultant for Winrock International for the EU Biofuel Baseline project.

GEXI, 2008. *Global Market Study on Jatropha Project Inventory: Latin America*. The Global Exchange for Social Investment. Available at: http://www.jatropha-alliance.org/fileadmin/documents/GEXSI_Jatropha-Project-Inventory_LATIN-AMERICA.pdf Accessed on May 12, 2011.

I 7 Peru

Selected biofuel crops for Peru include sugarcane and oil palm. As seen in Table 106, 5.3% of the total area under sugarcane cultivation in 2008 was used for domestic ethanol production and 3.6% of the total area was used for production of fuel ethanol for the EU market. No data on oil palm biodiesel production has been found.

Table 106. Area used for production of Peru's selected biofuel crops, including areas used for domestic biofuel production and feedstock for biofuels on the EU market in 2008

Crop	Total harvested area in 2008 (kha)	Cropland used for domestic biofuel production in 2008		Cropland used for production of feedstock for EU biofuels in 2008	
		kha	% of total	kha	% of total
Sugarcane	69	3.7	5.3%	2.5	3.6%
Oil Palm	14	-	-	-	-

Source: FAOSTAT (land data); Agra CEAS and Ecofys (biofuel production and trade data).

Sugarcane

As seen in Figure 129, pastures constitute the largest share of Peru's total agricultural area. Permanent crops are uncommon, making cultivated land dominated by annual crops. Sugarcane plays a small role in Peru's overall agriculture (although large in certain areas) and ethanol is not a main application.

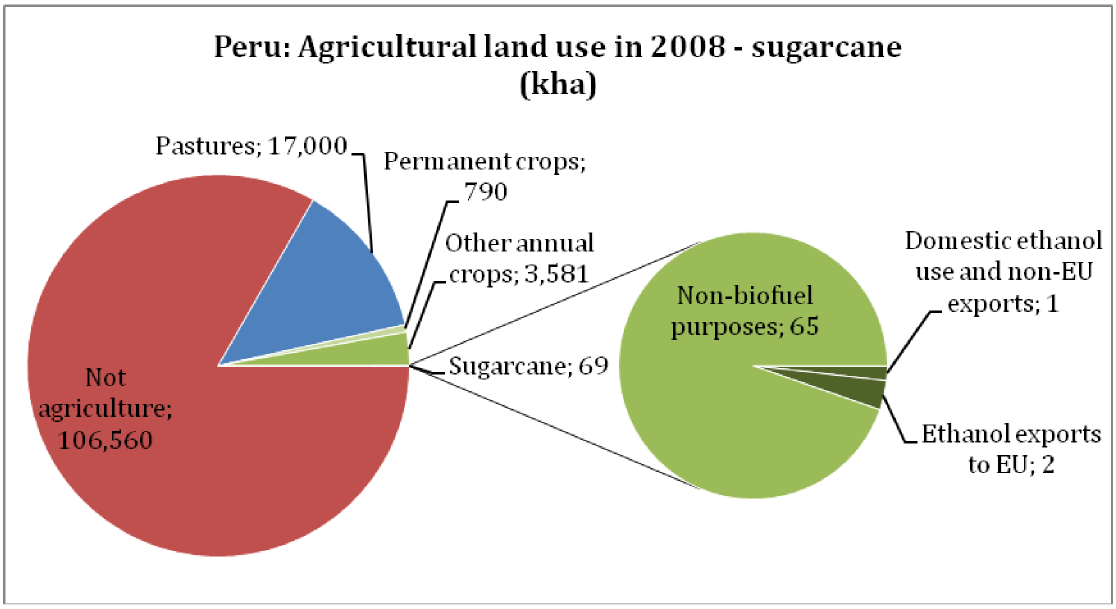


Figure 129. Agricultural land use in Peru in 2008, focused on sugarcane production

Historical developments

Between 1990 and 2008, sugarcane production in Peru increased with 40%. As seen in Figure 130, the production increase has been made possible mainly by increasing yields (+25%). The harvested area increased with 12% during the period.

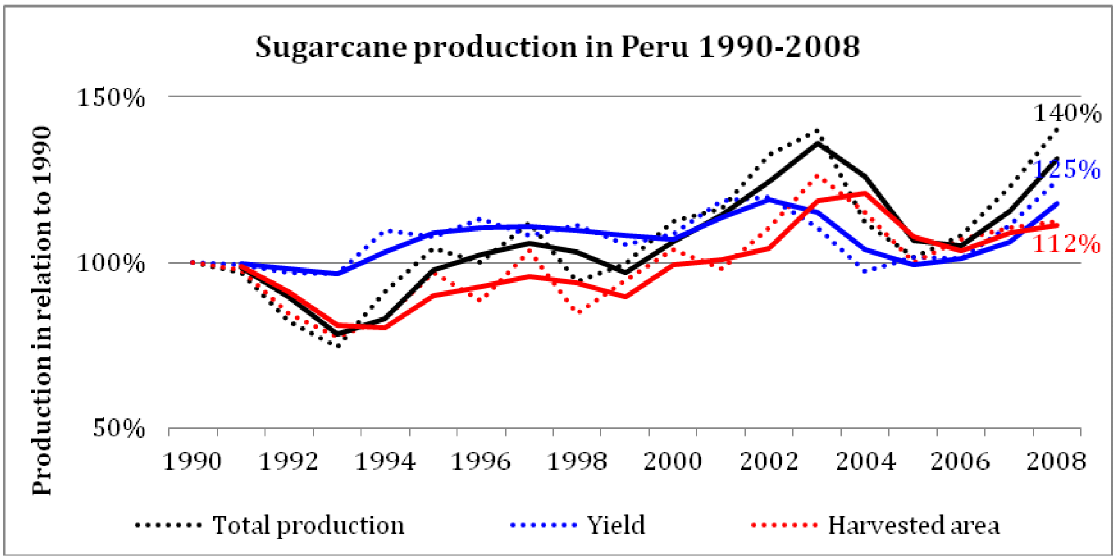


Figure 130. Change in sugarcane production, yields and harvested area in Peru, 1990-2008

The origins of the Peruvian sugar industry go back to the latter part of the Sixteenth Century when production was first introduced by Spanish colonists in the fertile river valleys of the otherwise barren, desert-like north coast. Because of the absence of rainfall due to the effects of the cold pacific current along the coast, agriculture there has always depended upon networks of irrigation, using water from the numerous rivers carrying seasonal rainfall down from the high Andes. At first north coast plantations were relatively small-scale, but during the Seventeenth Century their size increased, mostly at the expense of the remaining Indian communities. Skyrocketing sugar prices during the second half of the Seventeenth Century led to expansion of sugarcane to virtually all the coastal river valleys from Lambayeque in the north to Lima in the center. In the Trujillo region alone there were eighteen sugar plantations while several also appeared in the central and northern highlands (Klaren 2005).

Over time, sugarcane cultivation was concentrated to the northern coast while cotton came to replace sugar as the dominant crop along the central coast. One reason for the shift to the north was the ability to operate on a year-round basis due to the unique ecological conditions, which gave Peru a competitive advantage over Cuba and other sugar producing countries with seasonal limitations of growing and harvesting (Klaren 2005).

Today, sugar mills in Peru are located along the coast and have a total milling capacity of 37,000 MT of cane per day. Since sugar cane in Peru is produced year round, mills do not need to be very large. Yields and cane age vary greatly from one producer to another. Yields range from 53 to 190 MT of cane per hectare and age varies from 13 to 18 months between cuts. Average yields in CY 2010 were 126 MT per hectare. The Peruvian northern coast has excellent conditions for growing sugar cane due to high temperatures and lack of rain. All cultivation is surface irrigated, allowing producers to cut the supply of water at a given time to obtain higher sucrose yields. Under normal weather conditions, and provided the cane is milled on time, sucrose yields are around 12 percent (USDA 2011).

Land-use dynamics from future production increases

Most of Peru ś arable land is in the Costa (coastal) regions where the bulk of agricultural production takes place in the river valleys along the coast. In the Sierra (Andean) regions, agriculture is largely subsistence and in the Amazon (jungle) regions, agriculture has developed much more slowly (Khwaja 2010). The northern coast, which is most suitable for sugarcane growing, is undergoing an economic improvement process driven by private investments. Land is being purchased by both Peruvian and foreign investors, and property is being consolidated. The efficiency brought about by economies of scale is improving return rates, which attracts more investment, generating a beneficial cycle (USDA 2011).

Considering the possibility of year-round cultivation, future expansion of sugarcane is most likely to occur along the northern coast. Since the Costa region mainly consists of barren land, large-scale deforestation from sugarcane expansion is unlikely; there is even a potential to convert sand dynes into sugarcane production, something already happening (USDA 2011). However, since much irrigation is needed for such land conversion, water availability might become a constraint in case of a large sugarcane expansion in the Costa region (Khwaja 2010). Expansion in the Amazon region may also take place due to the high climatic production potential (FAO 200-). Since most of the Amazon region is undeveloped, expansion of sugarcane could drive deforestation, directly or indirectly. Expansion in the Sierra region is unlikely due to environmental constraints (FAO 200-).

Even though sugarcane is dominating in the northern Costa area, some potential still exists to shift from other crops, such as cotton. The potential of shifting from cotton (or other crops) to sugarcane is larger further south along the coast, but that would mean seasonal instead of year-round cultivation and thus lower productivity.

Oil Palm

Edible palm oil has been used for decades from commercial production of oil palm in agricultural lands, but areas are now expanding. In addition to the 14 kha of oil palm in production, 15 kha of oil palm are in growth and 12.6 are in nurseries (Garcia, 2010).

Historical developments

Between 1990 and 2008, oil palm production in Peru increased with 129%. As seen in Figure 131, the production increase has been made possible entirely by an increased harvested area (+337%), while yields decreased during the period (-32%).

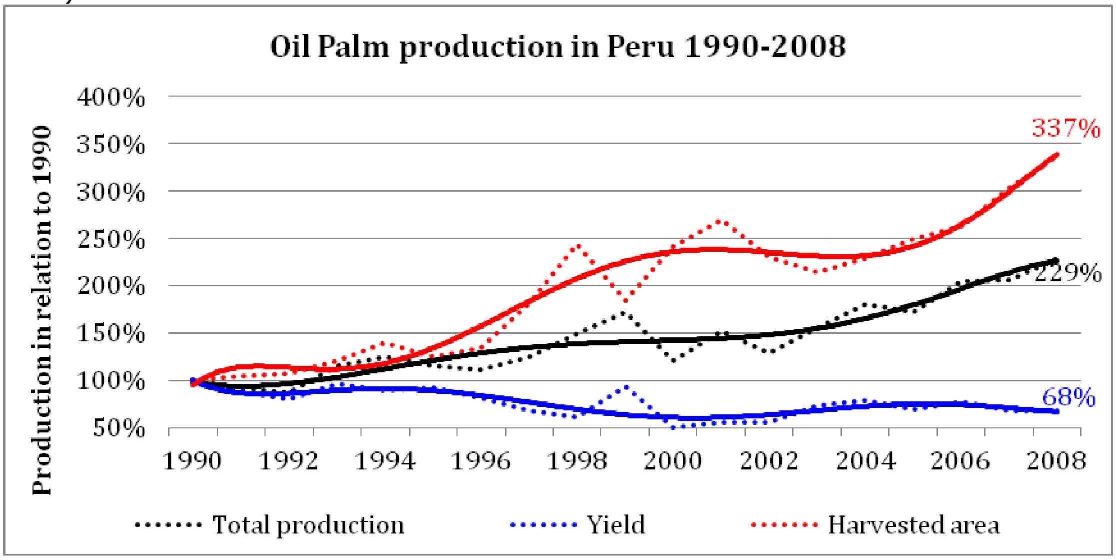


Figure 131. Change in oil palm production, yields and harvested area in Peru, 1990-2008

Oil palm is a rather new crop in Peru compared to sugarcane and little information exist on historical developments. Compared to sugarcane, which is preferably cultivated in the barren lands of the Costa region, oil palm is grown in the Amazon region. Oil palm has been expanding on already deforested areas but has also caused deforestation of primary forests, for example in the Barranquita district in the region of San Martin, as documented by the Peruvian Environmental Law Society (Khwaja 2010). In addition, Garcia (2010) reports that oil palm plantations have been established on existing farmland rather than abandoned or degraded land.

Land-use dynamics from future production increases

Large-scale oil palm expansion is likely in the Amazon regions only. Currently, oil palm is expanding in the Amazonian provinces of Ucayali, San Martin and Loreto, where deforested land is targeted for conversion into oil palm plantations. Such an expansion of oil palm for biodiesel in the poorly developed Amazon region is being pushed as part of Peru's anti-narcotics strategy, by creating alternatives to drug plant cultivation (Khwaja 2010). However, historical evidence, as previously discussed, show difficulties in enforcing that plantations are not established on natural vegetation or existing cropland. Therefore, oil palm may expand onto degraded land, existing cropland or natural vegetation, although the intention seems to be to expand onto degraded land.

Production system characteristics and local environmental impacts

Production system characteristics for sugarcane, oil palm and jatropha in Peru are summarised in Table 107.

Table 107. Production system characteristics for sugarcane, oil palm and jatropha in Peru

System component	Sugarcane	Oil Palm	Jatropha
Large scale	Large scale production at the coast dominant, but starting up also in the Amazon region	Dominant	81)
Small scale	Traditional production		
Mechanized farming system		Land preparation	Land preparation, e.g. in Amazon regions where secondary vegetation needs to be cleared for sowing
Manual farming system		Harvesting	
Tillage			
Reduced and no tillage		Perennial crop	Perennial crop
Irrigated	Drip irrigation in large scale production in coastal areas		Coastal areas
Rain fed			
Mono-cropping			
Multi-cropping			However, since Jatropha is toxic, there are limitations to intercropping with edible crops
Crop rotation		Perennial crop	Perennial crop
Mineral fertilizer used			
Chemical pesticides used			
GMO seeds for sowing			
Land preparation with fire			
By-products (from harvesting)	Tops and leaves from mechanical harvesting are left on the field		Fruit husks planned to be used for biogas production

Legend: Blue = occurring; orange = not occurring; white = occurrence unknown due to lack of information

Sources: (Brittaine and Lutaladio, 2010; Garcia, 2010; Khwaja, 2010; NL EVD Internationaal, 2009; Schweizer, 2009; USDA, 2009)

[81] It is difficult to estimate, from the information available, which production system is dominant today – large scale or small scale. By 2013, however, it is anticipated that nearly 50 percent of jatropha planting will be large scale.

Oil palm plantations in Peru have in some cases been found to divert the course of streams and drying up watercourses. Primary forests have been cleared for the development of oil palm plantations, primarily in the San Martin region, despite legal measures imposed. In some areas, oil palm plantations are established on farmland rather than abandoned or degraded land which can cause loss of agro-biodiversity (Garcia, 2010). Observed local environmental impacts from sugarcane, oil palm and jatropha production in Peru are summarised in Table 108.

Jatropha is part of the native flora in Peru. Production for biodiesel is still at an experimental stage and a number of jatropha pilot projects are implemented in the Amazon region (Garcia, 2010). Peru has implemented legislation that makes it obligatory to blend a minimum of 2.5% of biodiesel into fossil diesel fuel (NL EVD Internationaal, 2009). Current and planned production targets both domestic and international markets. By 2013, it is anticipated that nearly 50% of jatropha plantings will be large-scale, of which more than 20% will be plantations larger than 1 000 hectares. Areas that are used, or targeted, for jatropha are previously cleared forests, although often with secondary vegetation. Jatropha is observed to improve soil structure and is strongly believed to control and prevent soil erosion (Brittaine and Lutaladio, 2010). Fruit husks can be used for biogas production (Achten et al, 2007).

Table 108. Observed local environmental impacts from sugarcane, oil palm and jatropha production in Peru

Environmental impact	Sugarcane	Oil Palm	Jatropha
Deforestation			
Loss of agro-biodiversity			
Loss of biodiversity			
Air pollution			
Water pollution			
GMO contamination			
Eutrophication			
Soil fertility decline			
Erosion			

Legend: Red = occurring; green = not occurring; white = occurrence unknown due to lack of information
Sources: (Brittaine and Lutaladio 2010; Garcia 2010; Khwaja 2010; NL EVD Internationaal 2009; Schweizer 2009; USDA 2009)

Local environmental impacts allocated to domestic biofuel production

The share of the total sugarcane area that was harvested for domestic biofuel production was 5.3% in 2008. Since sugarcane cultivation for domestic biofuels has the same characteristics as sugarcane cultivation for other purposes, local environmental impacts are also the same and the importance of domestic biofuel production is proportional to the share of the total sugarcane area used for production of domestic biofuels (5.3%).

Since no production of domestic biofuels from oil palm has been identified for 2008; no local environmental impacts from cultivation of oil palm can be allocated to domestic biofuel production in Peru.

Local environmental impacts allocated to EU biofuel demands

The share of the total sugarcane area that was harvested for EU biofuel production was 3.6% in 2008. Since sugarcane cultivation for EU biofuel production has the same characteristics as sugarcane cultivation for other purposes, local environmental impacts are also the same and the importance of EU biofuel demand is proportional to the share of the total sugarcane area used for EU biofuel production (3.6%).

Since no feedstock for EU biofuels in 2008 has been traced to oil palm produced in Peru; no local environmental impacts from cultivation of Peruvian oil palm can be allocated to EU biofuel demands.

References

Achten et al., 2007. Jatropha biodiesel fueling sustainability? *Biofuels, Bioproducts and Biorefining*, 1(4), pp.283-291.

Brittaine, R. and Lutaladio, N., 2010. *Jatropha: A Smallholder Bioenergy Crop. The Potential for Pro-Poor Development*. Rome: Food and Agriculture Organization of the United Nations (FAO) and International Fund for Agricultural Development (IFAD) (Integrated Crop Management Vol. 8–2010).

FAO, 200-. *FAO country profile: Peru. Misc. maps*. Available at: http://www.fao.org/countryprofiles/ Accessed on June 16, 2011.

Garcia, H., 2010. Understanding the Bioenergy and Food security policy in landscape in Peru. In Y. Khwaja, ed. *Bioenergy and food security – The BEFS Analysis for Peru supporting the policy machinery in Peru*. Rome: Food and Agriculture Organization of the United Nations (FAO). Ch 2.

Khwaja, Y. ed., 2010. *Bioenergy and food security – The BEFS Analysis for Peru supporting the policy machinery in Peru*. Rome: Food and Agriculture Organization of the United Nations (FAO). Available at: http://www.fao.org/docrep/013/i1713e/i1713e00.pdf Accessed on June 28, 2011.

Klaren, P.F., 2005. The Sugar Industry in Peru. *Revista de Indias*, 65(233) pp. 33-48.

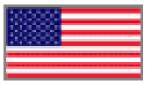
NL EVD Internationaal, 2009. *Peru: Natural Plant Oil Production in Ucayali*. Available at: http://www.fibronot.nl/download/Bioshape-in-Peru.pdf Accessed on May 24, 2011.

Schweizer, T., 2009. Agricultural potential of bioenergy production in Peru. With special focus on the impact on smallholders using the example of Jatropha curcas.

Stuttgart: University of Hohenheim. (Master thesis at the Institute for farm management)

USDA, 2011. *Peru: Sugar Annual Report*. Available at: http://gain.fas.usda.gov/Recent%20GAIN%20Publications/Commodity%20Report_SUGAR%20ANNUAL_Lima_Peru_4-8-2009.pdf Accessed on May 24, 2011.

I 8 United States



Selected biofuel crops for USA include maize and soybean. As seen in Table 109, very little maize ethanol for the EU market has been traced to USA, but about 28% of the total area under maize cultivation in 2008 was used for domestic ethanol production. About 11% of the total area under soybean cultivation in 2008 was used for domestic biodiesel production and about 4% of the total area was used for production of biodiesel or -feedstock for the EU market. It should be noted that ethanol and biodiesel are not the sole products associated with these areas; co-products include for example animal feed.

Table 109. Area used for production of USA's selected biofuel crops, including areas used for domestic biofuel production and feedstock for biofuels on the EU market in 2008

Crop	Total harvested area in 2008 (kha)	Cropland used for domestic biofuel production in 2008		Cropland used for production of feedstock for EU biofuels in 2008	
		kha	% of total	kha	% of total
Maize	31,796	8,994	28.3%	0.3	0.0%
Soybean	30,223	3,290	10.9%	1,270	4.2%

Source: FAOSTAT (land data); Agra CEAS and Ecofys (biofuel production and trade data).

Maize

As seen in Figure 132, pastures constitute a slightly larger share of the total agricultural land in USA than cultivated land. Permanent crops are uncommon, making cultivated land dominated by annual crops. Maize cultivation in 2008 constituted about 19% of the total area under annual crops, making it an important crop in USA's agriculture. Ethanol for domestic use is an important application for maize, although very little was exported to the EU in 2008. As already noted, co-products, such as animal feed, is likely to be produced on the same land as maize ethanol.

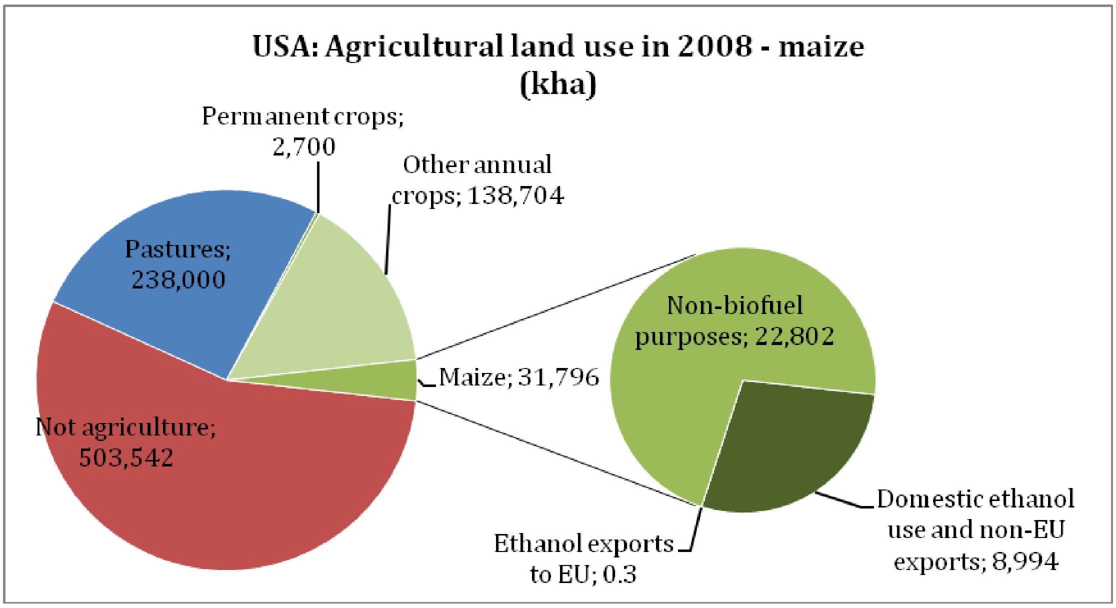


Figure 132. Agricultural land use in USA in 2008, focused on maize production.

Historical developments

Between 1990 and 2008, maize production in USA increased with 52%. As seen in Figure 133, the increase has been made possible mainly by increasing yields (+30%), although to some extent also by an increased harvested area (+17%). Maize acreage in the United States has varied since 1900 from a high of 116 million acres in 1917 to a low of 64 million acres in 1969 (Larson and Cardwell 1999).

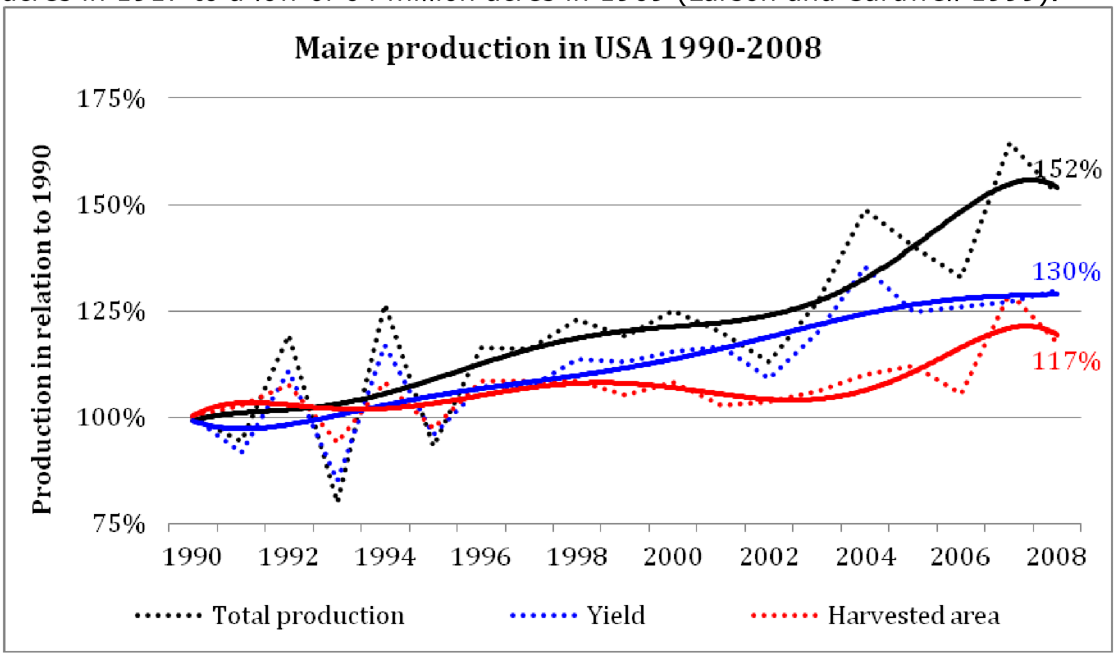


Figure 133. Change in maize production, yields and harvested area in USA, 1990-2008

Maize is cultivated in most U.S. States, although, as illustrated in Figure 134, production is concentrated to the Heartland region (Illinois, Iowa, Indiana, eastern portions of South Dakota and Nebraska, western Kentucky and Ohio, and the northern two-thirds of Missouri), also known as the *Corn Belt*. Iowa and Illinois are particularly important, constituting about one-third of the total maize production (USDA-ERS 2011a).

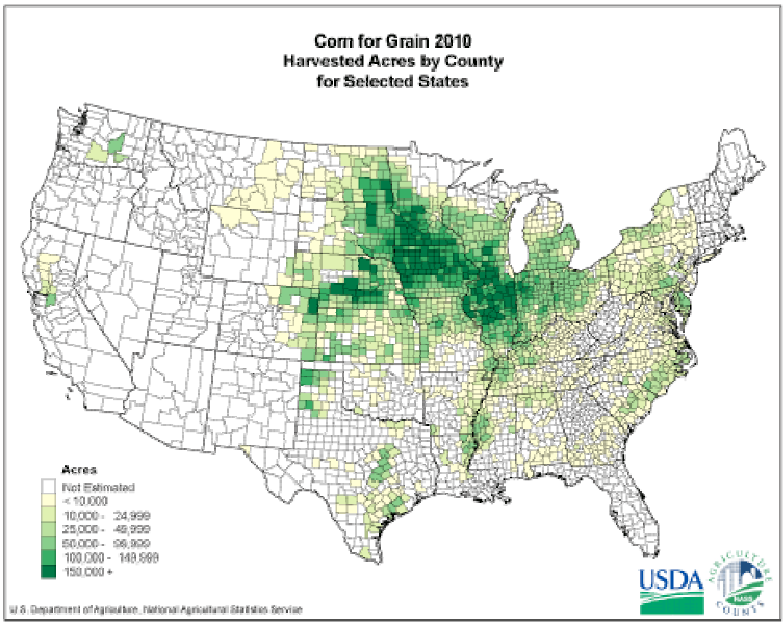
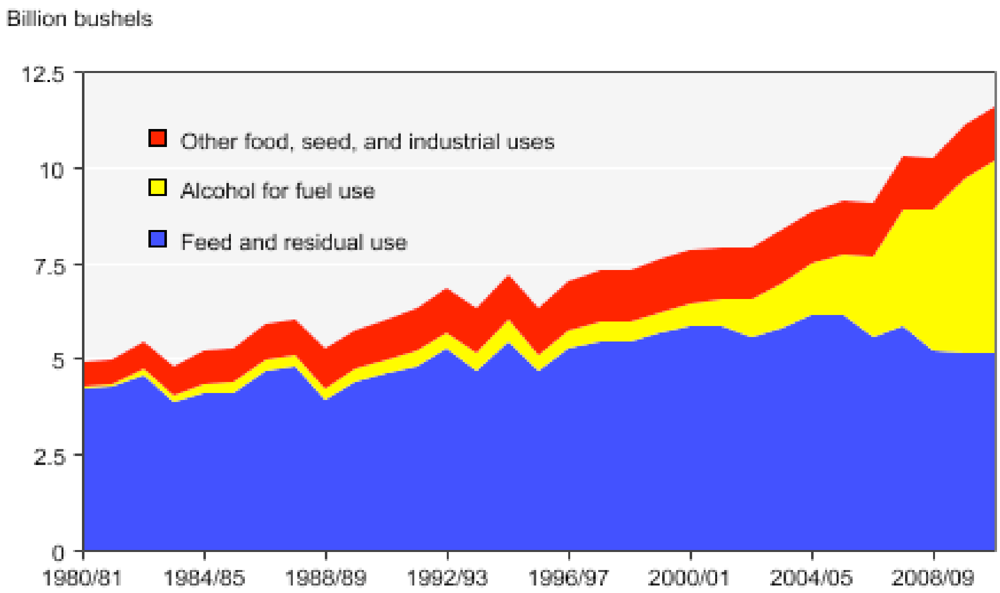


Figure 134. Geographical overview of maize cultivation in USA[82]

As already mentioned, maize acreage in the United States has, although fluctuated, not increased during the past century. The recent increase can, at least to some extent, be the result of the *Federal Agriculture Improvement and Reform Act of 1996*, which allows farmers to make their own crop planting decisions based on the most profitable crop for a given year. As illustrated in Figure 135, much of the increase since 2000 can be explained by an increased demand for ethanol fuel (USDA-ERS 2011a).

[82] Source: USDA-NASS 2011



Source: (USDA-ERS 2011)

Figure 135. Different uses of maize in USA during 1980-2009

Most of the fields in the Corn Belt now planted to grains were opened from forests or prairie in the last half of the 19th Century (Runge 2002). Wescott (2007) suggests that recent maize expansion has been made possible mainly by adjusting crop rotations between corn and soybeans.

Land-use dynamics from future production increases

The Energy Independence and Security Act of 2007 (EISA) restricts where feedstock for biofuels can be produced for compliance with the U.S. Renewable Fuels Standards RFS2. For planted crops/crop residue from agricultural land and planted trees/tree residue from actively managed tree plantations on non-federal land, feedstock must come from land cleared/cultivated prior to December 19, 2007 (USDA 2010). Therefore, a potential expansion of maize production for ethanol purposes is not likely to occur on natural vegetation. However, since exported ethanol does not need to comply with the EISA standard, maize for such purposes may therefore be produced on land cleared after 2007. An anonymous reviewer indicated though that such a scenario is unlikely, due to legislation and other incentives for protecting remaining natural vegetation.

USDA (2010) suggests that an increased production of maize is possible mainly in the *central east region*, including Delaware, Iowa, Illinois, Indiana, Kansas, Missouri, Ohio, Oklahoma, Maryland, Minnesota, Nebraska, North Dakota, Pennsylvania, South Dakota, Wisconsin and Virginia. The *northeast region*, including Connecticut, Massachusetts, Maine, Michigan, New Hampshire, New Jersey, New York, Rhode Island, Vermont and West Virginia, also hold potential to increase maize production. This means that much of the expected increase in maize production is predicted to occur near the current main maize production areas.

Soybeans compete most directly with maize and on the largest amount of land. Thus, much of the expansion in maize plantings is likely to come from soybean plantings. In the Corn Belt, where maize and soybeans are frequently used in rotations, planting maize one year and soybeans the next, some of the acreage shift can occur by changing rotational practices. For example, the rotation might be changed to planting maize 2 years successively, with soybeans planted every third year (Wescott 2007). This is supported by results from various CGE models:

- The GTAP model (Hertel et al. 2010 in Edwards et al. 2010), reports that 25% of a potential 252 kha increase in maize acreage would be on the expense of soybean.
- The IMPACT model (Edwards et al. 2010), reports that 18% of a potential 54.4 kha increase in maize acreage would be on the expense of soybean.
- Searchinger et al. (2008) reports that 41% of a potential 4 Mha increase in maize acreage would be on the expense of soybean.

Other sources of land for increased maize plantings include pastures, reduced fallow, acreage returning to production from expiring Conservation Reserve Program (CRP) contracts, and shifts from other crops such as cotton (Wescott 2007; USDA 2010). Again, CGE models suggest similar scenarios:

- GTAP (Hertel et al. 2010 in Edwards et al. 2010) reports that 22% of a potential 252 kha increase in maize acreage would occur on pastures and 25% would be on the expense of wheat production.
- Searchinger et al. (2010) reports that 33% of a potential 7.864 Mha increase in maize acreage would be on the expense of wheat production.

Even though a direct expansion of maize on natural vegetation seems unlikely, unless potentially on land previously under CRP contracts, maize expansion on pastures or replacement of other crops could result in a displacement of such agricultural activities into other areas, potentially on natural vegetation. Little detailed information about such dynamics has been found in scientific literature and in CGE models. In an attempt to assess which types of ecosystems that are more or less likely to be converted in case of a direct maize expansion or a resulting displacement of agricultural activities on natural vegetation, an overlay has been made of the USDA-NASS's (2011) map on maize production with a map over areas where maize production is predicted by the USDA (2010) to increase in a near future (i.e. the *central east region* or the *northeast region*, as previously discussed).

As seen in Table 110, most states that are likely to increase corn production contain *forest and woodland systems*, five states contain *grassland systems* and three states contain *shrubland, steppe and savannah systems*. Three states contain little natural vegetation making a potential direct or indirect expansion on natural vegetation unlikely.

Table 110. Existence of grassland-, forest and woodland- and shrubland steppe and savannah systems in the central east and northeast regions, by state.

Most natural vegetation already converted - potential expansion on natural vegetation is unlikely	Potential direct or indirect expansion on *grassland systems* possible	Potential direct or indirect expansion on *forest and woodland systems* possible	Potential direct or indirect expansion on *shrubland, steppe and savannah systems* possible
Delaware, Iowa, Illinois	North Dakota, South Dakota, Nebraska, Kansas, Oklahoma	Minnesota, Wisconsin, Indiana, Missouri, Ohio, Pennsylvania, Maryland, Virginia, Connecticut, Massachusetts, Maine, New Hampshire, New Jersey, New York, Rhode Island, Vermont and West Virginia, Wisconsin, Michigan, Oklahoma	Wisconsin, Michigan, Oklahoma

It should be noted that management of natural vegetation in the United States is managed on a state-by-state basis and different states have differently strict regulations. There is also a distinction between national land (national forests) and private land, which is typically less regulated. Therefore, state regulations for the states in Table 110 need to be carefully assessed in order to evaluate the legislative protection for natural vegetation. In addition, other incentives to protect natural vegetation (e.g. CRP contracts) in each state need to be assessed to fully understand where potential direct or indirect conversion of natural vegetation is likely to occur.

Indirect effects outside the United States, e.g. displacement of soybean production to Latin America, as discussed by for example Morton et al. (2006 in Searchinger et al. 2008), have not been treated in this study.

Soybean

As already described, pastures constitute a slightly larger share of the total agricultural land in USA than cultivated land. Permanent crops are uncommon, making cultivated land dominated by annual crops. As seen in Figure 136, soybean cultivation in 2008 constituted about 18% of the total area under annual crops (about the same as maize) making it an important crop in USA's agriculture. Biodiesel is a rather important application for soybean and a significant share of the produced biodiesel was exported to the EU in 2008, as well as smaller amounts of unprocessed feedstock for EU biodiesel. As already noted, co-products, such as animal feed, are likely to be produced on the same land as soybean biodiesel.

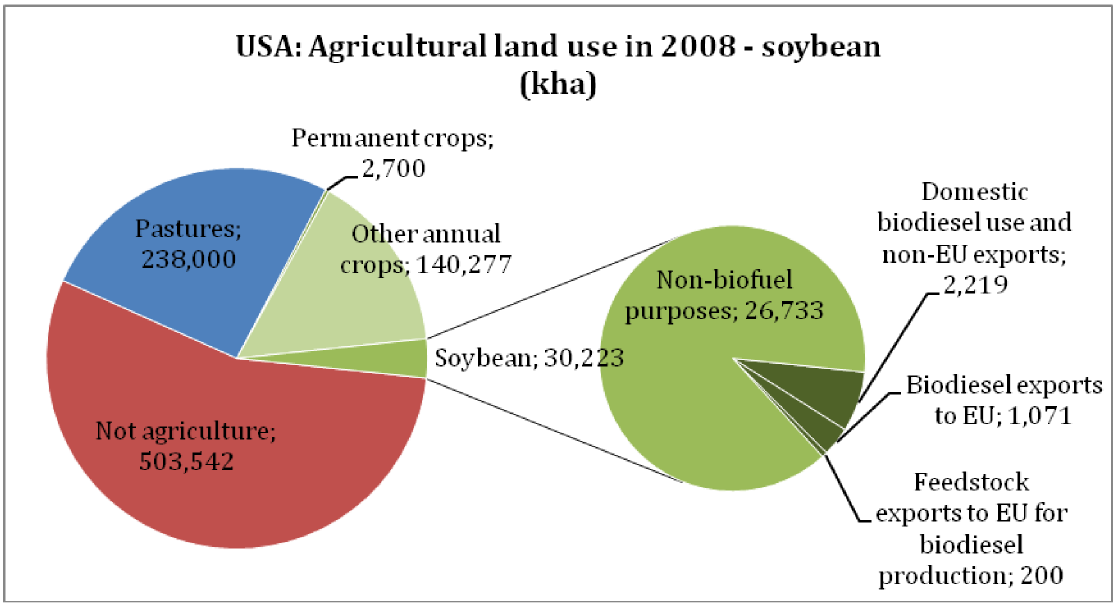


Figure 136. Agricultural land use in USA in 2008, focused on soybean production

Large-scale production of soybean in USA did not occur until the 20th century. Today, soybean is the second most planted field crop in the United States only trailing corn.

Historical developments

Between 1990 and 2008, soybean production in USA increased with 54%. As seen in Figure 137, the increase has been made possible both by an increased harvested area (+32%), and increasing yields (+17%).

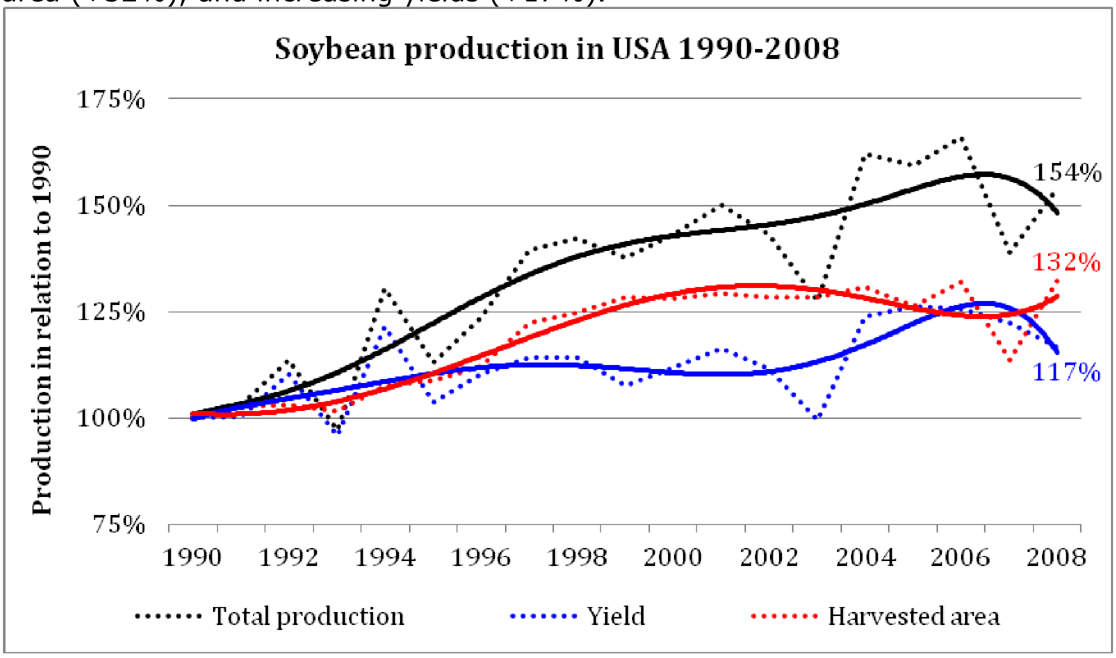
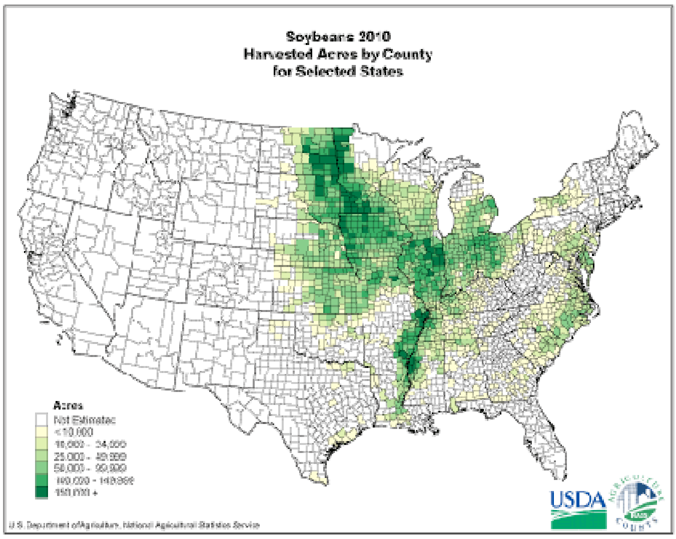


Figure 137. Change in soybean production, yields and harvested area in USA, 1990-2008

During the 20[th] century, soybean expansion was favoured by increased planting flexibility, steadily rising yield improvements from narrow-rowed seeding practices, a greater number of 50-50 corn-soybean rotations, and low production costs (partly due to widespread adoption of maize-tolerant varieties). Today, as illustrated in Figure 138, more than 80% of U.S. soybean acreage is concentrated in the upper Midwest (i.e. the Corn Belt), although significant amounts are still planted in the historically important areas of the Delta (western Arkansas, eastern Mississippi and northeastern Louisiana) and Southeast. Acreage tends to be concentrated where soybean yields are highest (USDA-ERS 2011b).



Source: (USDA-NASS 2011)

Figure 138. Geographical overview of soybean cultivation in USA

Most of the fields in the Corn Belt now planted to grains were opened from forests or prairie in the last half of the 19th Century (Runge 2002).

Land-use dynamics from future production increases

In contrary to the case with ethanol and maize, an increased demand for biodiesel may have little effects on soybean acreage. Bauen et al. (2010) reports that soybean acreage is only influenced by demand for soybean meal, i.e. within certain limits an increase in price for soy oil will not lead to an increase in the area of soybeans grown. ABIOVE (2009 in Bauen et al. 2010) states that: "It is a mistake to believe that the private sector will make decisions based on just 1/5 of the product (i.e. the oil), without a defined market for the other 4/5 (i.e. the meal)". Therefore, Bauen et al. (2010) assumes that neither soybean acreage nor yields would be affected by increased demand for soy oil. They do suggest that this assumption should be investigated further, and since the USDA (2010) reports that the EISA requires an increased U.S soybean production in order to meet the national targets for advanced biofuels, this study suggests that soybean expansion in the U.S due to an increased demand for biodiesel, national as well as international, cannot be discarded.

As for maize, the Energy Independence and Security Act of 2007 (EISA) restricts where feedstock for biofuels can be produced for compliance with the U.S. Renewable Fuels Standards RFS2. For planted crops/crop residue from agricultural land and planted trees/tree residue from actively managed tree plantations on non-federal land, feedstock must come from land cleared/cultivated prior to December

19, 2007 (USDA 2010). Therefore, a potential expansion of soybean production for biodiesel purposes is not likely to occur on natural vegetation. However, since exported biodiesel does not need to comply with the EISA standard, soybean for such purposes may therefore be produced on land cleared after 2007. An anonymous reviewer indicated though that such a scenario is unlikely, due to legislation and other incentives for protecting remaining natural vegetation.

USDA (2010) suggests that an increased production of soybean is possible in the *central east region* (including Delaware, Iowa, Illinois, Indiana, Kansas, Missouri, Ohio, Oklahoma, Maryland, Minnesota, Nebraska, North Dakota, Pennsylvania, South Dakota, Wisconsin and Virginia), the *northeast region* (including Connecticut, Massachusetts, Maine, Michigan, New Hampshire, New Jersey, New York, Rhode Island, Vermont and West Virginia) and the *southeast region* (Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, South Carolina, Tennessee and Texas) As for maize, much of the expected increase in soybean production is predicted to occur near the current main soybean production areas.

As already discussed in the U.S. maize section, soybeans and maize, even though rotated for mutual benefit, are in direct competition on a large amount of land. In the Corn Belt, where soybean is typically rotated with maize, acreage shifts are therefore possible by changing rotational practices (Wescott 2007). However, in the Delta region, particularly in eastern Arkansas where rotation with maize is less common, such soybean-maize acreage shifts are not feasible.

Considering that an increased maize acreage in areas where soybeans and maize are typically rotated, automatically result in increased soybean acreage. Therefore, some possibilities for maize expansion, as discussed in the U.S maize section, can also be relevant for soybeans. Examples on areas where soybean acreage can be increased include pastures, reduced fallow, areas returning to production from expiring CRP contracts, and shifts from other crops such as cotton, wheat or rice (primarily in the Delta region).

As for maize, soybean expansion on natural vegetation is in most cases not likely to occur. However, soybean expansion on pastures or replacement of other crops could result in a displacement of such agricultural activities into other areas, potentially on natural vegetation. Little detailed information about such dynamics has been found in scientific literature and in CGE models. In an attempt to assess which types of ecosystems that are more or less likely to be converted in case of a direct soybean expansion or a resulting displacement of agricultural activities on natural vegetation, an overlay has been made of the USDA-NASS's (2011) map on soybean production with a map over areas where maize production is predicted by the USDA (2010) to increase in a near future (i.e. the *central east region* or the *northeast region*, as previously discussed).

As seen in Table 111, most states that are likely to increase corn production contain *forest and woodland systems*, six states contain *grassland systems* and five states contain *shrubland, steppe and savannah systems*. Five states contain little natural vegetation making a potential direct or indirect expansion on natural vegetation unlikely.

Table 111. Existence of grassland-, forest and woodland- and shrubland steppe and savannah systems in the central east, northeast and southeast regions, by state

Most natural vegetation already converted - potential expansion on natural vegetation is unlikely	**Potential direct or indirect expansion on *grassland systems* possible**	**Potential direct or indirect expansion on *forest and woodland systems* possible**	**Potential direct or indirect expansion on *shrubland, steppe and savannah systems* possible**
Delaware, Iowa, Illinois, Florida, Louisiana	North Dakota, South Dakota, Nebraska, Kansas, Oklahoma, Texas	Minnesota, Wisconsin, Indiana, Missouri, Ohio, Pennsylvania, Maryland, Virginia, Connecticut, Massachusetts, Maine, New Hampshire, New Jersey, New York, Rhode Island, Vermont, West Virginia, Wisconsin, Michigan, Oklahoma, Alabama, Arkansas, Georgia, Kentucky, Mississippi, North Carolina, South Carolina, Tennessee, Texas	Wisconsin, Michigan, Oklahoma, Tennessee, Texas

It should be noted that management of natural vegetation in the United States is managed on a state-by-state basis and different states have differently strict regulations. There is also a distinction between national land (national forests) and private land, which is typically less regulated. Therefore, state regulations for the states in Table 110 need to be carefully assessed in order to evaluate the legislative protection for natural vegetation. In addition, other incentives to protect natural vegetation (e.g. CRP contracts) in each state need to be assessed to fully understand where potential direct or indirect conversion of natural vegetation is likely to occur.

Correlation between maize and soybean production

As described in the U.S. maize and -soybean sections, and illustrated in Figure 139, maize-soybean rotations are very common, particularly in the Corn Belt, and they are thus typically cultivated in the same areas. Since farmers may change rotational practices based on which crop that would be most profitable to produce, maize and soybean acreage may thus be shifted.

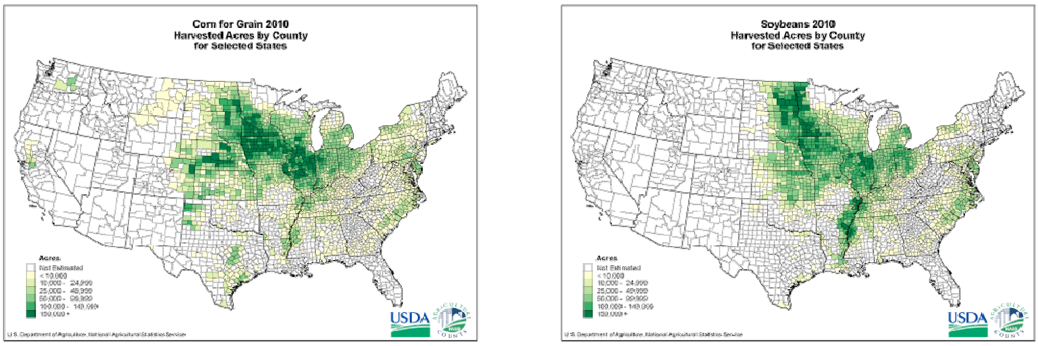


Figure 139. Geographical distribution of maize (left) and soybean (right) in USA
Source: (USDA-NASS 2011)

In an attempt to better understand how much the correlation between maize and soybean production affect their total annual changes in acreage, the annual changes in harvested area for maize and soybean, respectively, have been plotted in Figure 140 for the period 1990-2008.

It is obvious that not all of the annual changes in maize or soybean acreage can be explained by opposite changes for the other crop. In some years there has been an increased acreage for both crops, while other years show a mutual decreased acreage. However, in some years there seem to be a clear negative correlation between the crops, particularly apparent in the recent years 2006-2009. This means that even though the maize-soybean correlation is indisputable (due to the fact that maize-soybean rotations are very common), it cannot explain all, or even most, of the historical dynamics in maize and soybean acreage.

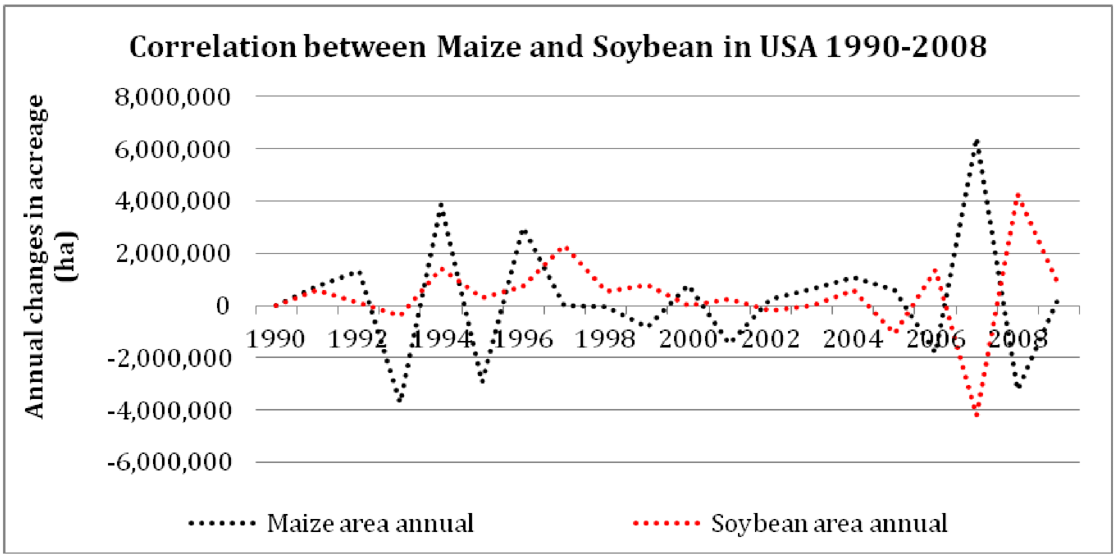


Figure 140. Annual changes in maize and soybean acreage 1990-2008
Source: FAOSTAT data

Production system characteristics and local environmental impacts

Production system characteristics for maize, soybean and sugarcane in USA are summarised in Table 112.

Table 112. Production system characteristics for maize, soybean and sugarcane in USA

System component	Maize	Soybean	Sugarcane
Large scale	Dominant	65%	Dominant
Small scale		35%	
Mechanized farming system			
Manual farming system			
Tillage		12%	
Reduced and no tillage		88%	
Irrigated	15%	7.5 %	
Rain fed			Dominant
Mono-cropping			
Multi-cropping			
Crop rotation	E.g. alfalfa, soybeans and wheat	E.g. corn, wheat, rice sorghum	
Mineral fertilizer used		Soybean is a biological nitrogen fixer and no or little nitrogen is therefore needed to add	
Chemical pesticides used		Particularly herbicides)	
GMO seeds for sowing	"Bt maize" produces toxins that kill certain insect pests, particularly the European corn borer and the South-western corn borer and represent 57 per cent of maize grown in the USA	92%	
Land preparation with fire			Burning after harvest
By-products (from harvesting)			Tops and leaves from mechanical harvesting are left on the field

Legend: Blue = occurring; orange = not occurring; white = occurrence unknown due to lack of information

Sources: (Ackerman et al., 2003; CAST, 2009; Dale et al., 2002; de Fraiture et al., 2008; Goldemberg et al., 2008; Proforest, 2010; Rice, 2007; USDA, 2009a).

Observed local environmental impacts from maize, soybean and sugarcane production in USA are summarised in Table 113.

Table 113. Observed local environmental impacts from maize, soybean and sugarcane production in USA

Environmental impact	Maize	Soybean	Sugarcane
Deforestation			
Loss of agro-biodiversity			
Loss of biodiversity			
Air pollution			
Water pollution			
GMO contamination			
Eutrophication			
Soil fertility decline			
Erosion			

Legend: Red = occurring; green = not occurring; white = occurrence unknown due to lack of information

Sources: (Ackerman et al., 2003; CAST, 2009; Dale et al., 2002; de Fraiture et al., 2008; Goldemberg et al., 2008; Proforest, 2010; Rice, 2007; USDA, 2009a).

Local environmental impacts allocated to domestic biofuel production

The share of the total maize area that was harvested for domestic biofuel production was 28.3% in 2008. However, the net area requirement is lower since maize biofuel production generates by-products that substitutes for other crop production: using RED allocation principles the area allocated to biofuels corresponded to 15.4% of the total maize area in 2008. Since maize cultivation for domestic biofuels has the same characteristics as maize cultivation for other purposes, local environmental impacts are also the same and the importance of domestic biofuel production is proportional to the share of the total maize area used for production of domestic biofuels (15.4%). It should be noted that maize for production of domestic biofuels in 2008 was cultivated on 8994 kha, which is a significant amount of land.

The share of the total soybean area that was harvested for domestic biofuel production was 10.9% in 2008. However, the net area requirement is lower since soybean biofuel production generates by-products that substitutes for other crop production: using RED allocation principles the area allocated to biofuels corresponded to 3.6% of the total soybean area in 2008. Since soybean cultivation for domestic biofuels has the same characteristics as soybean cultivation for other purposes, local environmental impacts are also the same and the importance of domestic biofuel production is proportional to the share of the total soybean area used for production of domestic biofuels (3.6%). It should be noted that soybeans for production of domestic biofuels in 2008 was cultivated on 3290 kha, which is a significant amount of land.

Local environmental impacts allocated to EU biofuel demands

The share of the total maize area that was harvested for EU biofuel production was close to 0% in 2008. Therefore, no local environmental impacts from cultivation of maize can be allocated to EU biofuel demands.

The share of the total soybean area that was harvested for EU biofuel production was 4.2% in 2008. However, the net area requirement is lower since soybean biofuel production generates by-products that substitutes for other crop production: using RED allocation principles the area allocated to biofuels corresponded to 1.4% of the total soybean area in 2008. Since soybean cultivation for EU biofuels has the same characteristics as soybean cultivation for other purposes, local environmental impacts are also the same and the importance of EU biofuel demand is proportional to the share of the total soybean area used for EU biofuel production (1.4%). It should be noted that soybeans used for EU biofuel production in 2008 was cultivated on 1444 kha, which is a significant amount of land.

References

Bauen, A., Chudziak, C., Vad K. and Watson, P., 2010. *A causal descriptive approach to modelling the GHG emissions associated with the indirect land use impacts of biofuels*. Available at: http://www.dft.gov.uk/pgr/roads/environment/research/biofuels/pdf/report.pdf Accessed on April 28, 2011.

Edwards, R., Mulligan, D. and Marelli, L., 2010. JRC Scientific and Technical Reports: Indirect Land Use Change from increased biofuels demand. Comparison of models and results for marginal biofuels production from different feedstocks. Available at: http://ec.europa.eu/energy/renewables/consultations/doc/public_consultation_iluc/study_4_iluc_modelling_comparison.pdf Accessed on April 27, 2011.

Hertel, T. W., Tyner W. E. and Birur D. K., 2010. Global Impacts of Biofuels. *Energy Journal*, 31(1), pp.75-100.

Larson, W. E.; Cardwell, V. B., 1999. *History of U.S. Corn Production.* University of Minnesota: Minneapolis. Available at: http://www.mindfully.org/Farm/US-Corn-Production1999.htm Accessed on April 14, 2011

Morton, D. C. et al., 2006. Cropland expansion changes deforestation dynamics in the southern Brazilian Amazon. *Proc Natl Acad Sci USA*, 103(39), pp.14637-14641.

Runge, C. F., 2002. *King Corn: The History, Trade and Environmental Consequences of Corn (Maize) Production in the United States*. Midwest Commodities & Conservation Initiative: Minnesota, USA. Available at: http://www.worldwildlife.org/what/globalmarkets/agriculture/WWFBinaryitem7205.pdf Accessed on April 14, 2011.

Sandretto, C. & Payne, J., 2006. *Agricultural Resources and Environmental Indicators, 2006 Edition / EIB-16, chapter 4.2: Soil Management and Conservation*. U.S. Department of Agriculture, Economic Research Service. Available at: http://www.ers.usda.gov/publications/arei/eib16/eib16_4-2.pdf Accessed on April 14, 2011

Searchinger, T. et al., 2008. Supporting Online Material for Use of U.S. Croplands for Biofuels Increases Greenhouse Gases Through Emissions from Land Use Change. Available at: http://www.sciencemag.org/content/suppl/2008/02/06/1151861.DC1/Searchinger.SOM.pdf Accessed on April 27, 2011.

USDA, 2010. *USDA Biofuels Strategic Production Report*. Available at: http://www.usda.gov/documents/USDA_Biofuels_Report_6232010.pdf Accessed on April 27, 2011.

USDA-ERS, 2011a. *U.S. Department of Agriculture, Economic Research Service: Corn Briefing Room.* Available at: http://www.ers.usda.gov/Briefing/Corn/ Accessed on April 14, 2011.

USDA-ERS, 2011b. *U.S. Department of Agriculture, Economic Research Service: Soybean and Oil Crops Briefing Room.* Available at: http://www.ers.usda.gov/Briefing/Corn/ Accessed on April 14, 2011.

USDA-NASS, 2011. *U.S. Department of Agriculture, National Statistics Service: Charts and Maps.* Available at: http://www.nass.usda.gov/Charts_and_Maps/Crops_County/index.asp Accessed on April 14, 2011.

USGS, 2009. *The Gap Analysis Program (GAP) national land cover viewer.* Available at: http://lc.gapanalysisprogram.com/landcoverviewer/Default.aspx Accessed on April 27, 2011.

Wescott, P. C., 2007. *Ethanol Expansion in the United States: How Will the Agricultural Sector Adjust*? U.S. Department of Agriculture, Economic Research Service. Available at: http://www.ers.usda.gov/Publications/FDS/2007/05May/FDS07D01/ Accessed on April 14, 2011

I 9 COUNTRY PROFILES – ASIA/UKRAINE

This section includes country profiles for Indonesia, Malaysia, India, Pakistan and Ukraine.

Regional conclusions

The most important crops for biofuel production in this region include oil palm, sugarcane, maize, jatropha, neem, rapeseed and sugarbeet.

The countries included in the study can be grouped into three groups, *Southeast Asia* (including Indonesia and Malaysia), *Pacific Asia* (including India and Pakistan) and *Europe* (including only Ukraine). Making general conclusions or a join summary would be unjust.

Southeast Asia

Both Indonesia and Malaysia contain high percentages of natural forest. Expansion of either oil palm or sugarcane may risk conversion of natural forest, in many cases highly carbon rich forest such as primary rainforest and forests on peatlands. The expansion is supported by the government as a mean for increasing exports of both feedstock and biofuels, although concerns about GHG emissions from deforestation are increasing. With an increased international demand for biofuels, oil palm production is likely to increase and, since the yield is already very high, the most likely outcome would be an expansion in planted area, at the expense of forests.

Pacific Asia

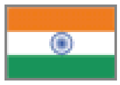
India has a strict no-deforestation policy, which has helped to halt deforestation and even resulted in some reforestation. Pakistan has very little forestland. India has vast areas of agricultural land while Pakistan is highly constrained when it comes to agricultural land, water availability being the primary limiting factor. As a result of an increased international demand for biofuels, domestic biofuel production in India and Pakistan might increase but most likely not on the expense of natural vegetation. An expansion on agricultural land would be an option, but that would require an increased irrigation and a price on either the feedstock or the end product – ethanol or biodiesel, which is higher than the price on the current crop. In India, and potentially also Pakistan, the government supports an expansion of biofuel feedstock production on wastelands, where the production would not compete with food production or negatively affect carbon balance.

Ukraine

About 70% of Ukraine’s total land area is already used for agriculture, mostly for cultivation of annual crops (56% of total land area). Forest and forest-covered areas constitute some 17% and built-up areas about 4%. Farmers employ a variety of crop-rotation schemes and increased production of biofuel crops will likely be achieved mainly by adjustments in crop rotations to increase the total area sown with such crops, reducing the area used for other crops such as barley and wheat and also reducing the fallow area. There is substantial scope for increasing yields in

Ukrainian agriculture and intensification may allow for increasing the production of both biofuel crops and other crops without expanding the total agricultural area significantly.

I 10 India



Selected biofuel crops for India include sugarcane, jatropha and neem. As seen in Table 114, more than 7% of the total area under sugarcane cultivation in 2008 was used for domestic ethanol production, although only very small amounts were exported to the EU. Domestic biofuel production from jatropha and neem has not been possible to identify or estimate.

Table 114. Area used for production of India's selected biofuel crops, including areas used for domestic biofuel production and feedstock for biofuels on the EU market in 2008

Crop	Total harvested area in 2008 (kha)	Cropland used for domestic biofuel production in 2008		Cropland used for production of feedstock for EU biofuels in 2008	
		kha	% of total	kha	% of total
Sugarcane	5,055	373	7.4%	0	0%
Jatropha	407	-	-	-	-
Neem	-	-	-	-	-

Source: FAOSTAT (land data); Agra CEAS and Ecofys (biofuel production and trade data).

As India's service sector has grown, agriculture's share of the GDP has dropped from 57% in 1950 to 22% in 2002. However, the agricultural sector provides income and employment to 233 million people, or almost 60% of the rural labour force. Farmers are mainly marginal farmers and smallholders cultivating land constituting less than one third of the country's total cultivated area (IFAD 2011). About two thirds of India's total area is under cultivation (FAO 2007), covering 180 Mha of which sugarcane is harvested on about 5 Mha. Irrigation is most common in the southern districts while the districts in the north are arid and holds little agriculture (FAO 2011).

Sugarcane

Historical developments

Between 1990 and 2008, sugarcane production in India increased by 54%. As seen in Figure 141, the increase has been made possible mostly by an increased harvested area, while yields have increased by 5% since 1990. The largest increase, both in harvested area and yields, has occurred since 2005.

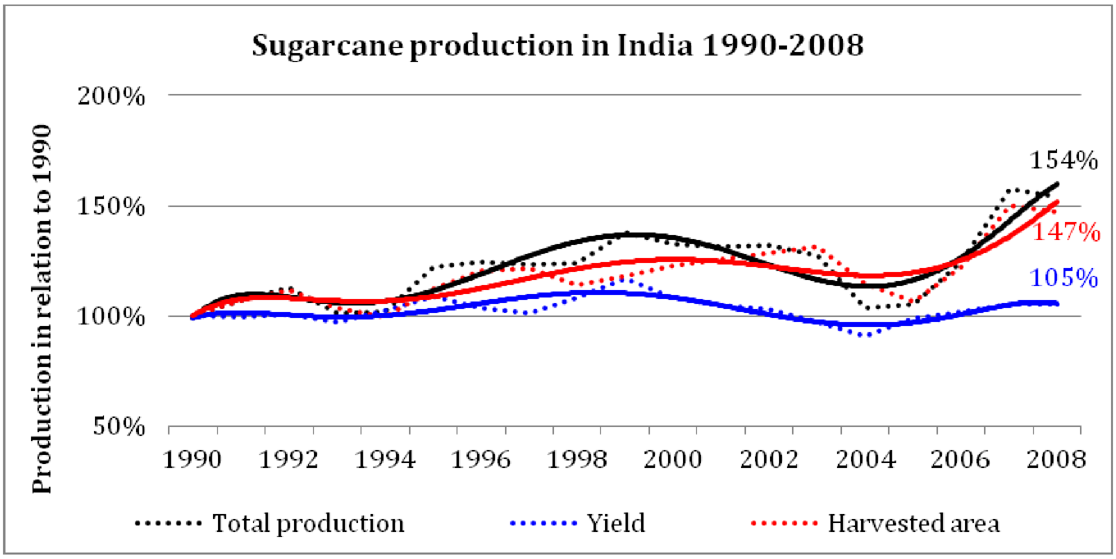


Figure 141. Change in sugarcane production, yields and harvested area in India, 1990-2008

In 2007/08 and 2008/09, Indian sugar production was on the downward side of the country's persistent cyclical fluctuations in production. Despite decreased harvested areas in 2009/10, sugar production increased by 7.3% because of higher yields. Sugar consumption fell by almost 3% in 2009/10. However, consumption is 6.2 MT higher than production, which resulted in an increase in net imports from 2.6 MT in 2008/09 to 6.0 MT in 2009/10 (FAPRI 2010).

Land-use dynamics from future production increases

In India, ethanol is produced mainly from molasses, a co-product in sugar production from sugarcane. India's ethanol production decreased 32.6%, from 1677 ML in 2008 to 1128 ML in 2009. However, production soon regained and is projected to increase by 113 % until 2019/20, resulting in a total production of 2403 ML (FAPRI 2010). According to FAPRI's (2010) projections, sugar production and consumption is projected to increase with 75.5% and 26.4%, respectively, by 2019/20. With the projected recovery in 2010/11, India becomes a net exporter, with net exports increasing and then declining over the projection period (FAPRI 2010).

Indian domestic ethanol consumption was 1790 ML in 2009/10 and is projected to increase with 48.3% to a total of 2658 ML in 2019/20. Currently, India is a net importer of ethanol with an import of 201 ML and is predicted to increase its import to 288 ML within the next 10 years (FAPRI 2010). This projection would require an increased production either from an expansion onto other areas or increased sugarcane yields. According to the Deininger et al (2011) there is in practice no land available for expansion. Any increase in production would thus come from increased yields rather than expansion onto non-agricultural land. Potential expansion on agricultural land might be possible, although not likely in areas with little potential for irrigation. Compared to other countries, India seems to have a rather good potential for increasing yields, although water availability might be constraining this. A potential expansion on natural vegetation is not likely.

Oilseed – Jatropha and Neem

Historical developments

India has a long history of producing oilseeds for various reasons, including medicine, fuel and food. Neem is a native species naturally appearing in forests, while Jatropha is a relatively new alien species originating from Latin America. Neem has been grown for a long time while the interest for Jatropha has emerged during the last 20 years.

Jatropha and Neem have become two of the most important crops for biofuel production in India and planting them in commercial plantations for biofuel purposes is a rather new concept, gaining more and more interest. Jatropha oil can be used directly after extraction (i.e. without refining) in diesel generators and engines. The production of Jatropha oil for biodiesel delivers economic benefits to India on the macroeconomic or national level as it reduces the nation's fossil fuel imports for diesel production, which is the main transportation fuel used in the country. One of the reasons for the large political and moral acceptance of Jatropha is the lack of dependence on agricultural land for expansion, unlike corn or sugarcane ethanol.

Land-use dynamics from future production increases

Due to the strict forest protection policy, which prohibits expansion of agriculture on natural forests, any expansion of biofuel crops in natural forest is unlikely. Other possibilities include an expansion onto agricultural or pasture land. Another possibility, which has been highlighted by the government, is the expansion of biofuel crops, especially Jatropha, onto degraded lands, in India called wasteland. Both Neem and Jatropha are hardy species that are resistant to drought and can survive on poor soils, which would make them suitable to be planted on wastelands (ICRAF 2009). However, yields are likely to be affected by the biophysical conditions and production would not be maximized. On the other hand, a study by Abou Kheira and Atta (2009) concludes that Jatropha can survive and produce full yields with high quality seeds on otherwise unproductive agricultural land and under minimum water requirements, without any significant effect of the oil composition. Foidl et al (1996) supports this theory and concludes that Jatropha is a wild species that doesn’t need irrigation to grow. Resent research show that Jatropha production on wastelands might even increase water availability downstream (see separate project report on *Water*).

In recent years, the Indian central Government as well as some State Governments has expressed their support for bringing wastelands, which cannot be used for food production, under cultivation for biofuel purposes (Kishwan et al. 2009). In 2003, the Indian Government announced the National Mission on Biofuel, which anticipated that 4 Mha of wasteland across the country would be converted to bioenergy crop, such as Jatropha and sweet sorghum, plantations by 2008-09. However, in 2008 the program was aborted due to a fear of land-grabbing by large energy companies. Another policy was established shortly after where the government introduced a general biofuel target aiming for a 20 % blend of biofuels, either ethanol or biodiesel in all petrol and diesel sold by the year 2017. The government stipulated that 11 Mha of plantations will be established nationwide to be able to cope with this target. Even though the policy is supposed to target wasteland, low Jatropha yields on wastelands has raised concerns that agricultural land can be used for the expansion instead (The Bioenergy Site 2010) altering the main argument for establishing Jatropha.

Production system characteristics and local environmental impacts

Production system characteristics for sugarcane, jatropha and neem in India are summarised in Table 115.

Table 115. Production system characteristics for sugarcane, jatropha and neem in India

System component	Sugarcane	Jatropha	Neem
Large scale			
Small scale			
Mechanized farming system			
Manual farming system			E.g. harvesting
Tillage			
Reduced and no tillage		Perennial	Perennial
Irrigated	Dominating		
Rain fed			
Mono-cropping	Dominating		
Multi-cropping	In some cases intercropping with crops like wheat, potato, cowpea, French bean, Chickpea, water melon, brinjal etc. in the initial state	E.g. ground nuts, pigeon pea. Research ongoing on suitable intercrops	
Crop rotation		Perennial crop	Perennial crop
Mineral fertilizer used			
Chemical pesticides used			
GMO seeds for sowing			
Land preparation with fire			
By-products (from harvesting)	Sugarcane tops can be used for feeding for animals when climate is relatively dry and sometimes also as fuel	Branches, leaves fruit shell and cake used for briquettes for heat or for biogas	

Legend: Blue = occurring; orange = not occurring; white = occurrence unknown due to lack of information
Sources: (Brittaine and Lutaladio, 2010; Cheesman, 2004; de Fraiture et al., 2008; FAO, 2005; Gonsalves, 2006; ICRISAT-WWF, 2009; Ministry of Agriculture)

Under marginal conditions jatropha does not reliably produce crop yields of commercial scale. The advantages that jatropha has on the small scale do not necessarily translate to plantation-scale cultivation. However, it is nitrogen-fixing and benefits from symbiosis with a fungus that can be inoculated so that the yield can be improved with about 15%. Most of the jatropha currently grown is toxic which renders the seedcake unsuitable for use as livestock feed unless detoxified and potentially a human safety hazard.

Observed local environmental impacts from sugarcane, jatropha and neem production in India are summarised in Table 116.

Table 116. Observed local environmental impacts from sugarcane, jatropha and neem production in India

Environmental impact	Sugarcane	Jatropha	Neem
Deforestation			
Loss of agro-biodiversity			
Loss of biodiversity			
Air pollution			
Water pollution			
GMO contamination			
Eutrophication			
Soil fertility decline			
Erosion			

Legend: Red = occurring; green = not occurring; white = occurrence unknown due to lack of information
Sources: (Brittaine and Lutaladio, 2010; Cheesman, 2004; de Fraiture et al., 2008; FAO, 2005b; Gonsalves, 2006; ICRISAT-WWF, 2009; Ministry of Agriculture; Uppal, 2008).

Local environmental impacts allocated to domestic biofuel production

The share of the total sugarcane area that was harvested for domestic biofuel production was 7.4% in 2008. Since sugarcane cultivation for domestic biofuels has the same characteristics as sugarcane cultivation for other purposes, local environmental impacts are also the same and the importance of domestic biofuel production is proportional to the share of the total sugarcane area used for production of domestic biofuels (7.4%).

Since no production of domestic biofuels from jatropha or neem has been identified for 2008; no local environmental impacts from cultivation of these crops can be allocated to domestic biofuel production in India. However, it is likely that biodiesel is being produced from both jatropha and neem in India, although to an unknown extent.

Local environmental impacts allocated to EU biofuel demands

Since no feedstock for EU biofuels in 2008 has been traced to jatropha or neem produced in India, and only small fractions of Indian sugarcane; no local environmental impacts from cultivation of these crops can be allocated to EU biofuel demands.

References

Abou Kheira, A.A. and Atta, N.M.M., 2009. Response of Jatropha Curcas L. to water deficit: yield, water use efficiency and oilseed characteristics. *Biomass and bioenergy*, 33(10), pp.1343-1350.

Bioenergy Site, the, 2010. Available at: http://www.thebioenergysite.com/news/5430/is-indias-miracle-biofuel-crop-too-good-to-be-true Accessed on January 27, 2010.

Brittaine, R. and Lutaladio, N., 2010. *Jatropha: A Smallholder Bioenergy Crop. The Potential for Pro-Poor Development*. Rome: Food and Agriculture Organization of the United Nations (FAO) and International Fund for Agricultural Development (IFAD) (Integrated Crop Management Vol. 8–2010).

Cheesman, O., 2004. *The environmental impacts of sugar production*. Trowbridge: CABI Publishing and WWF.

de Fraiture, C., Giordano, M., and Liao, Y., 2008. Biofuels and implications for agricultural water use: blue impacts of green energy. *Water Policy*, 10 Supplement 1, pp.67–81.

Deininger, K., Byerlee, D., Lindsay, J., Norton, A., Selod, H. and Stickler, M., 2011. *Rising global interest in farmland - can it yield sustainable and equitable benefits?* Washington DC: The International Bank for Reconstruction and Development/The World Bank.

FAO. 2005. *Fertilizer use by crop in India*. Rome: FAO - Land and Plant Nutrition Management Service Land and Water Development Division.

FAO, 2007. *FAO Country Profiles – India.* Available at: http://www.fao.org/countryprofiles/index.asp?lang=en&ISO3=IND Accessed on April 8, 2011.

FAO, 2011. *FAO country profile: India*. Available at: http://www.fao.org/countryprofiles/index.asp?lang=en&iso3=IND Accessed on May 30, 2011.

FAPRI, 2010. *FAPRI 2010 U.S. and World Agricultural Outlook*. Ames: Food and Agricultural Policy Research Institute, Iowa State University and University of Missouri-Columbia.

Foidl N., Foidl, G., Sanchez, M., Mittelbach, M. and Hackel, S., 1996. Jatropha curcas L. as a source for the production of biofuel in Nicaragua. *Bioresource Technology*, 58(1), pp.77-82.

Gonsalves, J.B., 2006. *An assessment of the biofuels industry in India*. United Nations Conference on Trade and Development. (UNCTAD/DITC/TED/2006/6).

ICRAF, 2009. *Agroforestree Database*. World Agroforestry Center. Available at: http://www.worldagroforestrycentre.org/sites/treedbs/aft.asp Accessed on October 1, 2009.

ICRISAT-WWF, 2009. Sustainable Sugarcane Initiative (SSI) - Improving Sugarcane Cultivation in India - Training Manual. Andhra Pradesh: ICRISAT - WWF Project.

IFAD, 2011. *Rural Poverty Portal*. Available at: http://www.ruralpovertyportal.org/web/guest/country/geography/tags/india Accessed on April 6, 2011.

Kishwan, J., Pandey, R and Dadhwal, V.K., 2009. *India's forest and tree cover: Contribution as a carbon sink*. Dehradun: The Indian Council of Forestry research and Education. (Technical paper No 130).

Ministry of Agriculture. *Neem -a versatile tree*. http://www.keralaagriculture.gov.in/htmle/bankableagriprojects/fw/neem.htm Accessed on February 27, 2011.

I 11 Indonesia

Selected biofuel crops for Indonesia include oil palm and sugarcane. As seen in Table 117, a rather small share (about 3%) of the total area under oil palm production in 2008 was used for domestic biodiesel production. However, about 4% of the total area was used for production of biodiesel and –feedstock for the EU market. The reason for this is that most (about 76%) of the EU palm oil biodiesel that originated from Indonesia in 2008 was processed outside Indonesia. It should be noted that some co-products are likely to have been produced on the same areas as biodiesel feedstock. About 10% of the total area under sugarcane cultivation in 2008 was used for domestic ethanol production, although none was exported to the EU.

Table 117. Area used for production of Indonesia's selected biofuel crops, including areas used for domestic biofuel production and feedstock for biofuels on the EU market in 2008

Crop	Total harvested area in 2008 (kha)	Cropland used for domestic biofuel production in 2008		Cropland used for production of feedstock for EU biofuels in 2008	
		kha	% of total	kha	% of total
Oil palm	5,000	142	2.8%	190	3.8%
Sugarcane	416	40	9.6%	0	0%

Source: FAOSTAT (land data); Agra CEAS and Ecofys (biofuel production and trade data).

Oil Palm

As seen in Figure 142, cultivated land constitutes a much larger share of the total agricultural land than pastures. Permanent crops are widespread, although slightly more land is used for the cultivation of annual crops. Oil palm production constitutes about one third of the total area under permanent crops, making it a very important crop in Indonesia's agriculture. Not much oil palm is used for domestic production of biodiesel, although significant amounts of Indonesian palm oil might be used for biodiesel production in other countries.

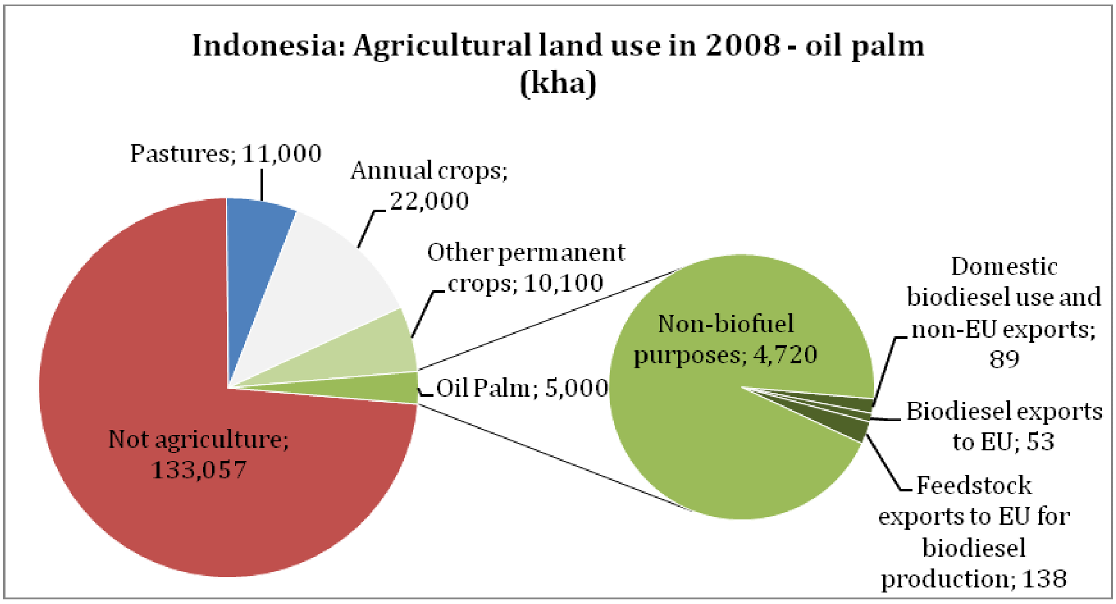


Figure 142. Agricultural land use in Indonesia in 2008, focused on oil palm production

Historical developments

Between 1990 and 2008, oil palm production in Indonesia increased more than 6.5 times. The increase was rather constant during 1990-1998 and then continued to be constant, but with a higher rate, between 1999-2008. As can be seen in Figure 143, yields have remained rather unchanged during the period, while acreage has increased in direct relation to production volumes. Therefore, oil palm production increases in Indonesia have been made possible due to a continuous expansion of oil palm plantations.

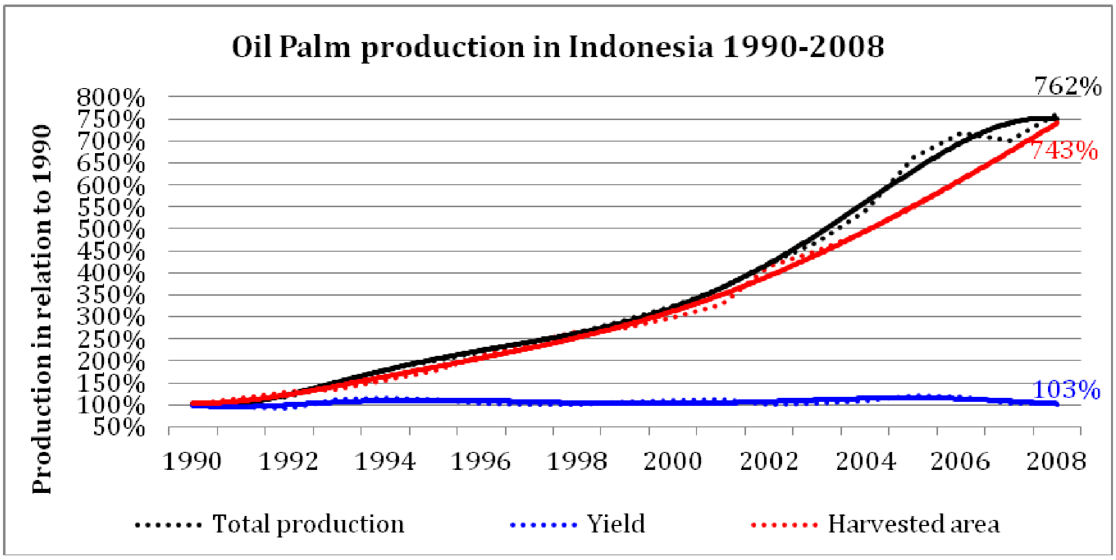


Figure 143. Change in oil palm production, yields and harvested area in Indonesia, 1990-2008

Historically, commercial oil palm cultivation started in Sumatra in 1911 while the expansion to other parts of Indonesia did not occur until the 1980s. Traditionally, oil palm plantations often have replaced forests previously degraded by fire and logging, although illegal oil palm developments have been reported inside protected areas.

Between 1990 and 2005 the area under oil palm production increased by 4.4 million ha to 6.1 million ha (MoA 2011), while total forest loss was 28.1 million ha. Hence, conversion to oil palm could account for at most 16% of recent deforestation. It has been estimated that 1.7–3.0 million ha of forest were lost to oil palm during this period (Fitzherbert et al 2008). However, Koh and Wilcove's (2008) analysis of land-cover data compiled by the FAO suggests that during the period 1990–2005 at least 56% of the oil palm expansion in Indonesia occurred at the expense of forests. It is clear that the uncertainties regarding these estimates are high and, as they exclude changes in unproductive land area and include only mature oil palm area, they could be over- or underestimates (FAO 2011).

The forest areas classified as conversion forest are allocated for utilization to non-forest uses. This mean that deforestation in these areas is planned losses within Indonesia's forest management framework. These planned losses constitute 25% of overall deforestation on state owned land. Areas of conversion forest are used for agriculture and plantation crops, and a high proportion is converted to timber (pulp) and oil palm plantations (the World Bank 2009). Some of this converted forest is swampland on peat soil, which represents only 5-8 Mha, but are likely among the most intensive sources of greenhouse gas emissions per hectare. Estimations show that approximately 25% of the historical oil palm establishments have been on peatlands. Because of high carbon concentrations in peat soil, smaller areas may lead to higher greenhouse gas emissions than deforestation on mineral soil, or "dry land". Developments of oil palm on peatlands cause irreversible damage to vulnerable ecosystems and require high levels of management to be sustainable (the World Bank 2009).

Land-use dynamics from future production increases

Even though the extent to which oil palm has been a direct cause of past deforestation is difficult to quantify, its potential as a future agent of deforestation is large (Fitzherbert et al. 2008). The demand for palm oil is predicted to continue increasing, and globally, most of the remaining areas suitable for planting are forested or under other land uses. Presently, relatively little oil palm is grown outside Southeast Asia, although, 410–570 million ha of currently forested land across Southeast Asia, Latin America and Central Africa are potentially suitable for oil palm cultivation and might be increasingly utilised as demand rises and agronomic advances are made (Fitzherbert et al. 2008).

According to projections made by FAPRI (2010) palm oil production is projected to increase by 35.7% from 21 Mt in 2009/10 to 28.5 Mt in 2019/20 (FAPRI 2010). Indonesia will continue to be a strong player in the international export of palm oil with a projected increase in export from 15.7 Mt during 2009/10 to 22.8 Mt in 2019/20, an increase of 45.2% (FAPRI 2010).

The biodiesel in Indonesia is produced mainly from palm oil. The amount produced feedstock for the biodiesel, in this case palm oil, was 84 kt in 2009/10 and is projected ton increase by 158,33% to 217 kt by 2019/20. (FAPRI 2010)

Indonesia's National Biofuel Development Committee has suggested that the government makes it mandatory for biofuels to constitute 2 to 2.5% of the nation's total fuel consumption (the World Bank 2009). This would result in an increase in the consumption of biofuel to 5.3 million kiloliters by 2010 and 9.8 million kiloliters by 2015. As in other countries, economic incentives and quotas are being suggested in Indonesia as means to stimulate the sector. This would equal 1.2 million to 1.5 million kiloliters (kl) per year. Tax exemptions for diesel fuel with biofuel added have been suggested by the industry at the same time as the Indonesian Biofuel Producers Association (APROBI) demanded the government to make biofuel use mandatory at 1% of the country's total fuel consumption as a way to help develop the industry.

The predicted domestic consumption of biodiesel in Indonesia was estimated by FAPRI (2010) at 11.4 ML in 2009/10 and is projected to increase 66.67%, to 19.0 ML, in 2019/20. At the same time Indonesia's net exports predicted to increase from 79.5 ML in 2009/10 to 219.5 ML in 2019/20.

Indonesia is actively promoting biofuel developments and oil palm expansion is often supported by the government (the World Bank 2009). As means to increase the production, forested and non-forested land has been provided at low rates within a legal framework, which in many cases have lacked attention to local land rights (Barr et al. 2010). The idea was that timber sales were expected to finance the establishment of oil palm plantations. However, in many cases palm oil schemes have been used to obtain logging licenses without ever establishing oil palm estates, resulting only in deforestation without replanting of oil palm. Some estimates predict that up to 12 million ha have been allocated to oil palm and deforested but not planted (Fargione et al. 2008).

As a way to avoid future deforestation from oil palm expansion, there have been suggestions to convert Imperata grasslands, which are usually portrayed as unproductive wasteland, into oil palm production (Deininger et al, 2011). According to Fairhurst and McLaughlin (2009), there are more than 20 million ha of Imperata grassland available for such developments. This would be more than enough to cover the estimated 10–20 million ha needed to meet oil palm demand for the next decade and beyond. Costs of establishing oil palm on these lands are much lower than on secondary forests, and yields are estimated to be similar to those on forestland. However, the current usage of these lands needs to be taken into account since they might be important to local communities. A study of the WWF (WWF 2009[83]) indicates that since 1995 already Imperata grasslands have been converted into land used for tree or crop production.

[83] http://www.tropcropconsult.com/downloads_files/Fairhurst2009.pdf

Bringing Imperata grasslands into oil palm production will thus require that land rights are recognised and negotiated and that benefits are shared with local communities. The World Resources Institute is currently conducting community mapping to identify degraded land of interest for oil palm developments, which could replace planned expansion in forest areas (Deininger et al, 2011).

Regarding potential expansion into other land uses FAPRI have projected that biofuel production in Indonesia is unlikely to expand onto existing agricultural land. According to FAO data from 2007, there is no decline in land areas harvested for other purposes; the area of oil palm is rapidly increasing, rice is increasing, rubber is increasing slightly while other production is more or less constant.

Sugarcane

Historical developments

Between 1990 and 2008, the total production of sugarcane in Indonesia fluctuated with an overall negative trend resulting in a decrease of 7% in 2008 compared to 1990. Yields have followed the same pattern although with less fluctuations and an overall decrease of 33%. As can be seen in Figure 144, the harvested area increased between 1990 and 1994 when it started to slowly decrease until 2003. Since then, the harvested area has increased to a total increase of 20% in 2008 compared to 1990. The small decrease in total production can be explained by the increase in harvested area at the same time as yields decreased.

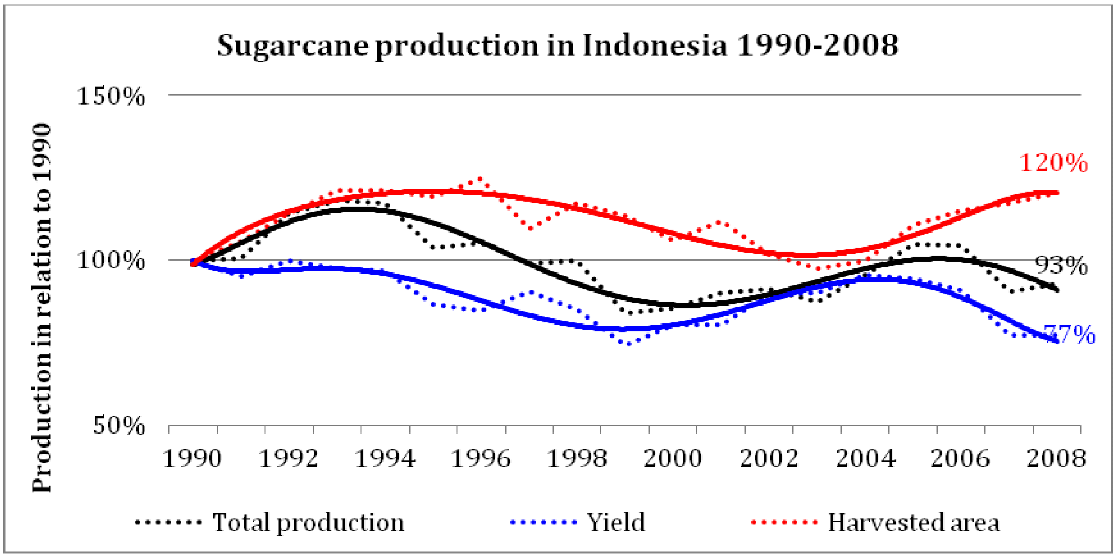


Figure 144. Change in sugarcane production, yields and harvested area in Indonesia, 1990-2008

Historically, sugarcane has had to compete with other crops, especially rice. Relatively less attractive returns as compared to other crops have continued to discourage some farmers from growing cane (FAO 1997). Competition for land, particularly irrigated areas, not only from other crops and livestock production, but also increasingly from urbanization in densely populated areas of Java, has resulted in a shift in the cultivation of sugarcane to non-irrigated areas and to poorer lands

(FAO 1997). Thus, unless yields can be sufficiently increased to enhance the economic viability of crop, possibilities for growth will continue to be limited.

Land-use dynamics from future production increases

According to FAPRI (2010), areas under sugarcane cultivation are not predicted to increase during the next ten years, remaining at a steady 350 000 ha. However, slightly increasing yields (+2.75%) and total production (+3.17%) are expected. The domestic consumption, however, is projected to increase with 23.07 % by 19/20, a demand likely to be met primarily by increasing imports. Indonesia is one of the main net importers of sugar, following only EU, Russia and the US. In addition, imports are projected to increase from 1.5 Mt to 2.3 Mt in 10 years (FAPRI 2010). As a region, Asia is the largest importer of sugar, with China, Indonesia, Japan, Malaysia and South Korea projected to account for 19% of world trade by 2019/20.

Since Indonesia is a large importer of sugar and is unavailable to meet domestic demands, it is unlikely that Indonesia will produce significant amounts of sugarcane ethanol for the EU-RED market.

Production system characteristics and local environmental impacts

Production system characteristics for oil palm and sugarcane in Indonesia are summarised in
Table 118.

Table 118. Production system characteristics for oil palm and sugarcane in Indonesia

System component	Oil Palm	Sugarcane
Large scale	Dominant	
Small scale	Outgrower schemes, 35-40 % of area planted	70% of the sugarcane areas are cultivated by farmers, mostly on small to medium sized holdings
Mechanized farming system	Land preparation	
Manual farming system	Harvesting	
Tillage		
Reduced and no tillage	Perennial crop	
Irrigated		
Rain fed		
Mono-cropping	Dominant	
Multi-cropping		
Crop rotation	Perennial crop	
Mineral fertilizer used		
Chemical pesticides used	E.g. "Paraquat"	
GMO seeds for sowing	Very little	
Land preparation with fire		
By-products (from harvesting)		

Legend: Blue = occurring; orange = not occurring; white = occurrence unknown due to lack of information

Sources: (German et al, 2010; FAO, 1997; Fitzherbert, 2008; Hooijer A, 2006; ICN, 2010; Koh and Wilcove, 2008; Movement, 2008; Oosterkamp, 2007; Pramudya and Pertiwi, 1998; Tauli-Corpuz, 2007; Vermeulen, 2006).

Deforestation and loss of biodiversity and ecosystem services is the most serious impact of oil palm plantations in Indonesia, including loss of habitat for endangered species. A report published in 2007 by UNEP (the United Nations Environment Programme) acknowledges that oil palm plantations are now the leading cause of rainforest destruction in Indonesia and Malaysia. Indonesia lost 1.7-3.0 million hectares of forest to oil palm plantations between 1990 and 2005 (Fitzherbert, 2008). Conversion of either primary or secondary (logged) forests to oil palm results in habitat fragmentation, soil erosion, landslides, haze, drought and floods, as well as significant biodiversity losses, whereas conversion of pre-existing cropland (rubber) to oil palm results in fewer biodiversity losses (Koh and Wilcove, 2008). It has been estimated that 80-100% of the species in a rainforest do not survive in the plantations (Movement, 2008). Data on indirect deforestation are largely qualitative. A CIFOR study found that oil palm plantations cause degradation in adjacent forest areas by displacing timber extraction activities and concentrating these activities in remaining forests (German et al, 2010). Conversion of peat swamp forest to oil palm is the land use change of greatest concern to global climate change mitigation (German et al, 2010). The burning of the country's peat land areas alone accounts for 4% of global greenhouse gas emissions (Hooijer A, 2006). Estimates for the time required to return to levels of carbon in the original ecosystem (the so-called 'carbon

payback time') for these forests range from 423 to 692 years (Fitzherbert et al. 2008; Fargione et al. 2008 in (German et al, 2010).
Besides GHG emissions resulting from construction of palm oil plantations on peat, also soil loss results from peat oxidation.

Air pollution results from using fire for land preparation, as well as annual fires from drained peat and deforested lands. In 1998, millions of people in the region were affected by the widespread fires, which have been related to the oil palm industry.

Water pollution results from increased erosion and siltation, use of pesticides and fertilizers and from the increased incidence of flooding resulting from the destruction of natural drainage in peatlands (German et al, 2010). Integrated pest management practices is used to an unclear but increasing extent both among smallholders and in plantations (FAO 2004).

By-products are palm kernel oil (pressed from the kernels of the oil palm fruit) and palm kernel meal (produced by grinding the kernels from which oil is pressed). Most of the palm kernel oil is used in e.g. soap, detergents and cosmetic industries. A recent trend is to use this as energy source for electricity plants and for biofuel (Oosterkamp, 2007).

Observed local environmental impacts from oil palm and sugarcane production in Indonesia are summarised in Table 119.

Table 119. Observed local environmental impacts from oil palm and sugarcane production in Indonesia

Environmental impact	Oil Palm	Sugarcane
Deforestation	[red]	[red]
Loss of agro-biodiversity	[red]	[white]
Loss of biodiversity	[red]	[red]
Air pollution	[red]	[red]
Water pollution	[red]	[red]
GMO contamination	[white]	[green]
Eutrophication	[red]	[red]
Soil fertility decline	[red]	[red]
Erosion	[red]	[red]

Legend: Red = occurring; green = not occurring; white = occurrence unknown due to lack of information
Sources: (German et al, 2010; FAO, 1997; Fitzherbert, 2008; Hooijer A, 2006; ICN, 2010; Koh and Wilcove, 2008; Movement, 2008; Oosterkamp, 2007; Pramudya and Pertiwi, 1998; Tauli-Corpuz, 2007; Vermeulen, 2006).

Local environmental impacts allocated to domestic biofuel production

The share of the total oil palm area that was harvested for domestic biofuel production was 2.8% in 2008. However, the net area requirement is lower since oil palm biofuel production generates by-products that substitutes for other crop production: using RED allocation principles the area allocated to biofuels corresponded to 2.6% of the total oil palm area in 2008. Since oil palm cultivation for domestic biofuels has the same characteristics as oil palm cultivation for other purposes, local environmental impacts are also the same and the importance of domestic biofuel production is proportional to the share of the total oil palm area used for production of domestic biofuels (2.6%). It should be noted though that a much larger share of the total oil palm was likely used for production of palm oil, processed into biofuels in other countries.

The share of the total sugarcane area that was harvested for domestic biofuel production was 9.6% in 2008. Since sugarcane cultivation for domestic biofuels has the same characteristics as sugarcane cultivation for other purposes, local environmental impacts are also the same and the importance of domestic biofuel production is proportional to the share of the total sugarcane area used for production of domestic biofuels (9.6%).

Local environmental impacts allocated to EU biofuel demands

The share of the total oil palm area that was harvested for EU biofuel production was 3.8% in 2008. However, the net area requirement is lower since oil palm biofuel production generates by-products that substitutes for other crop production: using RED allocation principles the area allocated to biofuels corresponded to 3.5% of the total oil palm area in 2008. Since oil palm cultivation for EU biofuels has the same characteristics as oil palm cultivation for other purposes, local environmental impacts are also the same and the importance of EU biofuel demand is proportional to the share of the total oil palm area used for EU biofuel production (3.5%).

Since no feedstock for EU biofuels in 2008 has been traced to sugarcane produced in Indonesia; no local environmental impacts from cultivation of these crops can be allocated to EU biofuel demands.

References

Barr, C., Dermawan, A., Purnomo, H. and others. 2010, *Financial Governance and Indonesia's Reforestation Fund during the Socharto and Post-Socharto Periods 1989–2009*. Bogor: Center for International Forestry Research. Occasional Paper 52.

Deininger, K., Byerlee, D., Lindsay, J., Norton, A., Selod, H. and Stickler, M., 2011. *Rising global interest in farmland - can it yield sustainable and equitable benefits?* Washington DC: The International Bank for Reconstruction and Development/The World Bank.

Fairhurst, T. and McLaughlin, D., 2009. *Sustainable Oil Palm Development on Degraded Land in Kalimantan*. Washington DC: World Wildlife Fund (WWF).

FAO, 1997 *Proceedings of the Fiji/FAO 1997 Asia Pacific Sugar Conference*. Available at: http://www.fao.org/docrep/005/x0513e/x0513e21.htm Accessed on March 13, 2011.

FAO, 2004. *Fertilizer use by crop in Malaysia*. Available at: http://www.fao.org/docrep/007/y5797e/y5797e00.htm Accessed on June 1, 2011.

FAO, 2011. *FAO country profile: Indonesia*. Available at: http://www.fao.org/countryprofiles/index.asp?lang=en&iso3=IDN Accessed on May 30, 2011.

FAPRI, 2010. *FAPRI 2010 U.S. and World Agricultural Outlook*. Ames: Food and Agricultural Policy Research Institute, Iowa State University and University of Missouri-Columbia.

Fargione, J., Hill, J., Tilman, D., Polasky, S. and Hawthorne, P., 2008. Land clearing and the biofuel carbon debt. *Science*, 319(5867), pp.1235–1238.

Fitzherbert, E.B., Struebig, M.J., Morel, A., Danielsen, F., Brühl, C.A., Donald, P.F. and Phalan, B., 2008. How will oil palm expansion affect biodiversity?. *Trends in Ecology & Evolution*, 23(10), pp.538-545.

German, L., Schoneveld, G., Skutsch, M., Andriani, R., Obidzinski, K., Pacheco, P., Komarudin, H., Andrianto, A., Lima, M. and Dayang Norwana, A.A.B., 2010. *The local social and environmental impacts of biofuel feedstock expansion - A synthesis of case studies from Asia, Africa and Latin America*. Bogor: Center for International Forestry Research (CIFOR).

Hooijer, A., Silvius, M., Wösten, H. and Page, S., 2006. *PEAT-CO_2, Assessment of CO_2 emissions from drained peatlands in SE Asia*. Delft Hydraulics Report Q3943.

ICN, 2010. *Development of sugar plantations toward sugar self sufficiency*. Indonesian Commercial Newsletter (ICN). Available at: http://www.datacon.co.id/Agri-2010Sugar.html Accessed on May 27, 2011.

Koh, P.L. and Wilcove, S.D., 2008. Is oil palm agriculture really destroying tropical biodiversity?. *Conservation Letters*, 1(2), pp.60–64.

MoA, 2011. *Ministry of Agriculture, Indonesia*. Available at: http://www.deptan.go.id Accessed on April 2, 2011.

Movement, W.R. 2008. Regional perspectives on plantations - Oil palm and rubber plantations in Western and Central Africa: An Overview. WRM Briefing.

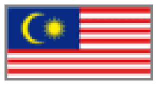
Oosterkamp, J.W., 2007. Oil Palm: comparing Chocó (Colombia) with West Kalimantan (Indonesia). Bogota: Cordaid.

Pramudya, B. and Pertiwi, S., 1998. *Sugar-cane Cropping and Operation Scheduler for Selective Mechanized Plantation*. Bogor: Agricultural Information Technology in Asia and Oceania.

Tauli-Corpuz, V. and Tamang, P., 2007. Oil Palm and Other Commercial Tree Plantations, Monocropping: Impacts on Indigenous Peoples' Land Tenure and Resource Management Systems and Livelihoods. New York City: UN Permanent Forum on Indigenous Peoples, Sixth Session.

Vermeulen, S. and Goad, N., 2006. *Towards better practice in smallholder palm oil production*. London: Institute for Environment and Development.

World Bank, the, 2009. Investing in a more sustainable Indonesia, Country environmental Analysis. Jakarta: the World Bank Group.



I 12 Malaysia

Selected biofuel crops for Malaysia include oil palm only. As seen in Table 120, a very small share (about 1%) of the total area under oil palm production in 2008 was used for domestic biodiesel production. However, 2.5% of the total oil palm area was used for production of biodiesel and –feedstock for the EU market. The reason for this is that most (about 96%) of the EU palm oil biodiesel that originated from Malaysia in 2008 was processed outside Malaysia. It should be noted that some co-products are likely to have been produced on the same areas as biodiesel feedstock.

Table 120. Area used for production of Malaysia's selected biofuel crops, including areas used for domestic biofuel production and feedstock for biofuels on the EU market in 2008

Crop	Total harvested area in 2008 (kha)	Cropland used for domestic biofuel production in 2008		Cropland used for production of feedstock for EU biofuels in 2008	
		kha	% of total	kha	% of total
Oil palm	3,900	43	1.1%	98	2.5%

Source: FAOSTAT (land data); Agra CEAS and Ecofys (biofuel production and trade data).

Oil Palm

As seen in Figure 145, most of the agricultural land in Malaysia is cultivated and pastures are uncommon. Permanent crops are widespread and constitute about 76% of the total cultivated land. Oil palm is being produced on about two thirds of the land under permanent crops, making it the most important crop in Malaysia's agriculture. Not much oil palm is used for domestic production of biodiesel, although significant amounts of Indonesian palm oil might be used for biodiesel production in other countries.

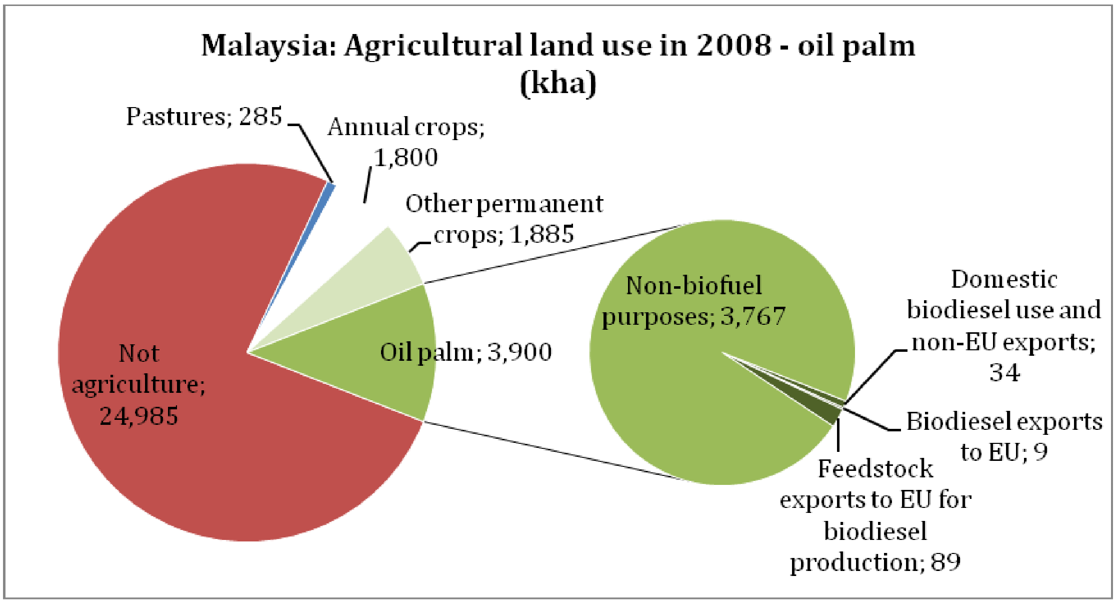


Figure 145. Agricultural land use in Malaysia in 2008, focused on oil palm production

Oil palm was first planted commercially in Peninsular Malaysia in 1917, where it historically has replaced both rubber plantations and forest. Large-scale expansion commenced during the 1960s, mainly in response to the government's diversification policy, which aimed to reduce the dependence of the national economy on natural rubber. Rubber prices were continuing to decline, there was mounting competition from synthetic rubber, and the demand for edible oils was expanding (UNDP 2007). As land became scarce, expansion of oil palm shifted to other areas, most commonly Sabah and Sarawak. Expansion often occurred in association with logging, which was facilitated by the reclassification of some state forest reserves to allow for conversion into plantations (Fitzherbert et al. 2008).

Historical developments

Malaysia has experienced a steady increase in palm oil production during 1990-2008 resulting in a total production increase of 168 %. As seen in Figure 146, the increase has been made possible mainly due to an increased harvested area (+123%). Yields remained rather unchanged until 2002, but have since then increased with 20%.

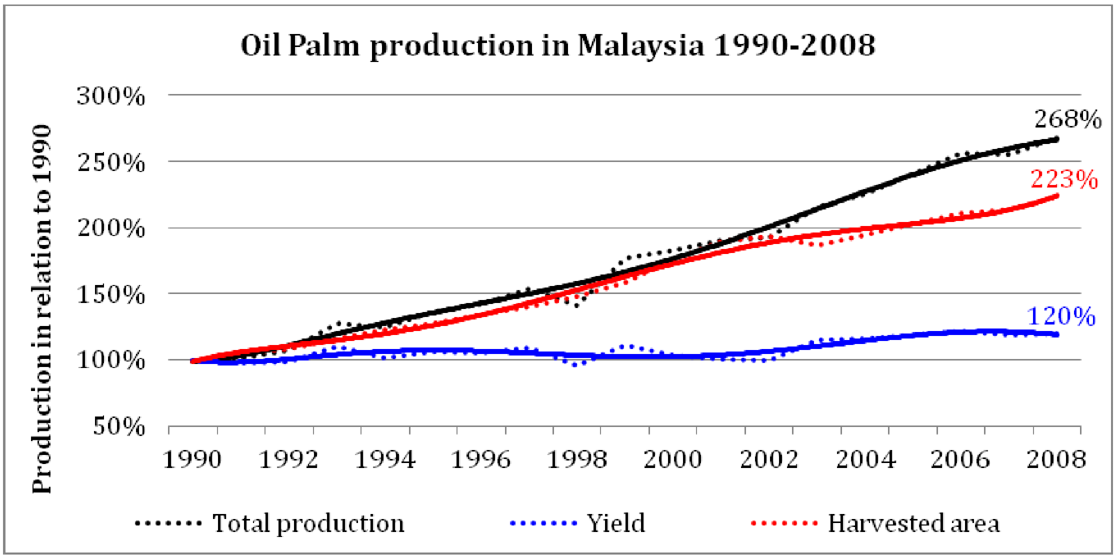


Figure 146. Change in oil palm production, yields and harvested area in Malaysia, 1990-2008

Agriculture in Malaysia is mainly taking place in the Peninsular Malaysia while northern Borneo is mostly covered with dense natural forest, although with smaller areas under intensive cultivation (FAO 2011). Even though oil palm production occurs in all states in Malaysia, four states; Sabah, Johor, Pahang and Sarawak constitute 75% of the total planted area. Each of these states has over half a million hectares under oil palm production (UNDP 2007).

Historical developments

Between 1990 and 2005 the area of oil palm in Malaysia increased by 1.8 Mha to 4.2 Mha, while at the same time 1.1 million ha of forest were lost (MPOB 2011). However, this estimate neither considers conversion of forests into unproductive land, nor whether oil palm caused or simply followed deforestation (Fitzherbert et al. 2008). According to Koh and Wilcove's (2008) analysis of land-cover data compiled by the FAO, 55%–59% of oil palm expansion in Malaysia during 1990–2005 occurred at the expense of forests. Besides expansion on forests, oil palm expansion has historically partly taken place on abandoned rubber plantations in Malaysia, as previously discussed.

Land-use dynamics from future production increases

Malaysia and Indonesia constitute 85 % of the global palm oil production. Palm oil is used for a variety of products, one of them being biodiesel. If demand for biodiesel would increase, demand for palm oil is likely to follow.

Palm oil production is projected to increase with 26.5 %, from 18.5 Mt in 2009/10 to 23.4 Mt in 2019/20 (FAPRI 2010). Malaysia will also continue to be a large exporter of palm oil with a projected 24.5% increase in export, from 15.1 Mt in 2009/10 to 18.8 Mt in 2019/20 (FAPRI 2010). Production of palm oil fruit is projected to increase with 57,36%, from 265 kt in 2009 to 417 kt in 2019/20.

Production of biodiesel in Malaysia is predicted to increase with 56,58%, from 288 ML in 2009/10 to 450 ML in 2019/20. Domestic consumption in 2009/10 was 68 ML and is projected to increase by 11,11%, to 76 ML in 2019/20. Malaysia's net export of biodiesel is predicted to increase from 220 ML in 2009/10 to 375 ML in 2019/20 (FAPRI 2010)

The predicted increase in both oil palm and biodiesel production will demand either increasing yields, as projected by Chan (2011), expansion onto new land, or both. Considering that Malaysia has the world's highest oil palm yields (21.3 t/ha) (the Deininger et al, 2011), increasing yields seems insufficient for meeting the projected production increases. Therefore, expansion onto new land is likely.

According to the Deininger et al (2011), available land for oil palm expansion in Malaysia adds up to 145 000 ha. However, most of the available areas have a population density of more than 25 people per ha and are located more than 6 hours from the closest market, which is likely to obstruct a potential expansion.

According to Chan (2011), a part of the expansion is very likely to occur on agricultural land, although not likely on pastures. Relations between oil palm expansion and agricultural land area can be seen in FAO statistics. As the oil palm area is rapidly increasing, areas planted with other crops are slightly declining (e.g. rubber) or remaining constant (e.g. rice). However, FAO (2011) reports that the risk of oil palm plantations expanding onto agricultural land is small. Therefore, it can be assumed that future expansion of oil palm production will occur either on degraded or abandoned rubber plantations, as projected by FAPRI (2010) or on natural vegetation. Areas of relevance would be coastal swamp areas, logged over secondary forest/degraded forest, and most likely primary rainforest. Fargione et al. (2008) estimates that accelerating demand for palm oil is contributing to 1.5% annual deforestation of tropical rainforests in Malaysia and Indonesia.

Production system characteristics and local environmental impacts

Production system characteristics for oil palm Malaysia are summarised in Table 121.

Table 121. Production system characteristics for oil palm in Malaysia

System component	Oil Palm
Large scale	62 %
Small scale	600 000 hectares of land settlement schemes, 11 % of oil palm plantations are independent small holder production
Mechanized farming system	E.g. land preparation
Manual farming system	E.g. harvesting
Tillage	
Reduced and no tillage	Perennial crop
Irrigated	
Rain fed	
Mono-cropping	Dominating
Multi-cropping	
Crop rotation	Perennial crop
Mineral fertilizer used	
Chemical pesticides used	
GMO seeds for sowing	
Land preparation with fire	
By-products (from harvesting)	

Legend: Blue = occurring; orange = not occurring; white = occurrence unknown due to lack of information
Sources: (German et al, 2010; Jelsma et al, 2009; Rahman, 2008; Tauli-Corpuz, 2007)

A report published in 2007 by UNEP acknowledges that oil palm plantations are the leading cause of rainforest destruction in Indonesia and Malaysia (WWF 200-). In Malaysia, 86% of deforestation from 1995-2000 was for oil palm plantations, which has led to a significant reduction in biological diversity (of 80% for plants and 80-90% for mammals, birds, and reptiles). Clearing land for oil palm production in slopes also causes erosion and landslides.

Air pollution results from using fire for land preparation, as well as annual fires from drained peat and deforested lands. In 1998, millions of people in the region were affected by the widespread fires, which have been related to the oil palm industry.

Water pollution and eutrophication results from fertilizers, and pesticides. In Malaysia, e.g. the poisonous chemical compounds paraquat and round-up are used by smallholders (Rahman, 2008). Water pollution also results from erosion, landslides and the destruction of natural drainage in peatlands (German et al, 2010). There is documentation of low water tables, as well as flooding and water logging (due to e.g. peat swamp drainage and removal of forests natural water retention services), which can lead to increased frequency of malaria and yellow fever (German et al, 2010).

As indicated by Tropical Peat Research Institute[84], in 2008 12% of existing Malaysian palm oil plantations have been constructed on peat land. In the region Sawarak this might even be as high as 23%. Besides greenhouse gas emissions, there will also be a loss of soil through the peat oxidation.

Observed local environmental impacts from oil palm production in Malaysia are summarised in Table 122.

Table 122. Observed local environmental impacts from oil palm production in Malaysia

Environmental impact	Oil Palm
Deforestation	Major issue
Loss of agro-biodiversity	
Loss of biodiversity	Major issue
Air pollution	Major issue
Water pollution	
GMO contamination	
Eutrophication	
Soil fertility decline	
Erosion	

Legend: Red = occurring; green = not occurring; white = occurrence unknown due to lack of information
Sources: (German et al, 2010; Jelsma et al, 2009; Rahman, 2008; Tauli-Corpuz, 2007)

Local environmental impacts allocated to domestic biofuel production

The share of the total oil palm area that was harvested for domestic biofuel production was 1.1% in 2008. However, the net area requirement is lower since oil palm biofuel production generates by-products that substitutes for other crop production: using RED allocation principles the area allocated to biofuels corresponded to 1% of the total oil palm area in 2008. Since oil palm cultivation for domestic biofuels has the same characteristics as oil palm cultivation for other purposes, local environmental impacts are also the same and the importance of domestic biofuel production is proportional to the share of the total oil palm area used for production of domestic biofuels (1%). It should be noted though that a much larger share of the total oil palm was likely used for production of palm oil, processed into biofuels in other countries.

[84] Figures of the Tropical Peat Research Institute 2009 in Wetlands International. 2010. A quickscan of Peatlands in Malaysia. Wetlands International Malaysia.

Local environmental impacts allocated to EU biofuel demands

The share of the total oil palm area that was harvested for EU biofuel production was 2.5% in 2008. However, the net area requirement is lower since oil palm biofuel production generates by-products that substitutes for other crop production: using RED allocation principles the area allocated to biofuels corresponded to 2.3% of the total oil palm area in 2008. Since oil palm cultivation for EU biofuels has the same characteristics as oil palm cultivation for other purposes, local environmental impacts are also the same and the importance of EU biofuel demand is proportional to the share of the total oil palm area used for EU biofuel production (2.3%).

References

Chan, J. H., 2011. Expert consultation: Carlos Duarte, consultant for Winrock International for the EU Biofuel Baseline project.

Deininger, K., Byerlee, D., Lindsay, J., Norton, A., Selod, H. and Stickler, M., 2011. *Rising global interest in farmland - can it yield sustainable and equitable benefits?* Washington DC: The International Bank for Reconstruction and Development/The World Bank.

FAO, 2011. *FAO country profile: Malaysia*. Available at: http://www.fao.org/countryprofiles/index.asp?lang=en&iso3=MYS Accessed on April 5, 2011.

FAPRI, 2010. *FAPRI 2010 U.S. and World Agricultural Outlook*. Ames: Food and Agricultural Policy Research Institute, Iowa State University and University of Missouri-Columbia.

Fargione, J., Hill, J., Tilman, D., Polasky, S. and Hawthorne, P., 2008. Land clearing and the biofuel carbon debt. *Science*, 319(5867), pp.1235–1238.

Fitzherbert, E.B., Struebig, M.J., Morel, A., Danielsen, F., Brühl, C.A., Donald, P.F. and Phalan, B., 2008. How will oil palm expansion affect biodiversity?. *Trends in Ecology & Evolution*, 23(10), pp.538-545.

German, L., Schoneveld, G., Skutsch, M., Andriani, R., Obidzinski, K., Pacheco, P., Komarudin, H., Andrianto, A., Lima, M. and Dayang Norwana, A.A.B., 2010. *The local social and environmental impacts of biofuel feedstock expansion - A synthesis of case studies from Asia, Africa and Latin America*. Bogor: Center for International Forestry Research (CIFOR).

Jelsma, I., Giller, K. and Fairhurst, T., 2009. *Smallholder Oil Palm Production Systems in Indonesia: Lessons from the NESP Ophir Project*. Wageningen: Wageningen University, Plant Science Group, Plant Production Systems.

Koh, P.L. and Wilcove, S.D., 2008. Is oil palm agriculture really destroying tropical biodiversity?. *Conservation Letters*, 1(2), pp.60–64.

MPOB, 2011. *Malaysian Palm Oil Board*. Available at: http://www.mpob.gov.my Accessed on April 5, 2011.

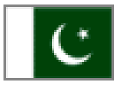
Rahman, A.K.A., Abdullah, R., Shariff, F.M. and Simeh, M.A., 2008. The Malaysian Palm Oil Supply Chain: The Role of the Independant Smallholders. *Oil palm industry economic journal*, 8(2), pp.17-27.

Tauli-Corpuz, V. and Tamang, P., 2007. Oil Palm and Other Commercial Tree Plantations, Monocropping: Impacts on Indigenous Peoples' Land Tenure and Resource Management Systems and Livelihoods. New York City: UN Permanent Forum on Indigenous Peoples, Sixth Session.

UNDP, 2007. *Malaysia Generating Renewable Energy From Palm Oil Wastes*. Kuala Lumpur: The United Nations Development Programme (UNDP).

WWF, 200-. *WWF website: Palm oil & forest conversion*. Available at: http://wwf.panda.org/what_we_do/footprint/agriculture/palm_oil/environmental_impacts/forest_conversion/ Accessed on June 1, 2011.

I 13 Pakistan



Selected biofuel crops for Pakistan include sugarcane, rapeseed and maize. As seen in Table 123, about 8% of the total area under sugarcane cultivation in 2008 was used for domestic ethanol production and about 1% of the total area was used for production of fuel ethanol for the EU market. Domestic biofuel production from rapeseed or maize has not been possible to identify or estimate.

Table 123. Area used for production of Pakistan's selected biofuel crops, including areas used for domestic biofuel production and feedstock for biofuels on the EU market in 2008

Crop	Total harvested area in 2008 (kha)	Cropland used for domestic biofuel production in 2008		Cropland used for production of feedstock for EU biofuels in 2008	
		kha	% of total	kha	% of total
Sugarcane	1,241	98	7.9%	16	1.3%
Rapeseed	396	0	0%	0	0%
Maize	1,052	-	-	0	0%

Source: FAOSTAT (land data); Agra CEAS and Ecofys (biofuel production and trade data).

Pakistan, which consumes about 3 million tons of vegetable oils, buys palm oil from Malaysia and Indonesia, and rapeseed from Canada, Australia and Europe. Cotton and sunflower seeds are the main sources of the nation's local cooking oil supplies" (Abraham, 2010).

Pakistan, which used to qualify for reduced tariffs under the original General System of Preference (GSP), is no longer a beneficiary since total EU imports of Pakistani ethanol are larger than 1% and thereby, subject to Full most Favoured Nations (MFN) imports. Resulting from the revocation from the GSP status, two of the seven operating distilleries in Pakistan shut down while, due to uncertain markets, another five new distilleries are likely to cancel their plans to start operation (FAO, 2007).

Agriculture accounts for more than one fifth of Pakistan's GDP. Large parts of the land area are arid, semi-arid or rugged, and not easily cultivated. The dry cropland and pastures as well as irrigated cropland are located along the major rivers in the central and southern areas of the country (FAO 2011). Most of the cropland in the country is used for rice and wheat production. Water resources are scarce throughout most of the country, and there are difficulties in providing remote rural communities with a reliable water supply (IFAD 2009). Agriculture is at the heart of the rural economy and most rural people rely on agriculture for their livelihood. Nearly two thirds of the population and 80% of the country's poor live in rural parts of the country (IFAD 2009). Large numbers of rural people are poor because of unequal land distribution; a few large landholders own a disproportionate amount of land. More than 4 million family farms have plots of less than 5 hectares each, and 25% of all farms have less than one hectare of land (IFAD 2009).

Sugarcane

As seen in Figure 147, most of the agricultural land in Pakistan is cultivated, primarily with annual crops. Sugarcane constitutes about 6% of the total land under annual crop cultivation, making it a rather important crop in Pakistan's agriculture. Since about 9% of the total sugarcane area in Pakistan is being used for domestic ethanol production, ethanol can be regarded as a rather important application for sugarcane. However, it should be noted that ethanol is primarily being produced from molasses, from sugar production.

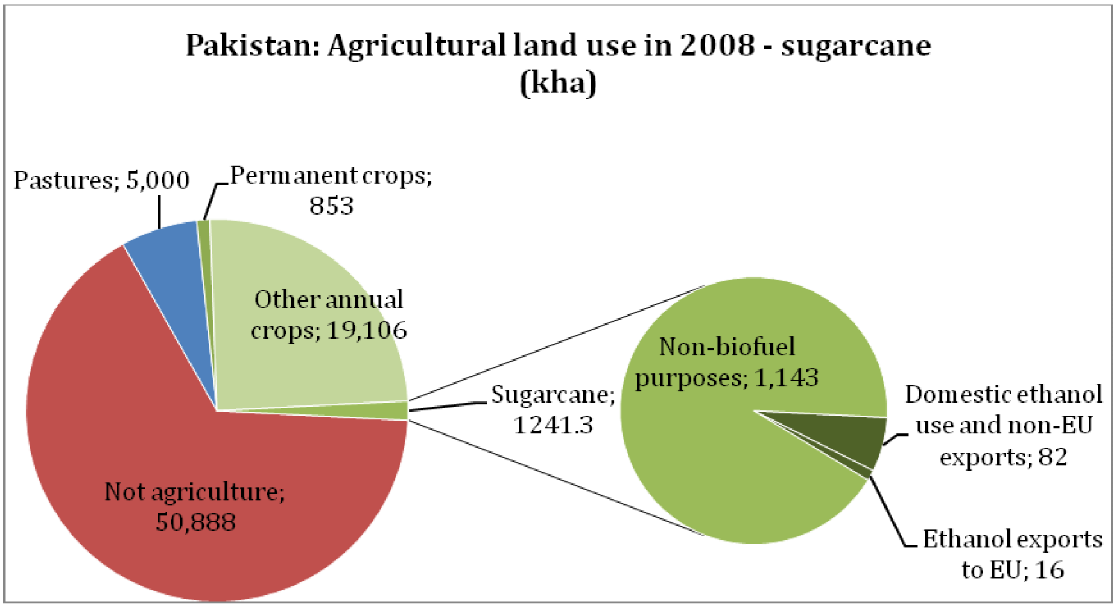


Figure 147. Agricultural land use in Pakistan in 2008, focused on sugarcane production

Historical developments

Between 1990 and 2008, sugarcane production in Pakistan increased with 80%. As seen in Figure 148, the increase has been made possible mainly by an increased harvested area (+45%), but also by increasing yields (+24%). Much of the increase in production and harvested area has happened since 2006.

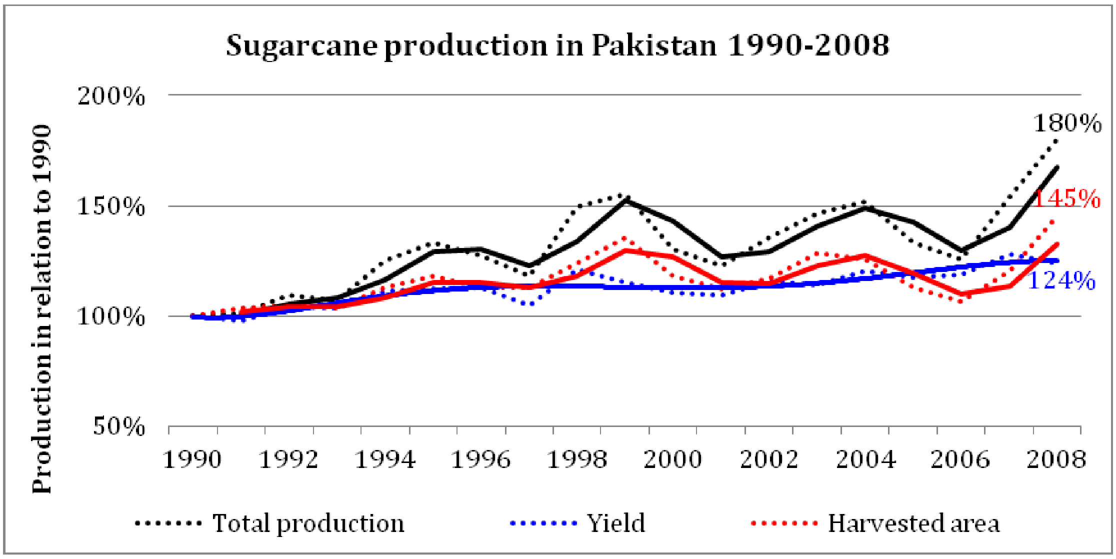


Figure 148. Change in sugarcane production, yields and harvested area in Pakistan, 1990-2008

The expansion during the last few years has mainly been at the expense of wheat production (Zaidi 2011).

Land-use dynamics from future production increases

According to Zaid (2011), a potential expansion of sugarcane is not likely to happen on agricultural land. However, if that would happen it would likely affect the production of wheat and maize during the fall and the production of cotton and rice during the spring. Sugarcane could also potentially expand on pastures, but only in areas with potential for irrigation. Any expansion onto natural vegetation is not likely due to water constraints. Rather than expanding onto new land, production should be increased by increasing yields or sucrose content, which currently is low. New and better varieties to increase sucrose content in cane are currently being investigated (Zaid 2011). This is supported by a World Bank report stating that the current area under sugarcane production is 1.2 Mha and that no land is available for expansion (Deininger et al, 2011). FAPRI (2010) also supports this, claiming that the area under sugar cane cultivation is projected to remain stable while yields, and thus production, are projected to slightly increase until 2020.

Pakistan is projected by FAPRI (2010) to be a net importer of sugar (including both beet and cane sugar) in the future and thus unlikely to produce additional sugarcane for bioethanol production. However, Pakistan's large sugar production provides for substantial amounts of ethanol being produced from molasses.

Rapeseed

Historical developments

Between 1990 and 2008, rapeseed production in Pakistan increased with 67%. As seen in Figure 149, both increasing yields (+29%) and an increased harvested area (+30%) has made the production increase possible.

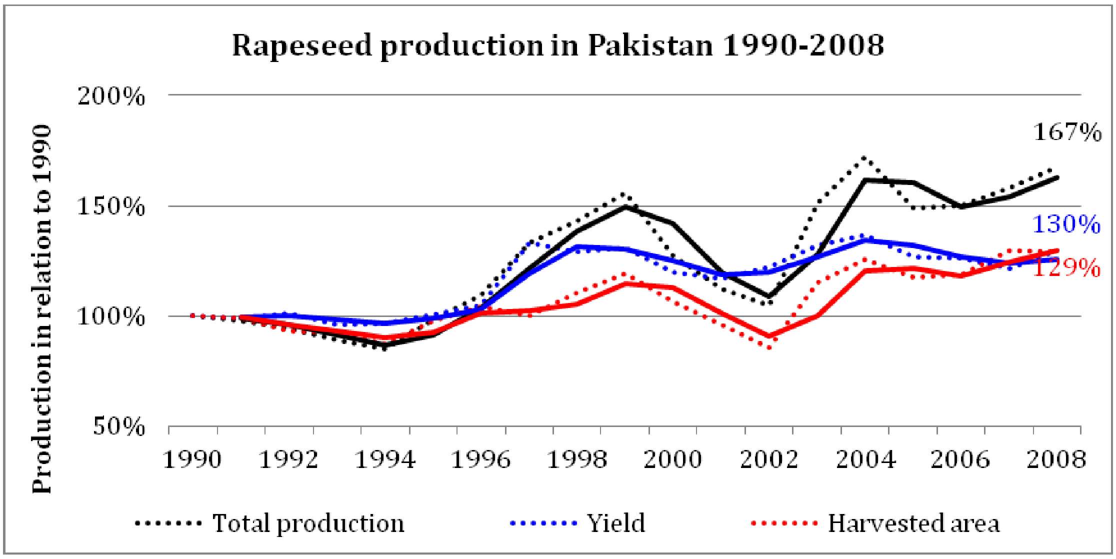


Figure 149. Change in rapeseed production, yields and harvested area in Pakistan, 1990-2008

Land-use dynamics from future production increases

A major challenge in Pakistan is the deficit of edible oils, with an indigenous production well below national consumption levels. Presently, oilseed production only meets about 25% of the demand. Rapeseed-mustard is the second most important crop, following cotton, constituting more than 17% of Pakistan's total oilseed production (PARC 2011).

According to Zaidi (2011), a potential expansion of rapeseed on existing farmland or pastures is not likely. If a potential expansion would still take place on existing cropland, it would most likely replace sugarcane and wheat production. However, the production of rapeseed already competes with wheat production for the limited water supplies and since farmers prefer to grow wheat, as it is not only a staple food but have higher economic returns, as confirmed by Zaidi (2011), such a replacement is not likely to happen. An expansion onto natural vegetation is not likely, mainly due to the limited water resources and the lack of financial capacity to invest. According to Ahmad (2010), the yield-gap for oilseeds in Pakistan is 54-85%. Therefore, by improving agricultural practices and/or intensifying cultivation, Pakistan has a theoretical potential to increase the total production of rapeseed with 54-85%, without having to expand onto new land. It should be noted though that Pakistan's limited water resources might make the yield-gap difficult to close.

Maize

Historical developments

Between 1990 and 2008, maize production in Pakistan increased with 203%. Most of the increase occurred after 2002. As seen in Figure 150, the increase was made possible mainly by increasing yields (+144%), but to a smaller extent also by an increased harvested area (+24%).

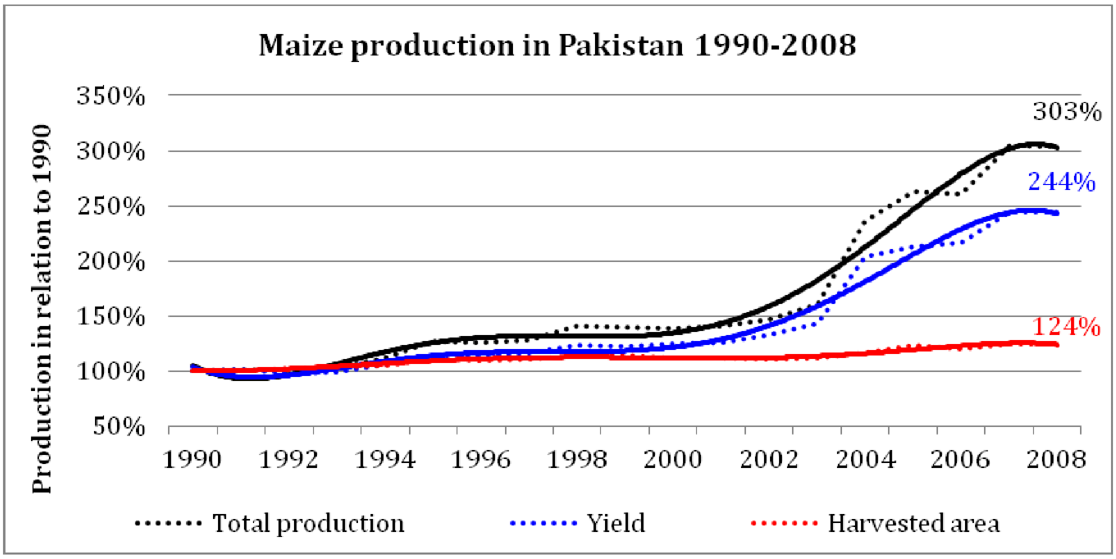


Figure 150. Change in maize production, yields and harvested area in Pakistan, 1990-2008

Land-use dynamics from future production increases

Pakistan is a net importer of maize with a projected continued steady import of 10 kt/y until 2019/20 (FAPRI 2010). A slight increase in harvested area is projected until 2019/20, from 1.05 Mha in 2009/10 to 1.07 Mha. Yields are projected to slightly increase during the same period from 2.86 t/ha in 2009/10 to 3.03 t/ha in 2019/20. According to Deininger et al (2011), there is no land available for maize expansion, which will make the country even more dependent on imports and make incentives to increase yields larger. This is supported by Zaidi (2011), who reports that a potential increase in maize production would demand investments in better yielding varieties.

Considering the high poverty levels and biophysical constraints, such as lack of water and land suitable for cultivation, most small-scale farmers are unlikely to have sufficient financial capacity for making large-scale investments. Most of the land available for expansion will require (expensive) intensive irrigation, making expansion difficult for others than financially strong large-scale landowners. However, the limited land availability might pose such a big constraint that expansion of any type of cultivation could be unprofitable, regardless of the financial capacity of the developer.

Production system characteristics and local environmental impacts

Production system characteristics for sugarcane, rapeseed and maize in Pakistan are summarised in Table 124.

Table 124. Production system characteristics for sugarcane, rapeseed and maize in Pakistan

System component	Sugarcane	Rapeseed	Maize
Large scale			
Small scale	Dominating		
Mechanized farming system			
Manual farming system	Dominating		
Tillage			
Reduced and no tillage			
Irrigated	Dominating		Dominating
Rain fed			
Mono-cropping			
Multi-cropping			
Crop rotation			
Mineral fertilizer used			
Chemical pesticides used			
GMO seeds for sowing			
Land preparation with fire			
By-products (from harvesting)	Limited use of sugarcane tops as animal feed		Green maize and dry stalks used for animal feed

Legend: Blue = occurring; orange = not occurring; white = occurrence unknown due to lack of information

Sources: Akbar and Khwaja, 2006; Cheesman, 2004; Dufey and Grieg-Gran, 2010; FAO, 1990; Majid et al, 2003; Muhammad D; Muhammad D., 1998; Pakissan.com 2011a; Pakissan.com 2011b; USDA 2009.

Observed local environmental impacts from sugarcane, rapeseed and maize production in Pakistan are summarised in Table 125.

Table 125. Observed local environmental impacts from sugarcane, rapeseed and maize production in Pakistan

Environmental impact	Sugarcane	Rapeseed	Maize
Deforestation			
Loss of agro-biodiversity			
Loss of biodiversity			
Air pollution	red		green
Water pollution	red	red	green
GMO contamination	green	green	red
Eutrophication	red		
Soil fertility decline	red	red	
Erosion	red		

Legend: Red = occurring; green = not occurring; white = occurrence unknown due to lack of information
Sources: Akbar and Khwaja, 2006; Cheesman, 2004; Dufey and Grieg-Gran, 2010; FAO, 1990; Majid et al, 2003; Muhammad D; Muhammad D., 1998; Pakissan.com 2011a; Pakissan.com 2011b; USDA 2009.

Local environmental impacts allocated to domestic biofuel production

The share of the total sugarcane area that was harvested for domestic biofuel production was 7.9% in 2008. Since sugarcane cultivation for domestic biofuels has the same characteristics as sugarcane cultivation for other purposes, local environmental impacts are also the same and the importance of domestic biofuel production is proportional to the share of the total sugarcane area used for production of domestic biofuels (7.9%).

Since no production of domestic biofuels from rapeseed or maize has been identified for 2008; no local environmental impacts from cultivation of these crops can be allocated to domestic biofuel production in Pakistan.

Local environmental impacts allocated to EU biofuel demands

The share of the total sugarcane area that was harvested for EU biofuel production was 1.3% in 2008. Since sugarcane cultivation for EU biofuel production has the same characteristics as sugarcane cultivation for other purposes, local environmental impacts are also the same and the importance of EU biofuel demand is proportional to the share of the total sugarcane area used for EU biofuel production (1.3%).

Since no feedstock for EU biofuels in 2008 has been traced to rapeseed or maize produced in Pakistan; no local environmental impacts from cultivation of these crops can be allocated to EU biofuel demands.

References

Abraham, T.K., 2010. Pakistan to Buy More Palm Oil, Rapeseed to Meet Ramadan Demand, Group Says. *Bloomberg*, 5 August.

Ahmad, S., 2010. *Oilseed crops for Spate irrigated farming in Pakistan, Practical Notes #4*. Spate Irrigation Network Pakistan. Available at: http://www.spate-irrigation.org/pakistan_network/documents/4_oil_seeds_spate_note_LQ.pdf Accessed on May 27, 2011.

Akbar, N.M. and Khwaja, M.A., 2006. Study on Effluents from Selected Sugar Mills in Pakistan: Potential Environmental, Health, and Economic Consequences of an Excessive Pollution Load. Islamabad: Sustainable Development Policy Institute (SDPI).

Cheesman, O., 2004. *The environmental impacts of sugar production*. Trowbridge: CABI Publishing and WWF.

Deininger, K., Byerlee, D., Lindsay, J., Norton, A., Selod, H. and Stickler, M., 2011. *Rising global interest in farmland - can it yield sustainable and equitable benefits?* Washington DC: The International Bank for Reconstruction and Development/The World Bank.

Dufey, A. and Grieg-Gran, M., eds., 2010. *Biofuels production, trade and sustainable development*. London: International Institute for Environment and Development.

FAO, 2007. A review of the current state of Bioenergy development in G8 + 5 countries. Rome: GBEP Secretariat.

FAO, 2011. *FAO country profile: Pakistan*. Available at: http://www.fao.org/countryprofiles/index.asp?lang=en&iso3=PAK Accessed on May 30, 2011.

FAPRI, 2010. *FAPRI 2010 U.S. and World Agricultural Outlook*. Ames: Food and Agricultural Policy Research Institute, Iowa State University and University of Missouri-Columbia.

FAO, 1990. *Pakistan Agricultural Census 1990 – Main Results*. Available at: http://www.fao.org/fileadmin/templates/ess/documents/world_census_of_agriculture/main_results_by_country/Pakistan_1990.pdf Accessed on February 20, 2011.

IFAD, 2009. *Enabling poor rural people to overcome poverty in Pakistan*. International Fund for Agricultural Development.

Majid, A., Nawaz, N., Hazara, R., Yousaf, M. and Baig, D., 2003. Weed dynamics, growth and yield of rapeseed canola in response to trifluralin efficacy under rainfed conditions. *Pakistan Journal of Arid Agriculture*, 6(2), pp.53-63.

Muhammad, D. *Fodder production for peri-urban dairies in Pakistan*. Available at: http://www.fao.org/ag/AGP/AGPC/doc/pasture/dost/fodderdost.htm Accessed on February 25, 2011.

Muhammad, D. 1998. *Pakistan Country Pasture/Forage resource profiles*. Available at: http://www.fao.org/ag/AGP/AGPC/doc/counprof/pakistan.htm Accessed on February 25, 2011. Last updated November 2002.

Pakissan.com, 2011a. *Rape seed mustard production in Pakistan*. Available at: http://www.pakissan.com/english/allabout/crop/rapeseed.shtml Accessed on March 1, 2010.

Pakissan.com, 2011b. *Maize production in Pakistan*. Available at: http://www.pakissan.com/english/allabout/crop/maize.shtml Accessed on March 1, 2010.

PARC, 2011. *National Coordinated Research Program*. Pakistan Agricultural Research Council. Available at: http://www.parc.gov.pk/1SubDivisions/NARCCSI/CSI/oil.html Accessed on May 27, 2011.

USDA, 2009. *Production levels different commodities*. Available at: http://www.indexmundi.com/agriculture/?country=pk&commodity=rapeseed-oilseed&graph=area-harvested Accessed on February 25, 2011.

Zaidi, M.S., 2011. Expert opinion, Muhammad Shifaat Zaidi, Islamabad, Pakistan, Advisor, Quality Control Molasses; ED&F Man Molasses, The Netherlands / United (Tate & Lyle) Molasses, UK Vice Chairman, Standing Committees on 1- Banking Credit & Finance 2- Environment, The federation of Pakistan Chambers of Commerce & Industry. Former President, Pakistan Society of Sugar Technologists.

I 14 Ukraine

Selected biofuel crops for Ukraine include rapeseed and sugarbeet. As seen in Table 126, no domestic rapeseed biodiesel production has been identified. However, 26.5% of the total area under rapeseed cultivation was used for production of biodiesel feedstock for the EU market. About 5% of the total area under sugarbeet cultivation was used for domestic ethanol production in 2008, although only small amounts were exported to the EU.

Table 126. Area used for production of Ukraine's selected biofuel crops, including areas used for domestic biofuel production and feedstock for biofuels on the EU market in 2008

Crop	Total harvested area in 2008 (kha)	Cropland used for domestic biofuel production in 2008		Cropland used for production of feedstock for EU biofuels in 2008	
		kha	% of total	kha	% of total
Rapeseed	1,380	0	0%	366	26.5%
Sugarbeet	377	19	5.1%	0.3	0.1%

Source: FAOSTAT (land data); Agra CEAS and Ecofys (biofuel production and trade data).

Rapeseed

As seen in Figure 151, most of the agricultural land in Ukraine is cultivated, almost entirely with annual crops. Actually, most of the total land area in Ukraine is under annual crop cultivation. Rapeseed constitutes about 4% of the total land under annual crop cultivation. Biodiesel production is not yet an application for rapeseed in Ukraine, although about 27% of the total land under rapeseed cultivation is used for production of feedstock for EU biodiesel.

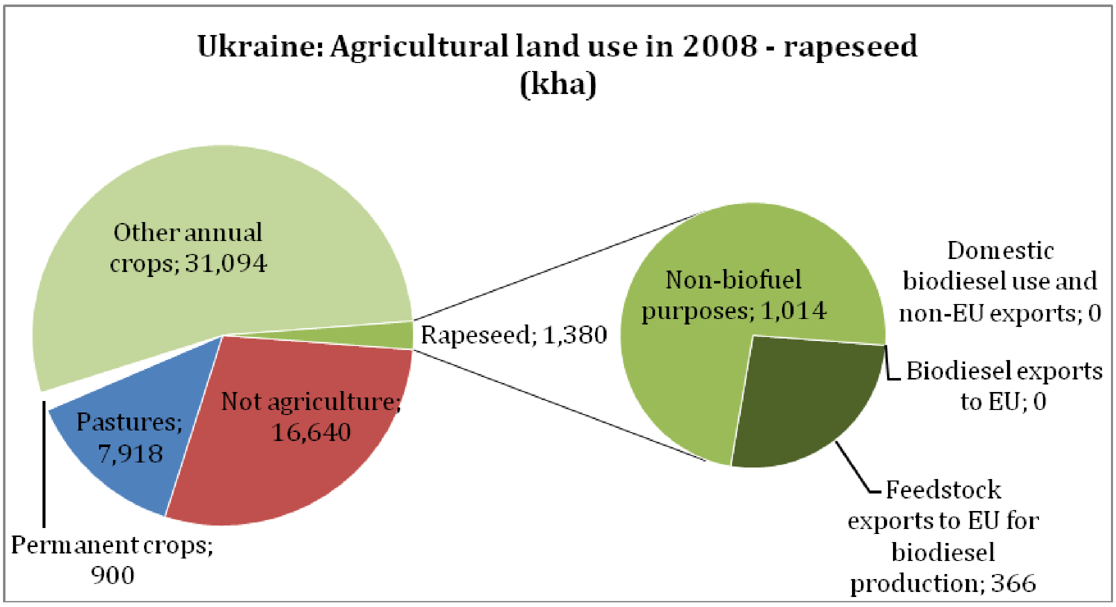


Figure 151. Agricultural land use in Ukraine in 2008, focused on rapeseed production

Ukraine is the largest exporter of rapeseed to the EU and the second largest exporter globally, trailing Canada (FAPRI 2010; MVO 2008). Regarding rapeseed oil, Ukraine is an important exporter but contributes less to the global trade due to lack of domestic crushing capacity (MVO 2008).

Historical developments

Since 1992, rapeseed production in Ukraine has increased with 2512%, which is a remarkable increase. As seen in Figure 152, the production increase has been made possible almost entirely from an increased harvested area (+2302%) while yields have remained rather unchanged during the period (+9%). Most of the increase has occurred since 1994.

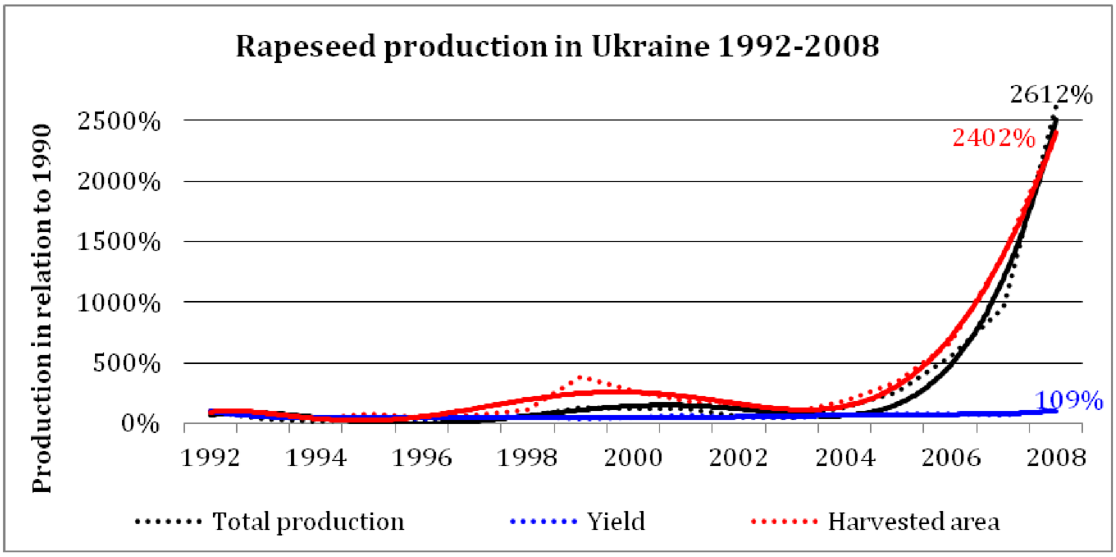


Figure 152. Change in rapeseed production, yields and harvested area in Ukraine, 1992-2008

Even though the expansion of rapeseed since 2004 is remarkable, no evidence has been found for expansion onto non-agricultural land. Instead, it seems like high EU demands, duty-free exports and high gross margins have made more farmers shift to rapeseed production (i.e. include rapeseed in their crop rotations). Technically, rapeseed is at present Ukraine's most profitable crop. In 2008, rapeseed, wheat and corn showed the greatest increases in sown areas. The acreage expansion took place chiefly at the expense of barley and sugar beet (FAO 2010).

Land-use dynamics from future production increases

About 70% of Ukraine's total land area is already used for agriculture of which 80% (56% of total land area) holds annual crop cultivation. Forest and forest-covered areas constitute 17% and built-up areas about 4% (Gumeniuk et al. 2010; FAOSTAT data). The main agro-ecological zones and land-use classes are illustrated in Figure 153.

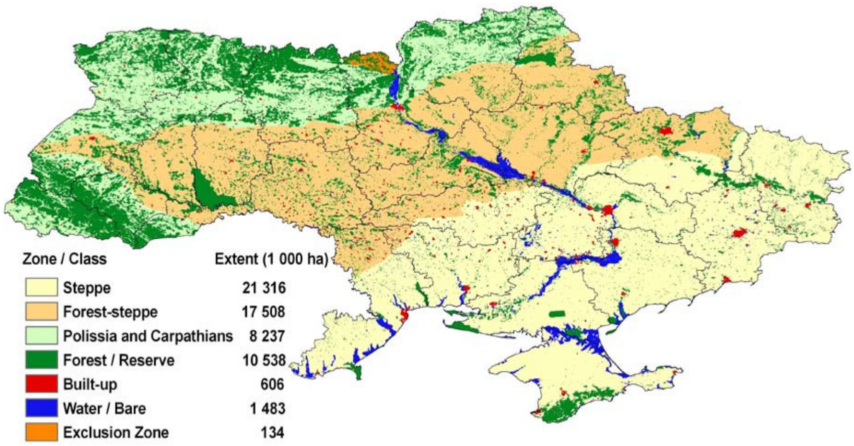


Figure 153. Main agro-ecological regions and land use classes. Source: (Gumeniuk et al. 2010)

Cropping patterns in Ukraine seem to be strongly determined by gross margins (FAO 2010). A comparison between average past, present and projected prices, yields, revenues and gross margins in the three main agro-ecological zones in Ukraine, the "Forest" (northern parts), "Forest-steppe" (middle parts) and "Steppe" (southern parts) zones, indicates that future expansion is more likely to occur in the Forest-steppe zone than in the Steppe zone. Probability of rapeseed expansion in the Forest zone cannot be determined with this approach, since no data is provided. Table 127 shows average price, yield, revenue and gross margin (direct costs only) for rapeseed in the three main agro-ecological zones in 2009.

Table 127. Average price, yield, revenue and gross margin (direct costs only) for rapeseed in Ukraine's three main agro-ecological zones in 2009

Agro-ecological zone	Price (USD/tonne)		Yield (tonnes/ha)		Revenue (USD/ha)		Gross margin (USD/ha, direct costs only)	
	Modern	Trad.	Modern	Trad.	Modern	Trad.	Modern	Trad.
Forest	-	-	-	-	-	-	-	-
Forest-steppe	443	443	2.4	1.2	1055	527	1015	447
Steppe	436	436	1.8	0.9	783	391	780	357

Source: (LMC International in FAO 2010)

Gumeniuk et al. (2010) determined the suitability for rapeseed production across Ukraine. Figure 154 (showing suitability for rain-fed spring rape) and Figure 155 (showing suitability for rain-fed winter rape) supports that rapeseed is most likely to expand in the Forest-steppe zone. It is also visible that large forested areas typically seem unsuitable for rapeseed production, although highly suitable land can be found in close vicinity to such areas.

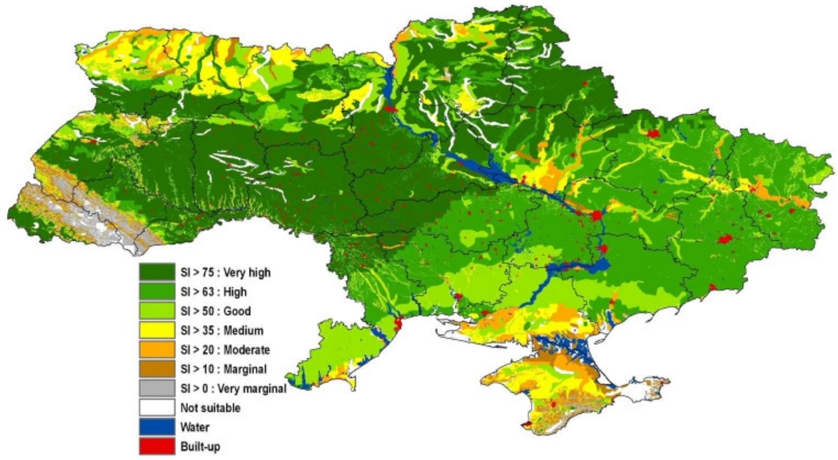


Figure 154. Suitability for rain-fed spring rape under high level of input and management (1971-2000). Source: (Gumeniuk et al. 2010)

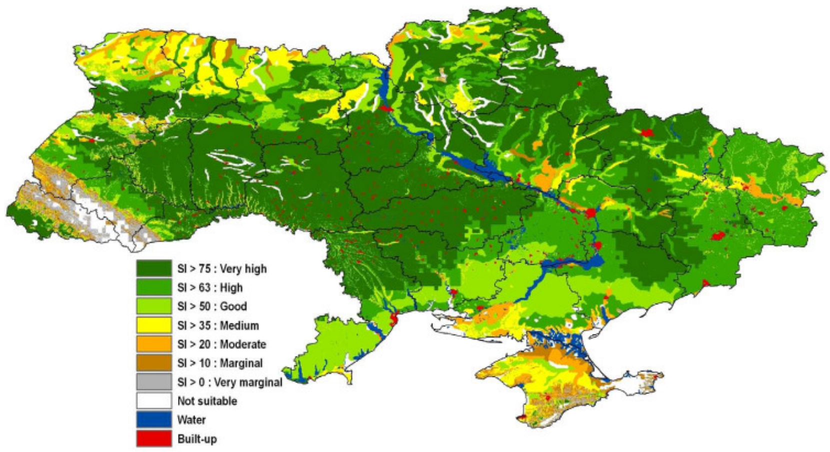


Figure 155. Suitability for rain-fed winter rape under high level of input and management (1971-2000). Source: (Gumeniuk et al. 2010)

A closer look at the suitability for spring rape (Figure 154) shows that 71.6% of the 16 Mha land suitable for rapeseed production in the Forest-steppe zone is classified as "very suitable". Corresponding shares for the Forest zone and Steppe zone are 47.5% (of 7 Mha) and 0.5% (of 19 Mha), respectively (Gumeniuk et al. 2010). Therefore, most signs point towards a potential expansion in the Forest-steppe zone while little expansion is likely in the Steppe zone. Some expansion is likely in the forest zone, although not likely in the forested areas.

Since most land suitable for rain-fed rapeseed production has already been cleared, significant expansion on natural vegetation is less likely. This is supported by Bauer et al. (2010), who claim that rapeseed is unlikely to expand onto new land but rather displace cereals or other break crops out of cereal brake rotations. Nesterov (2011) also supports this, claiming that expansion on already cultivated land is most likely, expansion on pastures is likely and on natural vegetation unlikely. More specific, Nesterov (2011) reports that barley, buckwheat, wheat and potato are crops most likely to be replaced in case of a rapeseed expansion. Historical events support this, as barley has recently competed for area in spring with corn and oilseeds and has declined significantly since 2003, despite increased demand (FAO 2010).

Displacement of replaced crops onto natural vegetation seems less likely, since even though certain crops (e.g. rapeseed) have expanded significantly since 2004, the total area under annual crop cultivation has remained rather unchanged. Therefore, a potential production increase of a certain crop (e.g. rapeseed) is likely to result in production decreases of other crops. Nesterov (2011) calls for caution to the fact that many land users are likely to change rotational practices to favour production of rapeseed. This could result in soil exhaustion, especially in traditional agriculture.

Sugarbeet

Historical developments

Since 1992, sugarbeet production in Ukraine has decreased with 53%. As seen in Figure 152, the harvested area has decreased even more than the production (-75%), but the production decrease has been limited due to significantly increased yields (+84%). Artiushyn (2010) suggests that the increased yields are thanks to the impact of large agricultural companies.

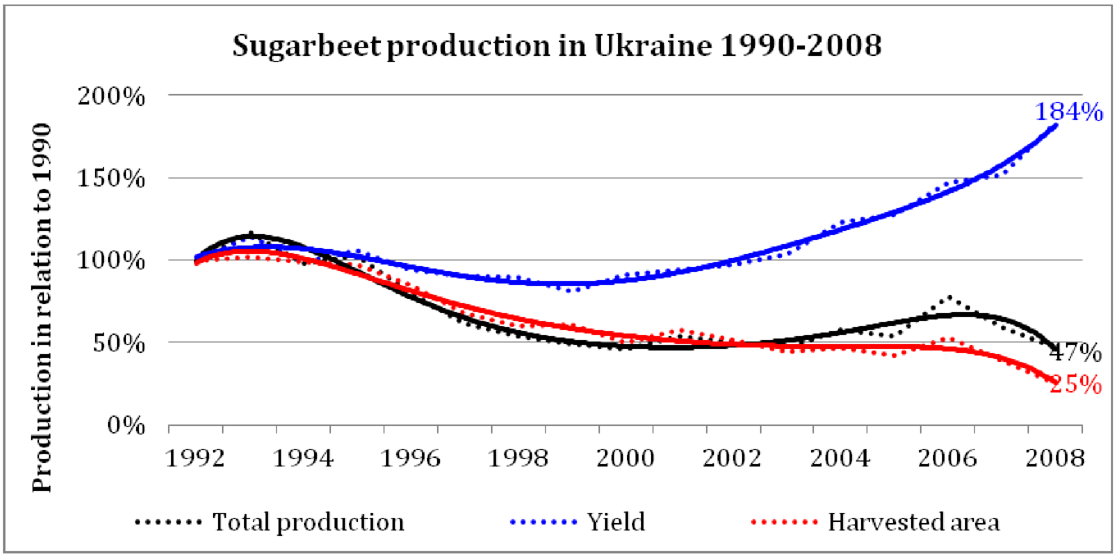


Figure 156. Change in sugarbeet production, yields and harvested area in Ukraine, 1992-2008

The share of sugar beets in the total area planted with agricultural crops in Ukraine is decreasing. Sugar beets are sown by both agricultural enterprises (farms) and private households. Only 9% of sugar beets were harvested from household plots in 2009, compared to 17% in 2008 (Artiushyn 2010). Sugarbeet is primarily produced in the Vinnytsya, Kyiv, Poltava, Rivne, Ternopil, Kharkiv and Khmelnytsk regions, in the Forest and Forest-steppe agro-ecological zones (State Statistics Committee of Ukraine in Artiushyn 2010).

Land-use dynamics from future production increases

About 70% of Ukraine's total land area is already used for agriculture of which 80% (56% of total land area) holds annual crop cultivation. Forest and forest-covered areas constitute 17% and built-up areas about 4% (Gumeniuk et al. 2010; FAOSTAT data). The main agro-ecological zones and land-use classes are illustrated in Figure 157.

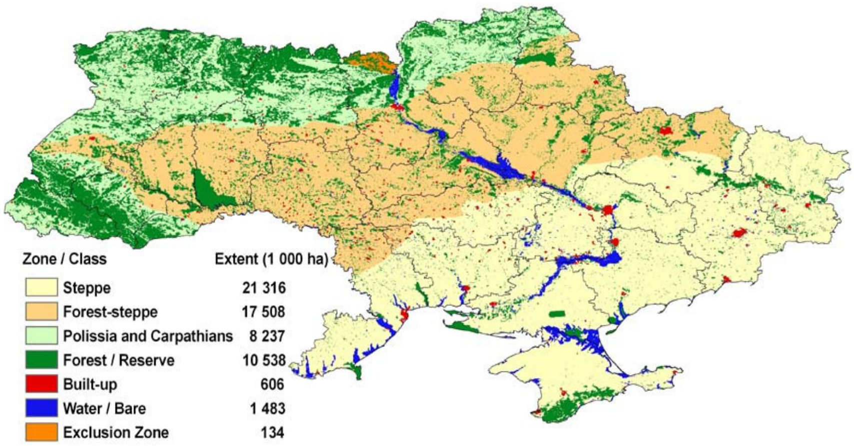


Figure 157. Main agro-ecological regions and land use classes. Source: (Gumeniuk et al. 2010)

Since LMC International (in FAO 2010) only presents values on price, yields, revenue and gross margins for sugarbeet production in the Forest zone, this approach (as used for rapeseed) cannot be used to determine where expansion is more likely to occur. However, expansion in the Steppe zone is regarded as less likely since little production takes place there (State Statistics Committee of Ukraine in Artiushyn 2010)

The suitability for sugarbeet production across Ukraine is illustrated in Figure 158. This supports that sugarbeet is less likely to expand in the Steppe zone than in the Forest and Forest-steppe zones. As for rapeseed, large forested areas typically seem unsuitable for sugarbeet production, although highly suitable land can be found in close vicinity to such areas.

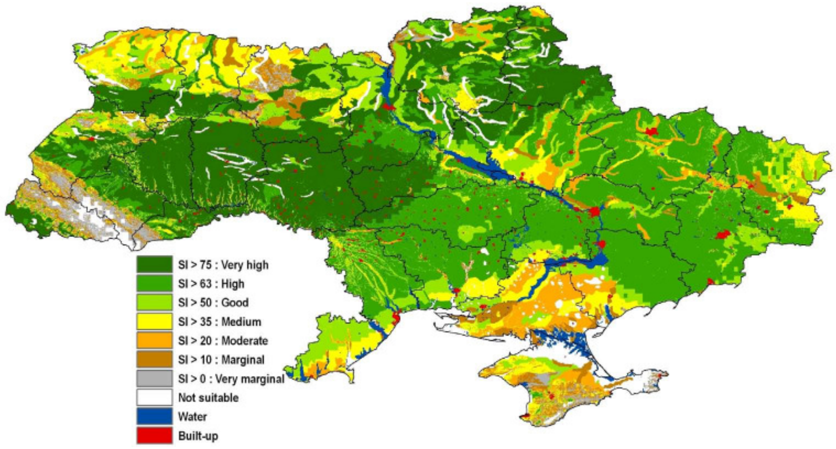


Figure 158. Suitability for rain-fed sugar beet under high level of input and management (1971-2000). Source: (Gumeniuk et al. 2010)

A closer look at the suitability for sugarbeet shows that 54.4% of the 16 Mha land suitable for sugarbeet production in the Forest-steppe zone is classified as "very suitable". Corresponding shares for the Forest zone and Steppe zone are 41.2% (of 6.4 Mha) and 0% (of 17 Mha), respectively (Gumeniuk et al. 2010). Therefore, most signs point towards a potential expansion in the Forest-steppe zone while little expansion is likely in the Steppe zone. Some expansion is likely in the forest zone, although not likely in the forested areas.

Since most land suitable for rain-fed sugarbeet production has already been cleared, significant expansion on natural vegetation is less likely. This is also supported by Nesterov (2011), who reports that expansion on already cultivated land is most likely, expansion on pastures is likely and on natural vegetation unlikely. More specific, Nesterov (2011) states that barley, buckwheat, wheat and potato are crops most likely to be replaced in case of a sugarbeet expansion.

Displacement of replaced crops onto natural vegetation seems less likely, since even though certain crops (e.g. rapeseed) have expanded significantly since 2004, the total area under annual crop cultivation has remained rather unchanged. Therefore, a potential production increase of a certain crop (e.g. sugarbeet) is likely to result in production decreases of other crops.

It should be noted that potential expansions of sugarbeet and rapeseed are expected to occur in similar areas and the crops may therefore compete for land. Gross margins, international demands for rapeseed and sugar and potential changes in national export taxation systems will most likely affect which crop that would be favoured by farmers. Currently, rapeseed is the most profitable choice.

Production system characteristics and local environmental impacts

Production system characteristics for rapeseed and sugarbeet in Ukraine are summarised in Table 128.

Table 128. Production system characteristics for rapeseed and sugarbeet in Ukraine

System component	Rapeseed	Sugarbeet
Large scale		
Small scale	Household farms; 25% of total production	Household farms: 9% of total production (2009) and decreasing
Mechanized farming system		
Manual farming system		
Tillage		
Reduced and no tillage		
Irrigated		
Rain-fed		
Mono-cropping		
Multi-cropping		
Crop rotation		
Mineral fertilizer used	60-65% of farmers	
Chemical pesticides used		
GMO seeds for sowing		
Land preparation with fire		
By-products (from harvesting)		

Legend: Blue = occurring; orange = not occurring; white = occurrence unknown due to lack of information

Sources: (Dufey, 2006; FAO, 2005; FAO/EBRD, 1999; The National Centre for Plant Genetic Resources of Ukraine, 2008; USDA-FAS 2001).

Observed local environmental impacts from rapeseed and sugarbeet production in Ukraine are summarised in Table 129.

Table 129. Observed local environmental impacts from rapeseed and sugarbeet production in Ukraine

Environmental impact	Rapeseed	Sugarbeet
Deforestation	[green]	[green]
Loss of agro-biodiversity		
Loss of biodiversity		[green]
Air pollution		[red]
Water pollution		[red]
GMO contamination		
Eutrophication		
Soil fertility decline		[red]
Erosion		[red]

Legend: Red = occurring; green = not occurring; white = occurrence unknown due to lack of information
Sources: (Dufey, 2006; FAO, 2005; FAO/EBRD, 1999; The National Centre for Plant Genetic Resources of Ukraine, 2008; USDA-FAS 2001).

Local environmental impacts allocated to domestic biofuel production

Since no production of domestic biofuels from rapeseed has been identified for 2008; no local environmental impacts from cultivation of rapeseed can be allocated to domestic biofuel production in Ukraine.

The share of the total sugarbeet area that was harvested for domestic biofuel production was 5.1% in 2008. However, the net area requirement is lower since sugarbeet biofuel production generates by-products that substitutes for other crop production: using RED allocation principles the area allocated to biofuels corresponded to 3% of the total sugarbeet area in 2008. Since sugarbeet cultivation for domestic biofuels has the same characteristics as sugarbeet cultivation for other purposes, local environmental impacts are also the same and the importance of domestic biofuel production is proportional to the share of the total sugarbeet area used for production of domestic biofuels (3%).

Local environmental impacts allocated to EU biofuel demands

The share of the total rapeseed area that was harvested for EU biofuel production was 26.5% in 2008. However, the net area requirement is lower since rapeseed biofuel production generates by-products that substitutes for other crop production: using RED allocation principles the area allocated to biofuels corresponded to 15.5% of the total rapeseed area in 2008. Since rapeseed cultivation for EU biofuels has the same characteristics as rapeseed cultivation for other purposes, local environmental impacts are also the same and the importance of EU biofuel demand is proportional to the share of the total rapeseed area used for EU biofuel production (15.5%).

The share of the total sugarbeet area that was harvested for EU biofuel production was close to 0% in 2008. Therefore, no local environmental impacts from cultivation of sugarbeet can be allocated to EU biofuel demands.

References

Artiushyn, O., 2010. *USDA Global Agriculture Information Network report: Ukraine Sugar Annual.* Available at: http://gain.fas.usda.gov/Recent%20GAIN%20Publications/Sugar%20Annual_Kiev_Ukraine_3-9-2010.pdf Accessed on April 29, 2011.

Bauen, A., Chudziak, C., Vad K. and Watson P., 2010. *A causal descriptive approach to modelling the GHG emissions associated with the indirect land use impacts of biofuels*. Available at: http://www.dft.gov.uk/pgr/roads/environment/research/biofuels/pdf/report.pdf Accessed on April 28, 2011.

Dufey, A., 2006. *Biofuels production, trade and sustainable development: emerging issues*. London: Environmental Economics Programme/Sustainable Markets Group.

FAO, 2005. *Fertilizer Use by Crop in Ukraine*. Rome: Food and Agriculture Organization of the United Nations.

FAO, 2010. *Ukraine: Grain Sector Review and Public Private Policy Dialogue*. Rome: FAO Investment Centre / EBRD Cooperation Programme. Available at: http://www.eastagri.org/publications/pub_docs/ebdr_Ukraine72c.pdf Accessed on April 28, 2011.

FAO/EBRD, 1999. *Sugar beets/White Sugar*. Rome: FAO/EBRD.

FAPRI, 2010. *U.S. and World Agricultural Outlook.* Available at: http://www.fapri.iastate.edu/outlook/ Accessed on April 28, 2011.

Gumeniuk, K., Mishchenko N., Fisher, G. and van Velthuizen H., 2010. Agro-ecological Assessment for the Transition of the Agricultural Sector in Ukraine: Methodology and Results for Baseline Climate. Available at: http://www.iiasa.ac.at/Admin/PUB/Documents/XO-10-002.pdf Accessed on April 29, 2011.

MVO, 2008. *Product Board for Margarine, Fats and Oils: Factsheet Rapeseed 2008*. Available at: http://www.mvo.nl/Portals/0/statistiek/factsheets/Factsheet-rapeseed-2008.pdf Accessed on April 28, 2011.

Nesterov, Y., 2011. Expert consultation: Yuriy Nesterov, Animal Genetic Resources Branch (AGAG) Food and Agriculture Organization of the United Nations.

The National Centre for Plant Genetic Resources of Ukraine, 2008. *Country Report on the State of Plant Genetic Resources for Food and Agriculture - Ukraine*. Kharkiv: Food and Agriculture Organization of the United Nations.

USDA-FAS, 2001. *US Department of Agriculture Foreign Agriculture Service: World Sugar Situation*. Available at: http://www.fas.usda.gov/htp2/sugar/1998/98-11/world.html Accessed on February 25, 2011.

I 15 Regional conclusions – AFRICA

This section includes country profiles for Ethiopia, Malawi, Mozambique, Nigeria, Sudan, Tanzania and Uganda.

Regional conclusions

Africa is an interesting region in regard to its potential to produce biofuel crops. However, socio-economic challenges, e.g. food insecurity, poverty and lack of infrastructure, are often large in African countries, which calls for careful consideration when assessing the region's potential to supply the EU with biofuels. Drawing generalised conclusions about Africa as a region is further difficult, due to lack of data and information.

Common for all African countries are high yield gaps, meaning that neither of the countries are close to producing as much crops as they have the potential to do, using the same amount of land as currently under cultivation. In addition, most African countries have large areas of unutilized land that can be suitable for producing biofuel crops. However, a few of the African countries, Malawi, Nigeria and Uganda, do not have an abundance of land suitable for rain-fed cultivation. Instead most suitable land is already cultivated, although with relatively low yields. From an investor perspective, African countries with large land areas suitable for cultivation have become increasingly interesting for biofuel projects.

For many of the African nations, a potential expansion is likely to occur on grasslands (savannahs). In addition, as shown in the separate project report on legislation, *Legislative readiness for RED*, conversion of grasslands seems to be universally poorly considered in environmental legislation. There seems to be a higher legislative support for protecting forest areas compared to grasslands, although not particularly strong either. Expansion of biofuel feedstock production on natural vegetation (most likely grasslands) is therefore likely to occur relatively unrestricted.

Common for all African countries is also that large parts of the population are very poor and highly dependent upon agriculture for their livelihood. This means that biofuel investments can compete with land needed for survival, even if marginal land is being targeted. On the other hand, production of energy crops may provide for a much-needed income for smallholders, processing of biofuels may create employment opportunities as well as a technology-transfer while export of biofuels may create a money-transfer into the country. It is therefore important to carefully evaluate potential impacts and benefits of biofuel production in Africa and to support domestic processing of biofuels.

I 16 Ethiopia

Selected biofuel crops for Ethiopia include sugarcane, castor and jatropha. As seen in

Table 130, domestic biofuel production has not been possible to identify or estimate, for neither of the crops. However, small amounts of feedstock for EU sugarcane ethanol in 2008 have been traced to Ethiopia.

Table 130. Area used for production of Ethiopia's selected biofuel crops, including areas used for domestic biofuel production and feedstock for biofuels on the EU market in 2008

Crop	Total harvested area in 2008 (kha)	Cropland used for domestic biofuel production in 2008		Cropland used for production of feedstock for EU biofuels in 2008	
		kha	% of total	kha	% of total
Sugarcane	21	-	-	0.1	0.5%
Castor	7	-	-	0	-
Jatropha	1,7	-	-	0	-

Source: FAOSTAT (land data); Agra CEAS and Ecofys (biofuel production and trade data).

Sugarcane

Historical developments

Between 1993 and 2008, sugarcane production in Ethiopia increased by 35%, although with a peak in 2003. As seen in Figure 159, the increase has been made possible almost entirely by an increased harvested area, while yields have remained rather unchanged during the period.

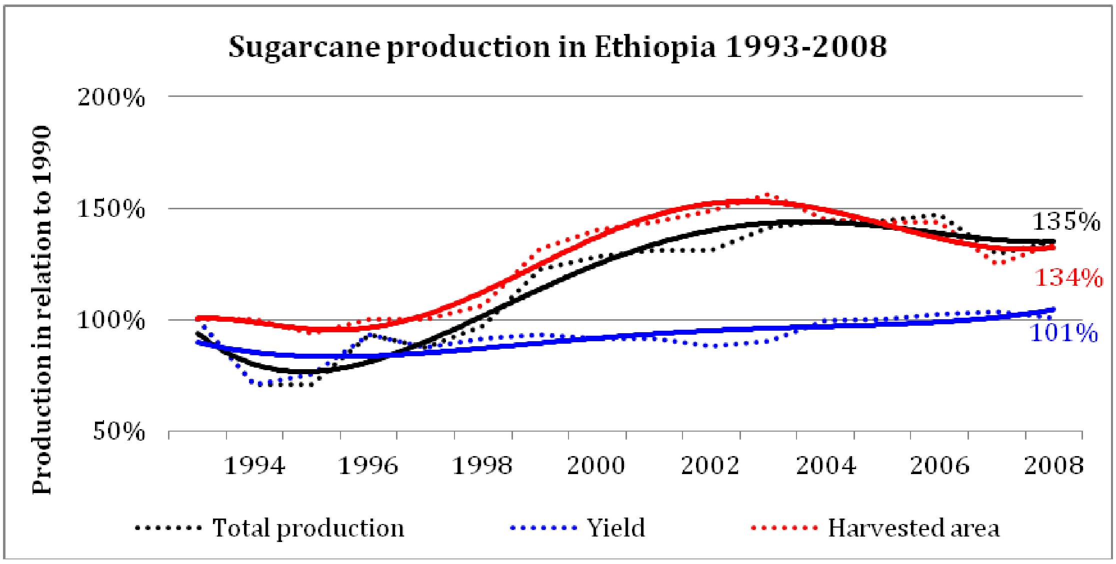


Figure 159. Change in sugarcane production, yields and harvested area in Ethiopia, 1993-2008

The recent developments of sugarcane production have occurred mainly in the Amahara region in the northwestern part of the country (Lawek & Shiferaw, 2008). The land used is both acquired by companies and used by out growers. According to Lawek and Shiferaw (2008) most of the expansion and development has occurred on forestland and arable cropland, since these are more fertile than marginal land or pastures.

Land-use dynamics from future production increases

Since sugarcane required irrigation it is likely that future expansion of sugarcane production will occur near river basins. Fessehaie (2009) highlights six river basins, which have potential for irrigated sugarcane plantations. The two largest are the Baro-Akabo basin in west Ethiopia (600 000 hectares of irrigable area) and the Abbay river basin in central/northwest Ethiopia (500 000 hectares). The Baro-Akabo basin contains mainly savannah whereas the Abbay basin contains both savannah and forestland (FAO, 2011a), making it likely that an expansion of sugarcane in these areas can occur on savannah or forested land. The Abbay basin also contains large areas of cropland (FAO, 2011a), making it a possible scenario that sugarcane can expand onto existing cropland. Fessehaie (2009) also see potential for irrigated sugarcane production in Lower Wabishebelle in Gode, Kelafo in the southeastern part of Ethiopia (120 000 hectares). This area is mainly located on shrubland and barren land, making it likely that an expansion in this area would occur on shrubland.

Smaller suitable areas include the river basins in Tekense in northern Ethiopia, and Ome-Ghibe and Lower Genale, both in the southern part of Ethiopia (Fessehaie, 2009). The Tekense river basin contains mainly savannah, whereas Ome-Ghibe and Lower Genale contain large forest areas. In addition, all areas contain relatively large areas of cropland, making an expansion on existing cropland another alternative.

The Abbay and Ome-ghibe river basins contain high densities of livestock (FAO, 2011b), making it likely that an expansion of sugarcane in these areas will occur on pastures. The other four areas contain relatively low densities of livestock. As mentioned, forest land and arable cropland land has historically been chosen for sugarcane production, instead of pastures (Lawek & Shiferaw, 2008), indicating that pastures probably are less likely to be used for an expansion in comparison to cropland and natural vegetation. Expansion on pastures is only a feasible alternative in areas close to the river deltas.

According to FAOSTAT data, the average yield for sugarcane in 2008 was 107 tonnes per hectare. Fessehaie (2009) reports that the potential yield in Ethiopia is 154 tonnes per hectare. Even though the yield-gap for sugarcane seems to be smaller than the national average for rainfed crops, Ethiopia still has a theoretical possibility to increase production with about 44%, by intensifying the cultivation or improving agricultural practices.

Castor

Historical developments

Between 1993 and 2008, castor production in Ethiopia increased by 40%. As seen in Figure 160, the increase has been made possible entirely by an increased harvested area, while yields have remained rather unchanged during the period.

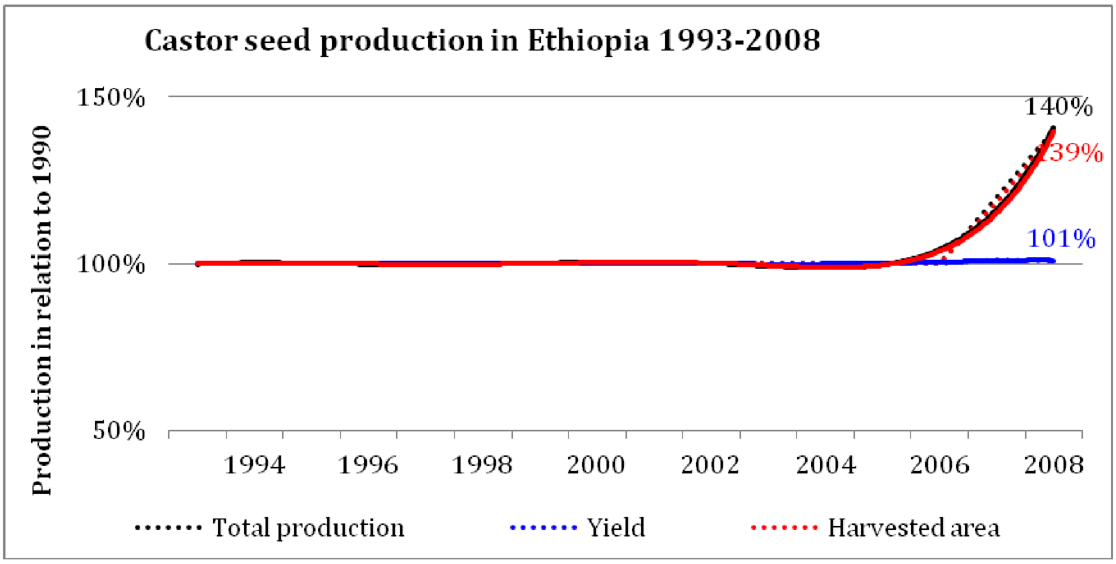


Figure 160. Change in castor production, yields and harvested area in Ethiopia, 1990-2008

Cultivation of castor in Ethiopia occupies a smaller land area than cultivation of jatropha or sugarcane (Lawek & Shiferaw, 2008). The largest area used for castor production is found in Oromia in central Ethiopia, which contains both large-scale and small-scale outgrower production. Castor has also been cultivated in Amahara in the northwest and SNNPR in southwestern Ethiopia. Most of the previous expansion has occurred on forestland and cropland (Lawek & Shiferaw, 2008).

Future production increases and resulting land-use dynamics

In contrary to sugarcane, castor has higher tolerance towards water stress. According to Fessehaie (2009) castor could be grown on lands in Afar in northeast Ethiopia, Kobo in northwest and Awash in central Ethiopia. However, these areas are densely populated and many small-scale farmers use them for growing sweet potato, taro and yam (Fessehaie 2009). It is therefore likely that arable land used for cultivation of these crops could be used for a potential expansion of castor production, since much of the expansion up until today has occurred on cropland.

Much of the land in Afar is barren, with some shrubland, savannah and other grassland (FAO, 2011a). An expansion of castor in the Afar region is therefore likely to occur on shrub- and grasslands, considering past developments. Afar has relatively little cropland that could be converted to castor production (FAO, 2011a). The Kobo region is mostly covered by Savannah, although with some cropland (FAO, 2011a), which could potentially be used to expand on. Awash has a varying land cover including forest, shrubland, savannah and other grassland. Like Kobo, Awash has large areas of cropland.

It is likely that areas currently used for castor production, such as Oromia in central Ethiopia, could be used for further expansion of castor. FAO (2011a) reports that there are still substantial amounts of uncultivated land suitable for castor production in the area. What regards natural vegetation, most of the land around the already existing cropland is savannah, although some forestland, which could be converted to castor production. According to Fessehaie (2009) companies are already starting to clear dry forests to make room for castor plantations.

Except for the western parts of Kobo, all four areas discussed above have a high density of livestock (FAO, 2011b). Since castor can be grown on marginal land, such as degraded pastures, expanding castor production on degraded pastureland can be a viable alternative in order to avoid conversion of undisturbed natural vegetation. Fessehaie (2009) reports that land formerly used for grazing are currently being converted into castor production.

Jatropha

The latest developments of jatropha cultivation have mainly occurred in Benishangul in the western part of Ethiopia. Areas in Amahara in the northwest and SNNPR in southwestern Ethiopia have also been cultivated, to a smaller extend. Most expansion has so far taken place on forest- and cropland (Lawek & Shiferaw, 2008). Country experts estimate the current land under Jatropha cultivation as 1,700 ha. This number is very likely to rise significantly as several foreign investors have applied for or already secured land titles. According to public sources, five Jatropha projects have already gone operational. Among the major investors are, according to public sources, Sunbiofuels, Global Energy and BioX Group (GEXI 2008)

According to Fessehaie (2009) Ethiopia holds around 23 million hectares of land that could be suitable for jatropha production. The five areas with the largest potential in terms of suitable area include Oromia in central Ethiopia (17 million hectare), Benshagul Gumz in the west (3 million hectares), Gambela in west (almost 3 million hectare), Somali in the southeast (1.5 million hectare) and Amhara in the central/south of Ethiopia (almost 1 million hectare).

Oromia, which according to Fessehaie (2009) has the largest area suitable for jatropha cultivation, is covered mostly by savannah but also largely by forest- and cropland. If an expansion occurs, it seems likely that savannah and forest will be converted. If an expansion occurs on Benshagul Gumz, it is likely to replace savannah. Amhara and Gambela are both to a large extent covered by savannahs and forests. Amhara also has large areas of cropland, which could be used for cultivation. Somali, on the other hand is mostly covered with shrubland and some barren land, making it likely that shrubland will be converted in case of a jatropha expansion.

The Ministry of Mines and Ministry of Energy in Ethiopia formulated a *Biofuel Development and Utilization Plan* in 2007. It reports that arable land should be preferred for biofuel feedstock production since that can be more economically viable than other types of land (Lawek & Shiferaw, 2008). If this is enforced, it is likely that already existing cropland will be used for production in all mentioned areas.

Since parts of Amahara and Oromia have large quantities of livestock (FAO, 2011b) expanding jatropha production on degraded pastureland can be a viable alternative in order to avoid conversion of undisturbed natural vegetation.

Yield-gap and available land for cultivation of rainfed crops

According to the Deininger et al (2011), Ethiopia's yield gap for rainfed crops is close to 80%. Therefore, by improving agricultural practices and/or intensifying cultivation, Ethiopia has a theoretical potential to increase the total production of rainfed crops with about 80%, without having to expand onto new land. Since large areas in Ethiopia are occupied by rainfed cropping, achieving higher yields might be a profitable strategy.

Production system characteristics and local environmental impacts

Production system characteristics for sugarcane, jatropha and castor bean in Ethiopia are summarised in Table 131.

Table 131. Production system characteristics for sugarcane, jatropha and castor bean in Ethiopia.

System component	Sugarcane	Jatropha	Castor bean
Large scale	Estates		Private companies
Small scale	Outgrowers		Outgrowers
Mechanized farming system			
Manual farming system	Harvesting		
Tillage			
Reduced and no tillage		Perennial crop	
Irrigated			
Rain fed			
Mono-cropping			
Multi-cropping			
Crop rotation		Perennial crop	
Mineral fertilizer used			
Chemical pesticides used			
GMO seeds for sowing			
Land preparation with fire			
By-products (from harvesting)	Tops and leaves from mechanical harvesting are left on the field		

Legend: Blue = occurring; orange = not occurring; white = occurrence unknown due to lack of information
Sources: (Anderson and Belay, 2008; Ayenew, 2007; Dove Biotech Ltd; FAO, 2005; Friends of the Earth, 2010; Heckett and Aklilu, 2008; IENICA, 2002; US Forest Service).

Observed local environmental impacts from sugarcane, jatropha and castor bean production in Ethiopia are summarised in Table 132.

Table 132. Observed local environmental impacts from sugarcane, jatropha and castor bean production in Ethiopia

Environmental impact	Sugarcane	Jatropha	Castor bean
Deforestation			
Loss of agro-biodiversity			
Loss of biodiversity			
Air pollution			
Water pollution			
GMO contamination			
Eutrophication			
Soil fertility decline			
Erosion			

Legend: Red = occurring; green = not occurring; white = occurrence unknown due to lack of information
Sources: (Anderson and Belay, 2008; Ayenew, 2007; Dove Biotech Ltd; FAO, 2005; Friends of the Earth, 2010; Heckett and Aklilu, 2008; IENICA, 2002; US Forest Service).

Local environmental impacts allocated to domestic biofuel production

Since no production of domestic biofuels from sugarcane, jatropha or castor has been identified for 2008; no local environmental impacts from cultivation of these crops can be allocated to domestic biofuel production in Ethiopia in 2008.

Local environmental impacts allocated to EU biofuel demands

The share of the total sugarcane area that was harvested for EU biofuel production was 0.5% in 2008. Since sugarcane cultivation for EU biofuel production has the same characteristics as sugarcane cultivation for other purposes, local environmental impacts are also the same and the importance of EU biofuel demand is proportional to the share of the total sugarcane area used for EU biofuel production (0.5%).

Since no feedstock for EU biofuels in 2008 has been traced to sugarcane, jatropha or castor produced in Ethiopia; no local environmental impacts from cultivation of these crops can be allocated to EU biofuel demands.

References

Anderson, T. and Belay, M. eds., 2008. Rapid Assessment of Biofuels Development Status in Ethiopia and Proceedings of the National Workshop on Environmental Impact Assessment and Biofuels. Addis Abeba: MELCA Mahiber.

Deininger, K., Byerlee, D., Lindsay, J., Norton, A., Selod, H. and Stickler, M., 2011. *Rising global interest in farmland - can it yield sustainable and equitable benefits?* Washington DC: The International Bank for Reconstruction and Development/The World Bank.

Dove Biotech Ltd., UNDATED. Castor Bean (Ricinus Communis) An International Botanical Answer to Biodiesel production & Renewable energy, Bangkok: Dove Biotech Ltd.

FAO, 2005. *AQUASTAT- FAO's Information System on Water and Agriculture: Ethiopia*. Available at: http://www.fao.org/nr/water/aquastat/countries/ethiopia/index.stm Accessed on February 21, 2011.

FAO, 2011a. *FAO country profile: Ethiopia. Map - Land cover*. Available at: http://www.fao.org/countryprofiles/ Accessed on April 4, 2011.

FAO, 2011b. *FAO country profile: Ethiopia. Map – Livestock Bovine*. Available at: http://www.fao.org/countryprofiles/ Accessed on April 4, 2011.

Fessehaie, R., 2009. *The status of bio-fuels in Ethiopia: Opportunities and challenges*. Presentation at UUCN Regional Workshop on Bio-Fuls Production and Invasive Species, 20-22 April 2009, Nairobi, Kenya.

Friends of the Earth, 2010. Africa: up for Grabs – The scale and impact of land grabbing for agrofuels. Brussels: Friends of the Earth Europe.

Lawek, H. & Shiferaw, Y. (2008). Rapid Assessment of Biofuels Development Status in Ethiopia And Proceedings of the National Workshop on Environmental Impact Assessment and Biofuels. MELCA Mahiber, Publication No. 6.

GEXI, 2008. *Global Market Study on Jatropha Project Inventory: Africa*. The Global Exchange for Social Investment. Available at: http://www.jatropha-alliance.org/fileadmin/documents/GEXSI_Jatropha-Project-Inventory_AFRICA.pdf Accessed on May 12, 2011.

Heckett, T., and Aklilu, N. eds., 2008. *Agrofuel Development in Ethiopia: Rhetoric, Reality and Recommendations*. Addis Ababa: Forum for Environment.

IENICA, 2002. *Castor*. Available at: http://www.ienica.net/crops/castor.htm Accessed on February 24, 2011.

US Forest Service, UNDATED. *Ricinus communis L*. Available at: http://www.fs.fed.us/global/iitf/pdf/shrubs/Ricinus%20communis.pdf Accessed on February 24, 2011.

I 17 Malawi

Selected biofuel crops for Malawi include sugarcane and jatropha. As seen in
Table 130, about 10% of the total area under sugarcane cultivation in 2008 was used for domestic ethanol production, although none was exported to the EU. No biofuels for the EU market in 2008 have been traced to Malawi.

Table 133. Area used for production of Malawi's selected biofuel crops, including areas used for domestic biofuel production and feedstock for biofuels on the EU market in 2008

Crop	Total harvested area in 2008 (kha)	Cropland used for domestic biofuel production in 2008		Cropland used for production of feedstock for EU biofuels in 2008	
		kha	% of total	kha	% of total
Sugarcane	23	2	9.5%	0	0%
Jatropha	5	-	-	-	-

Source: FAOSTAT (land data); Agra CEAS and Ecofys (biofuel production and trade data).

Sugarcane

Historical developments

Between 1990 and 2008, sugarcane production in Ethiopia increased by 40%. As seen in Figure 161, the increase has been made possible almost entirely by an increased harvested area, while yields have remained rather unchanged during the period.

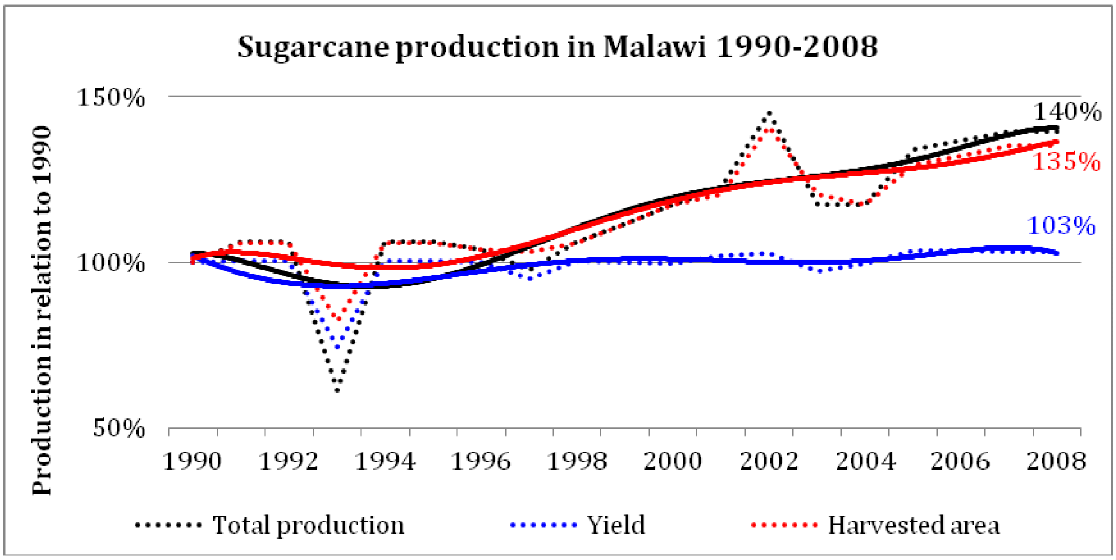


Figure 161. Change in sugarcane production, yields and harvested area in Malawi, 1990-2008

To promote sugarcane production the Malawian government established two schemes for smallholder farmers to produce sugar (Malawi government, 2005). These are located in Kasinhula in the Chikwawa district in southern Malawi and in Dwangwa in the Nikhotakota district near Lake Malawi. Dwanga is surrounded by forest areas, whereas Kasinhula contains mainly savannah with smaller forest areas (FAO, 2011).

Land-use dynamics from future production increases

According to the Malawian government (2005), there is a potential for expanding production in both areas hosting previously mentioned schemes. In that case, expansion is likely to occur on forest and/or savannah, considering the land cover in the areas (FAO, 2011). In addition to expanding existing schemes the Malawian government (2005) expresses that new schemes should be implemented, since there is a large demand for sugar. The schemes are currently promoting sugarcane for sugar production, but it is likely that an increased demand of sugarcane for ethanol production could be an additional driver for expanding the schemes and establishing new ones.

Cultivation of sugarcane requires irrigation but water management in Malawi is poor (FAO/WFP, 2005). Irrigation is uncommon even though almost one third of the country area consists of water. In fact all districts in Malawi have access to a water body, either a lake or a river (FAO, 2008). This means that sugarcane cultivation could, in theory, occur in all parts of the country.

Malawi is mostly covered by savannah, but has large areas of forest, especially along the coast of Lake Malawi (FAO, 2011). Considering the need for irrigation, it is possible that forest areas will be converted if production expands, since the lake can provide water resources without potential downstream effects and might in that sense be regarded as a beneficial water source.

Almost the entire food-crop production in Malawi is constituted by maize (90% of all cultivated land), but also by some cassava, pulses, sweet potato, fruit and vegetables (FAO, 2008). In the case of sugarcane becoming a profitable choice for farmers, it is likely that maize that will be replaced, provided that the area is irrigable.

Most grazing in Malawi occurs in the central parts and in some of the southern parts of the country (FAO, 2006). If sugarcane continue to expand in the regions where it mainly occurs today, it is less likely to occur on pastures, besides potentially in the southern parts near Kasinhula.

Jatropha

Legislation on biofuels already exists in Malawi, focusing on ethanol. It is currently opened up for including also Jatropha and other biofuel crops, under the responsibility of a Government task force including representatives from the

Departments of Energy, Forestry and Agriculture. Jatropha must be grown on degraded land or as fences to prevent impediment of food production (GEXI 2008).

Jatropha has been promoted for several years as part of the agroforestry extension package in the 90s (Pratt and Satali 2001). Malawi has launched a multimillion-dollar program focusing on large-scale farming of the jatropha plant, normally planted around homesteads as a hedge/living screen, mainly in the Dedza and Ntcheu Districts. Climate Change Corporation reports that they have secured agreements with rural communities to plant jatropha on 20,000 hectares of land. It has also signed contracts with two of Malawi's leading tobacco companies to plant the trees on their land (GEXI 2008; Mkok and Shanahan, 2005).

Several small-to-medium sized projects with a total current acreage of 4,500 ha have been identified. They are predominantly privately owned and commercial outgrower schemes - sometimes in combination with plantations. Cultivation is reported to be low maintenance with no irrigation and little fertilisation. As of 2008, the largest project identified (2,000 ha) is operated by Bio Energy Resources Ltd. near Salina and in the Nkhotakota area. The organisation C3 has set up an outgrower scheme and nurseries near Salina.

There is little information available on Jatropha cultivation in Malawi, making potential land-use dynamics difficult to assess.

Yield-gap and available land for cultivation of rainfed crops

According to the Deininger et al (2011), Malawi’s yield gap for rainfed crops is about 85%. Therefore, by improving agricultural practices and/or intensifying cultivation, Malawi has a theoretical potential to increase the total production of rainfed crops with about 85%, without having to expand onto new land. Being a densely populated country, Malawi is already cultivating most of the land that is suitable for rainfed cultivation. Therefore, closing yield-gaps is essential for achieving significant increases in rainfed crop production in Malawi.

Production system characteristics and local environmental impacts

Production system characteristics for sugarcane and jatropha in Malawi are summarised in Table 134.

Table 134. Production system characteristics for sugarcane and jatropha in Malawi

System component	Sugarcane	Jatropha
Large scale	Dominating	
Small scale	Outgrower schemes	
Mechanized farming system		
Manual farming system	Dominating	
Tillage		
Reduced and no tillage		Perennial crop
Irrigated	Dominating	
Rain fed		
Mono-cropping		
Multi-cropping		
Crop rotation		Perennial crop
Mineral fertilizer used		
Chemical pesticides used		
GMO seeds for sowing		
Land preparation with fire		
By-products (from harvesting)	Tops and leaves from mechanical harvesting are left on the field	Mosquito repellent from seed cake

Legend: Blue = occurring; orange = not occurring; white = occurrence unknown due to lack of information
Sources: (Frenken, 2005; J.H. Pratt &L.B. Satali, 2001; Mkoka and Shanahan, 2005; WWF, 2005).

Observed local environmental impacts from sugarcane and jatropha production in Malawi are summarised in Table 135.

Table 135. Observed local environmental impacts from sugarcane and jatropha production in Malawi

Environmental impact	Sugarcane	Jatropha
Deforestation		
Loss of agro-biodiversity		
Loss of biodiversity		
Air pollution		
Water pollution		
GMO contamination		
Eutrophication		
Soil fertility decline		
Erosion		

Legend: Red = occurring; green = not occurring; white = occurrence unknown due to lack of information
Sources: (Frenken, 2005; J.H. Pratt &L.B. Satali, 2001; Mkoka and Shanahan, 2005; WWF, 2005).

Local environmental impacts allocated to domestic biofuel production

The share of the total sugarcane area that was harvested for domestic biofuel production was 9.5% in 2008. Since sugarcane cultivation for domestic biofuels has the same characteristics as sugarcane cultivation for other purposes, local environmental impacts are also the same and the importance of domestic biofuel production is proportional to the share of the total sugarcane area used for production of domestic biofuels (9.5%).

Since no production of domestic biofuels from jatropha has been identified for 2008; no local environmental impacts from cultivation of jatropha can be allocated to domestic biofuel production in Malawi.

Local environmental impacts allocated to EU biofuel demands

Since no feedstock for EU biofuels in 2008 has been traced to sugarcane or jatropha produced in Malawi; no local environmental impacts from cultivation of these crops can be allocated to EU biofuel demands.

References

Brittaine, R. and Lutaladio, N., 2010. *Jatropha: A Smallholder Bioenergy Crop. The Potential for Pro-Poor Development*. Rome: Food and Agriculture Organization of the United Nations (FAO) and International Fund for Agricultural Development (IFAD) (Integrated Crop Management Vol. 8–2010).

Deininger, K., Byerlee, D., Lindsay, J., Norton, A., Selod, H. and Stickler, M., 2011. *Rising global interest in farmland - can it yield sustainable and equitable benefits?* Washington DC: The International Bank for Reconstruction and Development/The World Bank.

FAO, 2006. *Country Pasture/Forage Resource Profiles – Malawi.* Available at: http://www.fao.org/countryprofiles/ Accessed on April 4, 2011.

FAO, 2008. Nutrition Country Profile – Republic of Malawi. Rome: FAO.

FAO, 2011. *FAO country profile: Malawi. Map - Land cover*. Available at: http://www.fao.org/countryprofiles/ Accessed on April 4, 2011.

FAO/WFP, 2005. Special Report: FAO/WFP Crop and Food Supply Assessment Mission to Malawi - 20 June 2005. FAO/WFP.

Frenken, K., 2005. Irrigation in Africa in figures, AQUASTAT Survey – 2005. Rome: FAO.

GEXI, 2008. *Global Market Study on Jatropha Project Inventory: Africa*. The Global Exchange for Social Investment. Available at: http://www.jatropha-alliance.org/fileadmin/documents/GEXSI_Jatropha-Project-Inventory_AFRICA.pdf Accessed on May 12, 2011.

Malawian government, 2005. Support to NEPAD–CAADP implementation. Volume II of V. Bankable investment project profile – Commercialization of High-Value Crop. NEPAD/FAO.

Pratt, J. H. and Satali, L. B., 2001. MAFE Marketing & Enterprise Program (MEP)

Mkoka, C. and Shanahan, M., 2005. *The bumpy road to clean, green fuel*. Available at: http://www.scidev.net/en/features/the-bumpy-road-to-clean-green-fuel.html Accessed on 25 May, 2011.

WWF, 2005. Sugar and the Environment: Encouraging Better Management Practices in sugar production. Zeist: WWF Global Freshwater Programme.

I 18 Mozambique

Selected biofuel crops for Mozambique include sugarcane and jatropha. As seen in
Table 130, domestic biofuel production has not been possible to identify or estimate, for neither of the crops. No biofuels for the EU market in 2008 have been traced to Mozambique.

Table 136. Area used for production of Mozambique's selected biofuel crops, including areas used for domestic biofuel production and feedstock for biofuels on the EU market in 2008

Crop	Total harvested area in 2008 (kha)	Cropland used for domestic biofuel production in 2008		Cropland used for production of feedstock for EU biofuels in 2008	
		kha	% of total	kha	% of total
Sugarcane	180	-	-	-	-
Jatropha	8	-	-	-	-

Source: FAOSTAT (land data); Agra CEAS and Ecofys (biofuel production and trade data).

As seen in Figure 162, pastures constitute the largest share of the total agricultural area in Mozambique. Permanent crops are uncommon compared to annual crops, which are dominating the cultivated land. Jatropha plantings in 2008 were rather insignificant while sugarcane cultivations constituted about 4% of the total land under annual crops in 2008.

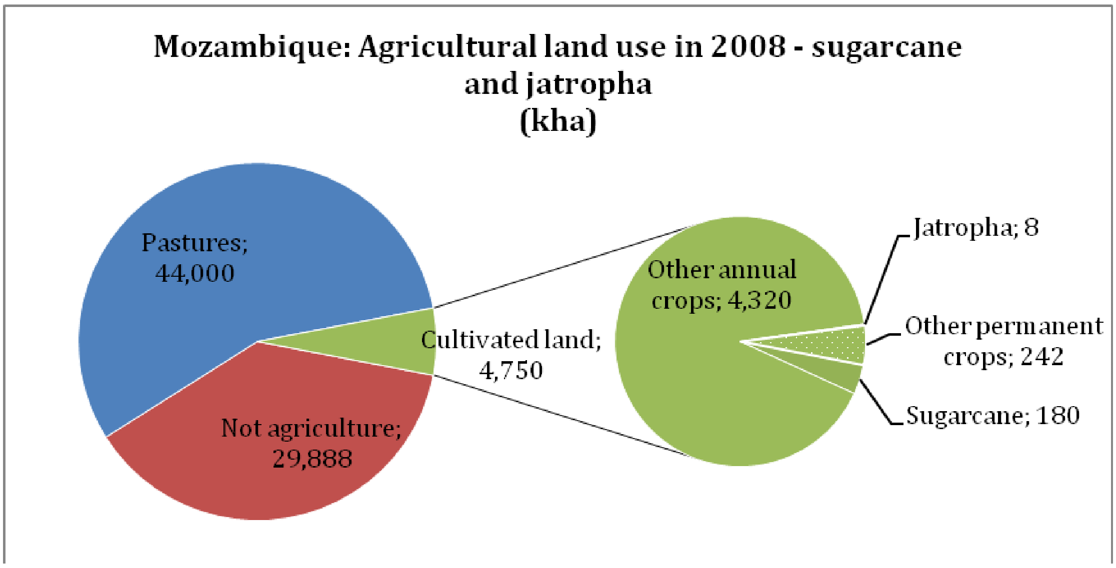


Figure 162. Agricultural land use in Mozambique in 2008, focused on sugarcane and jatropha production

Sugarcane

Historical developments

Between 1990 and 2008, sugarcane production in Mozambique increased by 639%. As seen in Figure 163, the increase has been made possible almost entirely by an increased harvested area, while yields have remained rather unchanged during the period. Most of the production increase and expansion occurred after 2000.

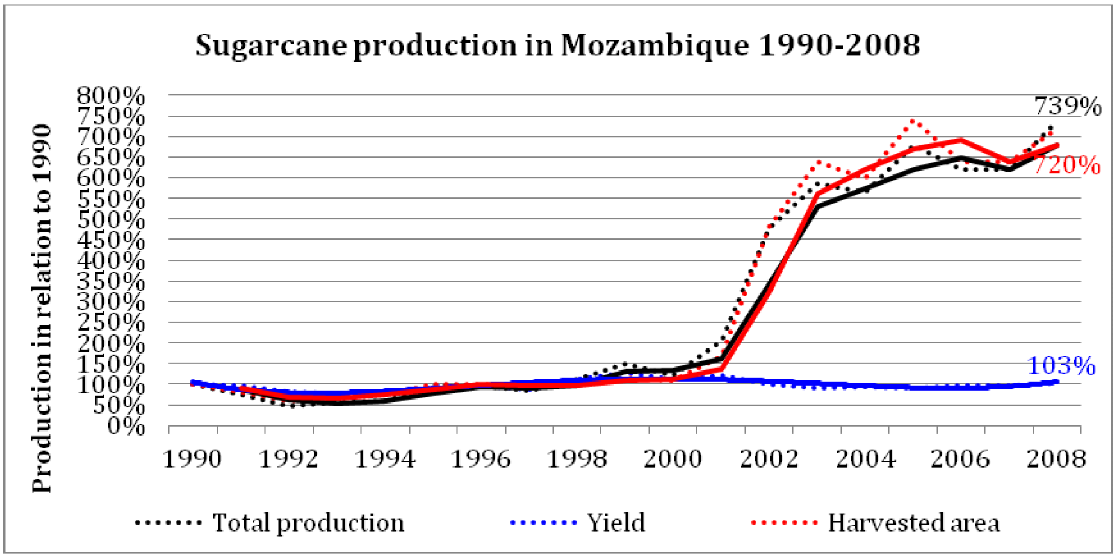


Figure 163. Change in sugarcane production, yields and harvested area in Mozambique, 1990-2008

Several sugarcane plantations are located in areas with easy access to water for irrigation, around rivers and dams (Nhantombo & Salamão, 2010). Popular areas for sugarcane production are the areas around the Incomati river, in Maputo in the southern part of Mozambique, the areas around the Buzi and Zambezi rivers in Sofala in central Mozambique as well as around Lurio and other rivers in in Cabo Delgado in the northern part of Mozambique.

Land-use dynamics from future production increases

By the end of 2008, Mozambique had formally received 17 investment proposals for biofuel projects (Schut et al., 2010). Five of these proposals were focused on ethanol production, mainly from sugarcane. As of 2010, three out of these five had been approved. The projects are located in Sofala (15 000 ha mainly sugarcane), Manica in the central parts (18 000 ha sugarcane) and Gaza in the northern parts of the country (30 000 ha sugarcane). There are also planned or suggested sugarcane projects in the areas of Cabo Delgado (Nhantombo & Salamão, 2010) and in Maputo (Nhantombo & Salamão, 2010; Schut et al., 2010).

The five regions identified as suitable for sugarcane production are all covered with savannah and some woodland (FAO, 2011a), making it likely that these types of vegetation can be converted in case of a sugarcane expansion. This is supported by Atanassov (2011), who reports that savannahs and forestland are likely to be converted in case of a sugarcane expansion in Mozambique.

Cropland for other types of production are established in all five regions identified as suitable for sugarcane production (FAO, 2011a). Atanassov (2011) believes that an expansion on existing cropland is very likely, but is not likely to replace any specific crops.

Most parts of Mozambique have low densities of livestock (FAO, 2011b), which makes it less likely that a potential expansion of sugarcane would occur on pastures. This is also supported by Atanassov (2011). The Maputo area, in the northern part of Mozambique, has a higher density of livestock than the other areas, but still relatively few animals per square meter.

According to Schut et al. (2010) the average yields of the officially proposed sugarcane projects are expected to be around 50% higher than the highest yields achieved by industries in Mozambique during the past five years (113,3 ton per hectare compared to 72 ton per hectare). A technology transfer from these projects to domestic sugarcane production might therefore result in an increased average yield and consequently help to decrease the immediate demand for land, that otherwise would be likely in the event of an increased demand for sugarcane.

Jatropha

The climatic and political situation in Mozambique is in general considered favourable for commercial Jatropha cultivation. Local experts suggest a significant increase in Jatropha cultivation to 170,000 ha by 2015. Project owners as well state optimistic plans for growth – especially for commercial plantations (GEXI 2008).

Prior to 2006, only small quantities of oilseed were produced in Mozambique, for domestic use, and no biodiesel was produced from jatropha (Schut et al., 2010). Out of the 17 formally proposed biofuel projects in Mozambique, 12 are biodiesel projects mainly focused on jatropha (Schut et al., 2010). By 2010, only one has formally been approved; a Jatropha plantation on 18 920 ha located in Sofala in the central parts of Mozambique. The other formal proposals are distributed in all but one of the provinces in Mozambique (Tete, in the northwest part). However, the proposed projects are mainly located in the central parts of Mozambique (Manica, Sofala and Zambézia) and along the cost of Inhambane in the southern parts of the country. Even though only one jatropha project has been formally approved according to Schut et al. (2010), five projects had started cultivating jatropha in 2008 and another 7 projects were initiating operations (GEXI 2008). The vast majority of Jatropha projects are found in the southern provinces Inhambane and Gaza, the central provinces Sofala and Manica as well as in the Northern Provinces of Nampula (see figure). Climatic features in these regions are reported advantageous for Jatropha cultivation, especially the sandy soils of Inhambane and Gaza (see figure). Some local experts reported a lower growth rate for Jatropha on sites in the central-western area, which may be related to soil characteristics.

According to Atanassov (2011), jatropha production is very likely to occur on natural vegetation such as savannah, forestland and costal vegetation. This is partly supported by available information about the proposed projects, as reported by GEXI (2008) and Schut et al. (2010). Several of the most important provinces in regard to existing and proposed projects are located in the southern areas near the coast and in addition to coastal vegetation; they contain both forestland and savannahs (FAO, 2011b).

Large areas of cropland exist in most provinces that have been targeted by jatropha projects (FAO, 2011a), indicating that cropland might be converted in case of an increased jatropha expansion. Atanassov (2011) supports this by claiming that an expansion of jatropha on cropland is likely to occur, although not likely to replace any specific crops. As previously mentioned, the livestock density is low in Mozambique (FAO, 2011b), indicating that an expansion of jatropha on pastures is less likely. Atanassov (2011) supports this by claiming that a potential expansion of jatropha is unlikely to occur on pastures.

Yield-gap and available land for cultivation of rainfed crops

According to the Deininger et al (2011), Mozambique's yield gap for rainfed crops is about 90%. Therefore, by improving agricultural practices and/or intensifying cultivation, Mozambique has a theoretical potential to increase the total production of rainfed crops with about 90%, without having to expand onto new land. However, since unused land suitable for production of rainfed crops is rather abundant (only 25% is currently under cultivation) (Deininger et al 2011), incentives to increase yields in Mozambique may be lower compared to countries with lower land availability, such as Malawi.

Production system characteristics and local environmental impacts

Production system characteristics for sugarcane and jatropha in Mozambique are summarised in Table 137.

Table 137. Production system characteristics for sugarcane and jatropha in Mozambique

System component	Sugarcane	Jatropha
Large scale	Outgrowers	Industrial
Small scale	Outgrowers	Experimental
Mechanized farming system		
Manual farming system	Dominant	
Tillage		
Reduced and no tillage		Perennial crop
Irrigated	Limited scale	Manual and industrial irrigation in south, partial manual irrigation in the beginning of the plantation/propagation process, central areas
Rain fed		
Mono-cropping		
Multi-cropping		Small scale – not recommended with cassava as they are from same family
Crop rotation		Perennial crop
Mineral fertilizer used		
Chemical pesticides used		
GMO seeds for sowing		
Land preparation with fire		
By-products (from harvesting)	Tops and leaves from mechanical harvesting are left on the field	

Legend: Blue = occurring; orange = not occurring; white = occurrence unknown due to lack of information
Sources: (Friends of the Earth, 2010; Jelsma et al., 2010; WorldBank, 2008).

97% of the cultivated land in Mozambique is comprised of 3 million family-based small-scale farms, with a average farm size of about 1.24 hectares and very rarely exceeding 5 hectares. Nevertheless, small farmers produce about 95% of the country's agricultural GDP. The small-scale production system is characterised by manual work, use of simple cultivation techniques, rainfed farming systems without use of chemicals, while the large-scale plantation system is characterised by mechanisation, large-scale irrigation and chemical input usage. Jatropha, has largely, until recently, been planted as hedge or a living fence. Now jatropha is also grown as cash crop and produced industrially making use of chemical based fertilizers and pesticides.

Observed local environmental impacts from sugarcane and jatropha production in Mozambique are summarised in Table 138.

Table 138. Observed local environmental impacts from sugarcane and jatropha production in Mozambique

Environmental impact	Sugarcane	Jatropha
Deforestation		
Loss of agro-biodiversity		
Loss of biodiversity		Can be invasive to native species and agroforestry systems
Air pollution		
Water pollution		
GMO contamination		
Eutrophication		
Soil fertility decline		
Erosion		

Legend: Red = occurring; green = not occurring; white = occurrence unknown due to lack of information
Sources: (Friends of the Earth, 2010; Jelsma et al., 2010; WorldBank, 2008).

Local environmental impacts allocated to domestic biofuel production

Since no production of domestic biofuels from sugarcane or jatropha has been identified for 2008; no local environmental impacts from cultivation of these crops can be allocated to domestic biofuel production in Mozambique.

Local environmental impacts allocated to EU biofuel demands

Since no feedstock for EU biofuels in 2008 has been traced to sugarcane or jatropha produced in Mozambique; no local environmental impacts from cultivation of these crops can be allocated to EU biofuel demands.

References

Atanassov, B., 2011. *Expert consultation*. Boris Atanassov, Director GreenLight Ltd.

Deininger, K., Byerlee, D., Lindsay, J., Norton, A., Selod, H. and Stickler, M., 2011. *Rising global interest in farmland - can it yield sustainable and equitable benefits?* Washington DC: The International Bank for Reconstruction and Development/The World Bank.

FAO, 2011a. *FAO country profile: Mozambique. Map - Land cover*. Available: http://www.fao.org/countryprofiles/ Accessed on April 4, 2011.

FAO, 2011b. *FAO country profile: Mozambique. Map – Livestock Bovine*. Available: http://www.fao.org/countryprofiles/ Accessed on April 4, 2011.

Friends of the Earth. 2010. *The Jatropha trap? The realities of farming Jatropha in Mozambique*. Amsterdam: Friends of the Earth. (May 2010, Issue 118).

GEXI, 2008. *Global Market Study on Jatropha Project Inventory: Africa*. The Global Exchange for Social Investment. Available at: http://www.jatropha-alliance.org/fileadmin/documents/GEXSI_Jatropha-Project-Inventory_AFRICA.pdf Accessed on May 12, 2011.

Jelsma, I., Bolding, A. and Slingerland, M., 2010. *Smallholder Sugarcane Production Systems in Xinavane, Mozambique: Report from the Field*. Wageningen: Wageningen University, Plant Science Group, Plant Production Systems.

Nhantombo, I. and Salamão, A., 2010. Biofuels, land access and rural livelihoods in Mozambique. London: IIED.

Schut, M., Slingerland, M. and Locke, A., 2010. Biofuel developments in Mozambique. Update and analysis of policy, potential and reality. *Energy Policy,* 38(9), pp.5151-5165.

World Bank, 2008. *Mozambique Biofuels Assessment*. Maputo: World Bank.

I 19 Nigeria

Selected biofuel crops for Nigeria include oil palm, soybean and cassava. As seen in Table 139, domestic biofuel production has not been possible to identify or estimate, for neither of the crops. No biofuels for the EU market in 2008 have been traced to Nigeria.

Table 139. Area used for production of Nigeria's selected biofuel crops, including areas used for domestic biofuel production and feedstock for biofuels on the EU market in 2008

Crop	Total harvested area in 2008 (kha)	Cropland used for domestic biofuel production in 2008		Cropland used for production of feedstock for EU biofuels in 2008	
		kha	% of total	kha	% of total
Oil palm	3,200	0	0%	0	0%
Soybean	609	0	0%	0	0%
Cassava	3,778	-	-	0	0%

Source: FAOSTAT (land data); Agra CEAS and Ecofys (biofuel production and trade data).

Oil Palm

Historical developments

Between 1990 and 2008, Oil Palm production in Nigeria increased by 37%. As seen in Figure 164, the increase has been made possible entirely by an increased harvested area, while yields have remained rather unchanged during the period.

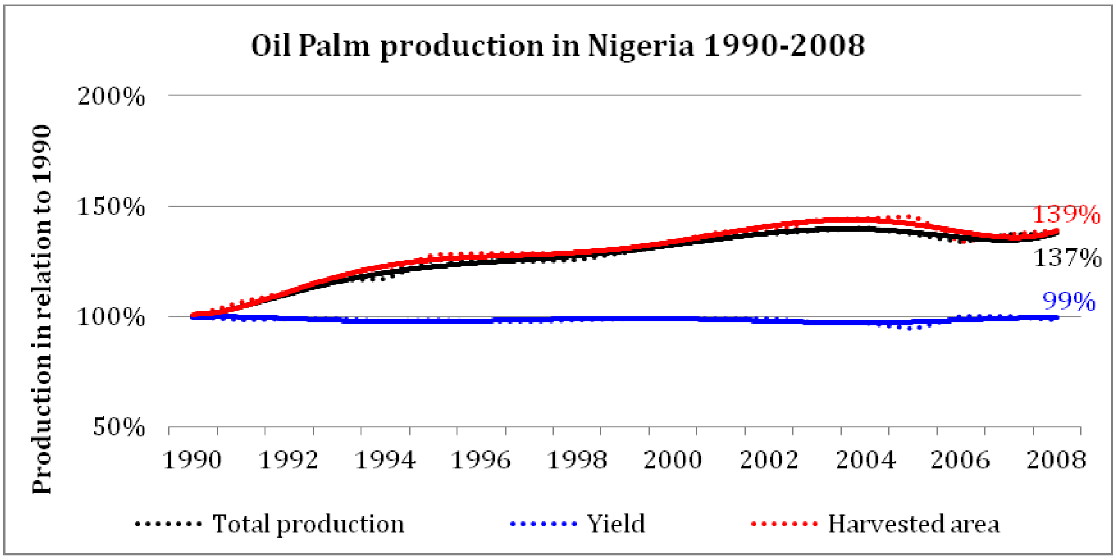


Figure 164. Change in oil palm production, yields and harvested area in Nigeria, 1990-2008

Oil palm is grown in the southern, more humid parts of Nigeria and in the tropical high forest zones (FAO, 2006). It is likely that forests have been cleared for establishing the plantations. Most of the oil palm plantations in the eastern and western parts on Nigeria are old and have low productivity (Abila, 2010).

Land-use dynamics from future production increases

Abila (2011) argues that if cultural practices and plantations maintenance were intensified, the production of oil palm would probably increase in Nigeria. Considering that the oil palm plantations in the eastern and western parts are old with low yields (Abila, 2010), there is a potential to improve the production in these areas.

If the production of oil palm would increase in Nigeria, expansion would most likely occur on existing farmland, according to Abila (2011). Farmers would likely shift to producing oil palm for increasing income. It is however difficult to say if there are any particular types of crops that would be replaced by oil palm production.

A potential expansion is not likely to occur on pastures or natural vegetation, according to Abili (2011), but rather on abandoned, unused or underutilized arable land. Especially arable land not under aided fallow or undertaken by invasive species is likely to be used. It is also likely that old plantations that were used for production of cash crops, but have been rendered unproductive due to fires or neglect, could be used.

Soybean

Historical developments

Between 1990 and 2008, Soybean production in Nigeria increased by 171%. As seen in Figure 165, the increase has been made possible entirely by continuously increasing yields, while the harvested area seems to have decreased by 16% since 1990.

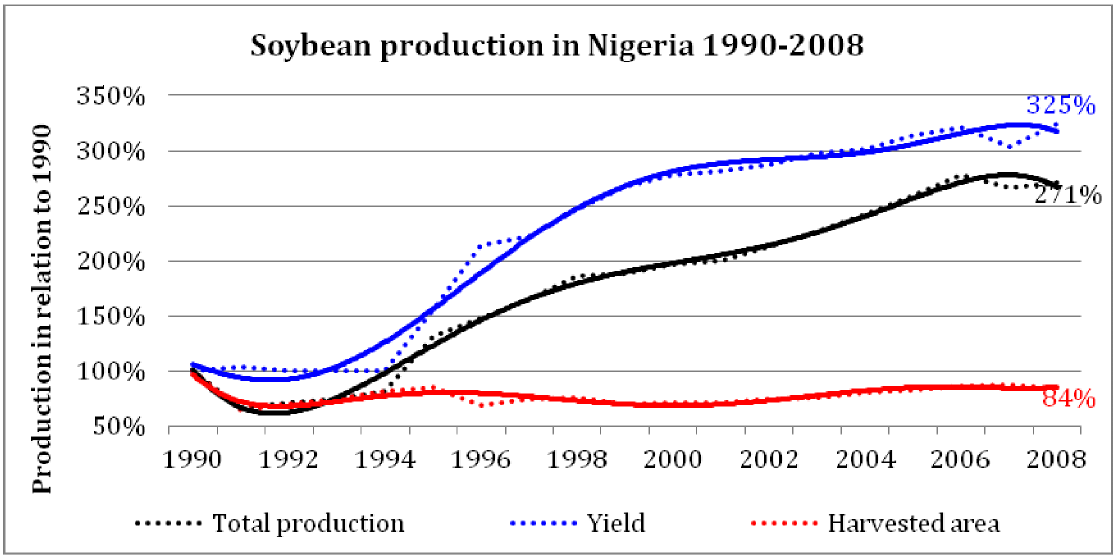


Figure 165. Change in soybean production, yields and harvested area in Nigeria, 1990-2008

Land-use dynamics from future production increases

According to Abila (2011), increased production of soybean in Nigeria is very likely to occur on existing arable farmland, where it is likely to replace crops growing during the same season as soybean, such as maize, sesame or other beans. Most food crops are produced in the central and western parts of Nigeria (FAO, 2006). It is not likely that soybean production would occur on pastures or on natural vegetation, according to Abili (2011).

As also seen in Figure 165, Abila (2011) reports that farmland devoted to production of soybean has not increased the past decades. Instead yields have increased significantly during the past decades as a result of better practices and better seeds. With an increased demand for soybean, these practices are likely to be implemented more widely. This could help to keep the demand for land low, even though the demand for soybean increases.

Studies have also shown that soybean can be intercropped with cassava, for example in the southeastern parts of Nigeria (Umeh & Mbah, 2008). Soybean, being a nitrogen-fixating crop, acts as a soil improver by increasing the nitrogen concentration in the soil. Rotating these biofuel crops can thus be a potentially beneficial strategy for Nigeria.

Cassava

Nigeria is the world's largest cassava producer (Truman et al. 2004). Over the last decade, cassava has evolved in Nigeria from a mere food security crop to a cash and industrial crop (IITA 2011) . Cassava is one of the most important food crops for both urban and rural consumers in Nigeria (FAO 2005). The cassava roots are processed into granules, pastes, flours, chips etc., or consumed freshly boiled or raw, also the leaves are also consumed as a green vegetable (providing protein and vitamins A and B) (IITA, 2011). Cassava has many qualities as a crop which makes it appreciated by farmers; the ability to grow on marginal lands where cereals and other crops do not grow well; it can tolerate drought and can grow in low-nutrient soils, cassava roots can be stored in the ground for up to 24-36 months (depending on variety), harvest may be delayed until market, processing, or other conditions are favourable (IITA, 2011). Research is on-going into genetically modified forms of cassava financed by the Nigerian government and Shell (Friends of the Earth, 2010).

Historical developments

Between 1990 and 2008, cassava production in Nigeria increased by 134%. As seen in Figure 166, the increase has been made possible entirely by an increased harvested area, while yields have remained rather unchanged during the period.

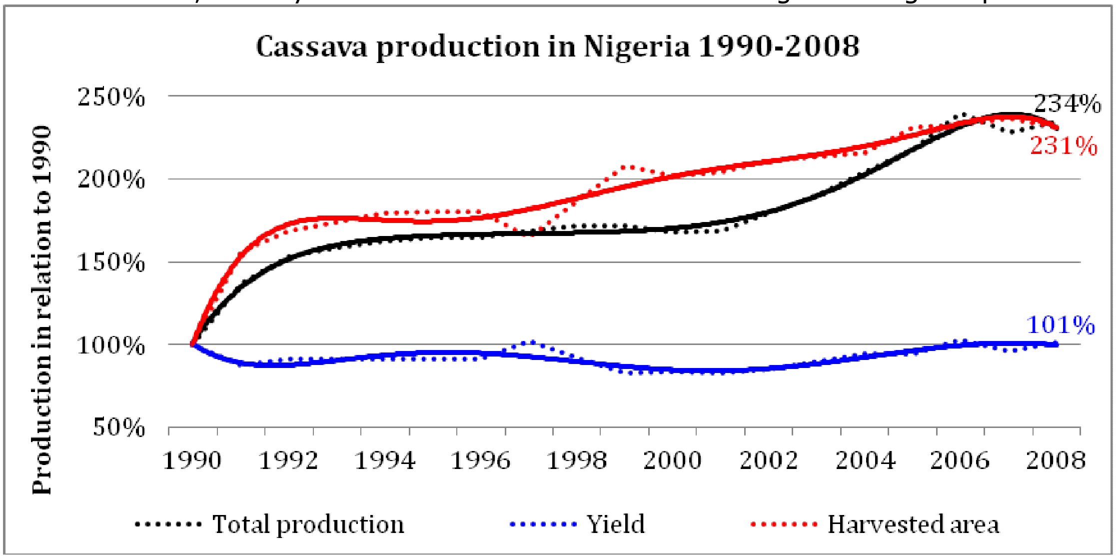


Figure 166. Change in cassava production, yields and harvested area in Nigeria, 1990-2008

Most food crops, including cassava, are grown in the central and western parts of Nigeria (FAO 2006).

Land-use dynamics from future production increases

Abila (2011) refers to cassava as a "crop of the poor". Increased population in Nigeria has caused unemployment and inflation and since the price of cassava has remained relatively stable, the production of cassava has increased with population.

Although Nigeria has large oil reserves, the country is still a large importer of refined oil products such as gasoline (Ohimain, 2010). Lately, Nigeria has shown interest in ethanol and has imported large quantities from Brazil. There are several emerging bioethanol projects in Nigeria, although mainly focused on domestic consumption. Out of twenty projects, half are focused on ethanol production from cassava. Most of the projects are planned to be located in the southern/southwest parts of Nigeria, in which forest is the main land cover (FAO, 2011). According to Abali (2011), it is likely that cassava expansion would occur on natural vegetation, mainly forests recovering from agricultural overuse. It is not likely that pastures would be used for cassava (Abila 2011).

Abila (2011) reports that cassava production is most likely to occur on already existing farmland, and likely to replace other tubers such as yams. Yams require more input and takes a longer time to mature. According to Ohimain (2010) an increased interest in crop production for ethanol purposes, e.g. sugarcane, sweet sorghum and cassava, is likely to shift cultivation from maize, rice and yams.

Yield-gap and available land for cultivation of rainfed crops

According to the Deininger et al (2011), Nigeria's yield gap for rainfed crops is about 80%. Therefore, by improving agricultural practices and/or intensifying cultivation, Nigeria has a theoretical potential to increase the total production of rainfed crops with about 80%, without having to expand onto new land. Since unused land suitable for production of rainfed crops is scarce (more than 90% is already under cultivation) (Deininger et al 2011), incentives to increase yields in Nigeria may be higher compared to countries with higher land availability, such as Mozambique. This supports Abali's (2011) statements on soybean production.

Production system characteristics and local environmental impacts

Production system characteristics for oil palm, soybean and cassava in Nigeria are summarised in Table 140.

Table 140. Production system characteristics for oil palm, soybean and in Nigeria

System component	Oil Palm	Soybean	Cassava
Large scale	370 000 ha[85] out of some intercropped with cassava		
Small scale	80-90%		
Mechanized farming system			
Manual farming system	Dominating	Dominating	
Tillage			
Reduced and no tillage	Perennial crop		
Irrigated			
Rain fed			
Mono-cropping			
Multi-cropping	Dominant		E.g. vegetables, plantation crops (such as coconut, oil palm, and coffee), yams, sweet potato, melon, maize, rice, groundnut, or other legumes
Crop rotation	Perennial crop		
Mineral fertilizer used			Although in limited scale
Chemical pesticides used	Some are banned in the EU	Observe that "Paraquat" is recommended	Although in limited scale
GMO seeds for sowing			
Land preparation with fire			
By-products (from harvesting)			

Legend: Blue = occurring; orange = not occurring; white = occurrence unknown due to lack of information
Sources: (Dugje et al., 2009; Waters-Bayer, 1988).

Observed local environmental impacts from oil palm, soybean and cassava production in Nigeria are summarised in Table 141.

Oil palm is a native species in many West African countries. Nigeria has set a national target for using up to 10% domestically produced agrofuel in transport fuel by 2020. Roads constructed for the oil palm plantations and mills increase the access to previously remote areas, facilitating logging and hunting. Nigeria's forests are only some 10% of the size they were just two decades ago, but they still provide an incredibly rich and diverse habitat. Poisoned fishponds from pesticide use in oil

[85] Source: *Oil World Monthly*, april 2006; *Oil Annual* 2005.

palm plantations have been observed. In Nigeria, farmers use pesticides banned in Europe. There is also evidence on altered hydrology. Oil palm plantations have led to compaction of soils, as well as soil and water mining. Oil palm is a native species in many West African countries. Nigeria has set a national target for using up to 10% domestically produced agrofuel in transport fuel by 2020.

Soybean production in Nigeria is mainly small holder non-mechanised for domestic food market, and industrial use (FAO 2004). Nigeria is the largest producer of soybeans for food in West and Central Africa. (Waters-Bayer 1988).

Table 141. Observed local environmental impacts from oil palm, soybean and cassava production in Nigeria

Environmental impact	Oil Palm	Soybean	Cassava
Deforestation	Red	Red	Red
Loss of agro-biodiversity	White	White	White
Loss of biodiversity	Red	Red	Red
Air pollution	White	White	White
Water pollution	Red	Red	Red
GMO contamination	White	White	Green
Eutrophication	White	White	White
Soil fertility decline	Red	Red	Red
Erosion	White	Red	Red

Legend: Red = occurring; green = not occurring; white = occurrence unknown due to lack of information
Sources: (Dugje et al., 2009; Waters-Bayer, 1988).

Local environmental impacts allocated to domestic biofuel production

Since no production of domestic biofuels from oil palm, soybean or cassava has been identified for 2008; no local environmental impacts from cultivation of these crops can be allocated to domestic biofuel production in Nigeria.

Local environmental impacts allocated to EU biofuel demands

Since no feedstock for EU biofuels in 2008 has been traced to oil palm, soybean or cassava produced in Nigeria; no local environmental impacts from cultivation of these crops can be allocated to EU biofuel demands.

References

Abila, N., 2010. Biofuels adoption in Nigeria: A preliminary review of feedstock and fuel production potentials. *Management of Environmental Quality*, 21(6), pp.785-795.

Abila, N., 2011. Expert consultation: Nelson Abila, Business Development Consultant *at* Millennium Village Project.

Deininger, K., Byerlee, D., Lindsay, J., Norton, A., Selod, H. and Stickler, M., 2011. *Rising global interest in farmland - can it yield sustainable and equitable benefits?*

Washington DC: The International Bank for Reconstruction and Development/The World Bank.

Dugje, I.Y., Omoigui, L.O., Ekeleme, F., Bandyopadhyay, R., Lava Kumar, P. and Kamar, A.Y., 2009. *Farmers' Guide to Soybean Production in Northern Nigeria*. Ibadan: International Institute of Tropical Agriculture (IITA).

FAO, 2004. *The role of soybean in fighting world hunger*. Rome: FAO Commodities and Trade Division, Basic Foodstuffs Service.

FAO, 2005. A review of cassava in Africa with country case studies on Nigeria, Ghana, the United Republic of Tanzania, Uganda and Benin. Rome: Food and Agriculture Organisation of the United Nations.

FAO, 2006. *Country Pasture/Forage Resource Profiles – Nigeria.* Available at: http://www.fao.org/countryprofiles/ Accessed on April 4, 2011.

FAO, 2011. *FAO country profile: Nigeria. Map - Land cover*. Available at: http://www.fao.org/countryprofiles/ Accessed on April 4, 2011.

Friends of the Earth, 2010. Africa: up for Grabs – The scale and impact of land grabbing for agrofuels. Brussels: Friends of the Earth Europe.

IITA, 2011. Available at http://www.iita.org/ Accessed on May 30, 2011.

Ohimain, E.I., 2010. Emerging bio-ethanol projects in Nigeria: Their opportunities and challenges. *Energy Policy* 38(11), pp.7161-7168.

Truman, P.P., Taylor, D.S., Sanni, L., and Akoroda, M.O., 2004. *A Cassava Industrial Revolution in Nigeria: The Potential for a New Industrial Crop*. Rome: Food and Agriculture Organisation of the United Nations.

Umeh, S.I. & Mbah, B.N., 2010. Intercrop performance of different varieties of soybean (Glycine Max. (L) Merril) in a cassava (Manihot esculenta Crantz) based cropping system within the derived savannah zone. *African Journal of Biotechnology*, 9(50), pp.8636-8642.

Waters-Bayer, A., 1988. Soybean Daddawa: an innovation by Nigerian Women. *ILEIA Newsletter*, 4(3), October 1988.

I 20 Sudan

Selected biofuel crops for Nigeria include sugarcane, soybean and millet. As seen in Table 139, domestic biofuel production has not been possible to identify or estimate, for neither of the crops. No biofuels for the EU market in 2008 have been traced to Sudan.

Table 142. Area used for production of Sudan's selected biofuel crops, including areas used for domestic biofuel production and feedstock for biofuels on the EU market in 2008

Crop	Total harvested area in 2008 (kha)	Cropland used for domestic biofuel production in 2008		Cropland used for production of feedstock for EU biofuels in 2008	
		kha	% of total	kha	% of total
Sugarcane	69	-	-	-	-
Sorghum	6,619	-	-	-	-
Millet	2,333	-	-	-	-

Source: FAOSTAT (land data); Agra CEAS and Ecofys (biofuel production and trade data).

Sugarcane

Historical developments

Between 1990 and 2008, sugarcane production in Sudan increased by 77%. As seen in Figure 167, the increase has been made possible mostly by continuously increasing yields, while the harvested area increased by 6% since 1990.

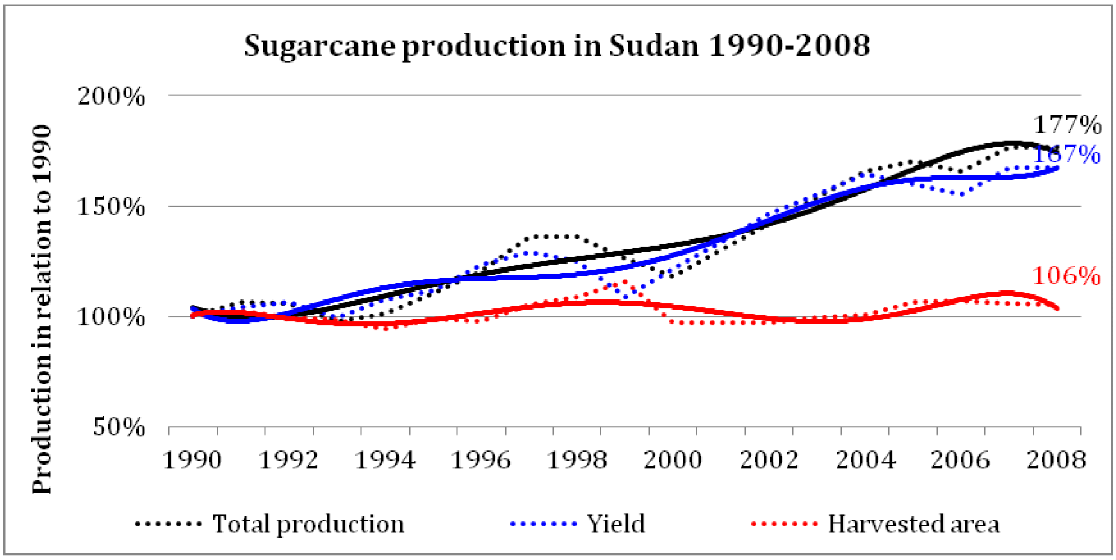


Figure 167. Change in sugarcane production, yields and harvested area in Sudan, 1990-2008

Large parts of northern Sudan are covered with barren desert land (FAO, 2006). Most of the large-scale cultivation initiatives in Sudan are located in the low rainfall savannah zone south of the desert. The zone stretches along the central parts of Sudan and along parts of the river Nile. There are three large-scale sugarcane plantations located in the central/east parts in the irrigated area near the river Nile.

Land-use dynamics from future production increases

Large parts of the savannah are cultivated with rainfed crops and have limited possibilities for irrigation (FAO, 2006). If sugarcane production expands in Sudan it is likely to occur in areas close to where it is currently cultivated, along the upper parts of the river Nile. Few other areas in Sudan have possibilities for irrigation. According to Gaiballa (2011), natural vegetation is likely to be converted in case of sugarcane expansion. Natural vegetation surrounding existing sugarcane plantations is primarily savannah, making it likely that savannah can be converted to sugarcane production in case of an increased demand for sugarcane.

Gaiballa (2011) reports that sugarcane production is not likely to occur on existing cropland. Since there are several large-scale agricultural initiatives in the irrigated areas around the river Nile (FAO, 2006), irrigation has a potential to be extended to new sugarcane initiatives in the near vicinity.

According to Gaiballa (2011), pastures on the rangelands in central Sudan are likely to be used for an expansion of sugarcane production. According to FAO (2006), free grazing on these rangelands is the most common type of managing livestock. Areas in these rangelands with possibilities for irrigation can therefore be suitable for sugarcane production, supporting Gaiballa's (2011) statement.

Sorghum

Historical developments

Between 1990 and 2008, sorghum production in Nigeria increased by 228%. As seen in Figure 168, the increase has been made possible mostly by an increased harvested area. Yields increased with 37% during the period. There have been significant fluctuations in production and harvested area during the period. Yields have also been fluctuating, although to a smaller extent. Reasons for the fluctuations are unknown.

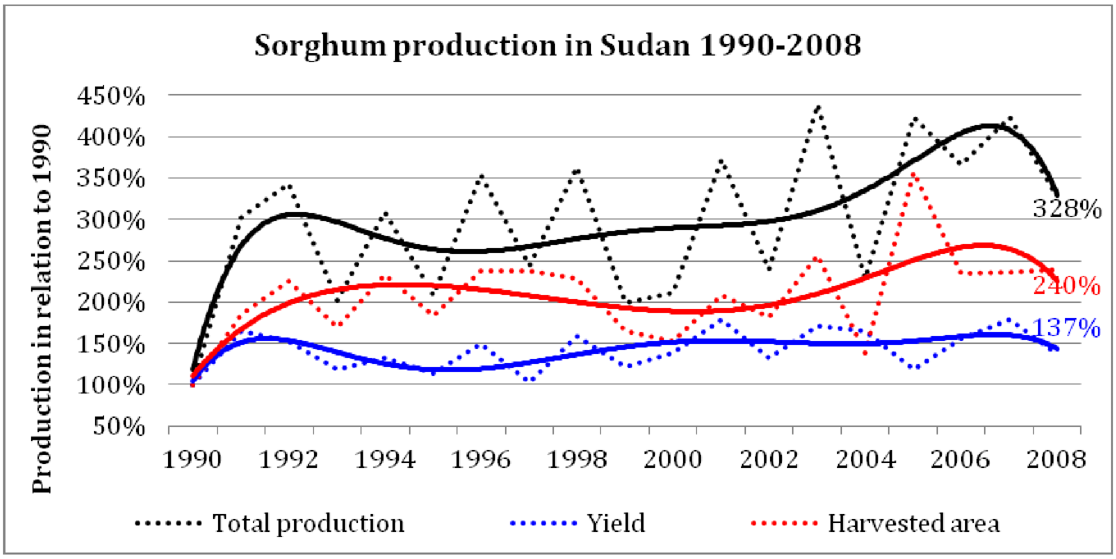


Figure 168. Change in sorghum production, yields and harvested area in Sudan, 1990-2008

Sorghum is the most commonly cultivated cereal crop in Sudan and is cultivated both in the northern semi-desert zones, on soils with high clay content, as well as in the flood plains in the southern part of Sudan (GIEWS, 2011). Most of the cultivation is rainfed (FAO, 2006).

Land-use dynamics from future production increases

Sorghum does not require irrigation in the same was as sugarcane and could therefore be cultivated on land where it is not possible to irrigate, such as central parts of Sudan with longer distance to the river Nile. According to Gaiballa (2011), a potential expansion of sorghum is not likely to occur on existing farmland. Instead he states that such an expansion is most likely to occur on natural vegetation. Since Sudan is mostly covered by savannah and only has small areas of other grassland, forest and shrubland, it is likely that savannah will be converted to sorghum production if the demand increases.

Gaiballa (2011) argues that sorghum and pastures are unlikely to compete for land in case of a sorghum expansion.

Millet

Historical developments

Between 1990 and 2008, millet production in Nigeria increased by 748%. As seen in Figure 169, the increase has been made possible both by an increased harvested area (+253%) and increased yields (+141%).

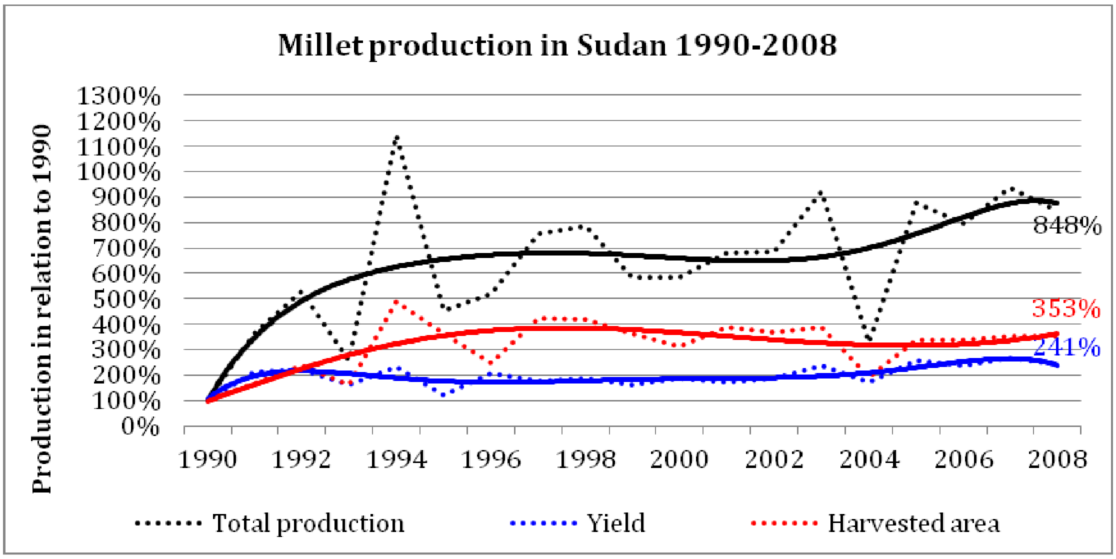


Figure 169. Change in millet production, yields and harvested area in Sudan, 1990-2008

Millet is primarily cultivated in the western parts of the country (Gaiballa 2011). However, it is also grown both in the semi-desert zones in the north and in the low rainfall savannah zones in central Sudan, although on sandy soils in contrary to sorghum which is grown on clay soils (FAO, 2006). According to Gaiballa (2011), most of the production is for local consumption.

Land-use dynamics from future production increases

Gaiballa (2011) does not expect millet production to increase and, consequently, does not believe that an expansion on arable land, pastures or natural vegetation is likely to happen. However, considering past trends, it seems unreasonable to rule out further production increases in such a way. Potential external demand for biofuel feedstock may also increase the demand for millet. However, little information regarding the potential of future millet expansion for biofuel purposes has been found, so the above discussion should be regarded as conjecture.

Yield-gap and available land for cultivation of rainfed crops

According to the Deininger et al (2011), Sudan's yield gap for rainfed crops is more than 90%. Therefore, by improving agricultural practices and/or intensifying cultivation, Sudan has a theoretical potential to increase the total production of rainfed crops with more than 90%, without having to expand onto new land. Since unused land suitable for production of rainfed crops is rather abundant (less than 30% is under cultivation) (Deininger et al 2011), there are no apparent incentives to increase yields. Therefore, past trends of both expansion and increased yields are likely to continue.

Production system characteristics and local environmental impacts

Production system characteristics for sugarcane, sorghum and millet in Sudan are summarised in Table 143.

Table 143. Production system characteristics for sugarcane, sorghum and millet in Sudan

System component	Sugarcane	Sorghum	Millet
Large scale	The company 'Kenana Sugar', transformed 40 000 ha a long the White Nile into one of the world's largest sugarcane plantations in 2007. The Sudanese government want to expand the current 200 000 ha into 1.4 million hectares.		
Small scale		Traditional farming for subsistence dominant	Traditional farming for subsistence dominant
Mechanized farming system		Mainly land preparation and sowing	
Manual farming system			
Tillage			
Reduced and no tillage			
Irrigated		In 2000/2001, irrigated sorghum accounted for 35% of total production, however, this was proposed by the government to cater for the "food gap".	
Rain fed			
Mono-cropping			
Multi-cropping			
Crop rotation			
Mineral fertilizer used		Limited scale	
Chemical pesticides used		Limited scale	
GMO seeds for sowing			
Land preparation with fire			
By-products (from harvesting)	Tops and leaves from mechanical harvesting are left on the field		

Legend: Blue = occurring; orange = not occurring; white = occurrence unknown due to lack of information

Sources: (AchaNoticias, 2007; Cheesman, 2004; El Moghraby, 2002; Elnagheeb and Bromley, 1994; Sudan Tribune, 2007; UNEP, 2007; World Resource Institute, 2003)

Observed local environmental impacts from sugarcane, sorghum and millet production in Sudan are summarised in Table 144.

Sorghum and millet are currently promoted as water saving bio-energy crops on account of their superior drought tolerance in comparison to e.g. maize. However, at the same time sorghum and millet are two of the main staple foods in and play a vital role in food security for smallholder farmers in dryland areas such as Sudan. Sudan is the third largest sugar cane producer in Africa (Hassan, 2008).

Table 144. Observed local environmental impacts from sugarcane, sorghum and millet production in Sudan

Environmental impact	Sugarcane	Sorghum	Millet
Deforestation		Red	Red
Loss of agro-biodiversity			
Loss of biodiversity		Red	Red
Air pollution			
Water pollution	Red	Red	
GMO contamination	Green	Green	Green
Eutrophication			
Soil fertility decline	Red	Red	Red
Erosion		Red	Red

Legend: Red = occurring; green = not occurring; white = occurrence unknown due to lack of information
Sources: (AchaNoticias, 2007; Cheesman, 2004; El Moghraby, 2002; Elnagheeb and Bromley, 1994; Sudan Tribune, 2007; UNEP, 2007; World Resource Institute, 2003)

Local environmental impacts allocated to domestic biofuel production

Since no production of domestic biofuels from sugarcane, sorghum or millet has been identified for 2008; no local environmental impacts from cultivation of these crops can be allocated to domestic biofuel production in Sudan.

Local environmental impacts allocated to EU biofuel demands

Since no feedstock for EU biofuels in 2008 has been traced to sugarcane, sorghum or millet produced in Sudan; no local environmental impacts from cultivation of these crops can be allocated to EU biofuel demands.

References

AchaNoticias, 2007. *Sugar factory in Sudan to double production*. Available at www.achanoticias.com.br/noticia_pdf.kmf?noticia=7443399 Acccessed on May 30, 2011.

Cheesman, O., 2004. *The environmental impacts of sugar production*. Trowbridge: CABI Publishing and WWF.

Deininger, K., Byerlee, D., Lindsay, J., Norton, A., Selod, H. and Stickler, M., 2011. *Rising global interest in farmland - can it yield sustainable and equitable benefits?* Washington DC: The International Bank for Reconstruction and Development/The World Bank.

El Moghraby, A.I., 2002. State of the environment in Sudan. In B. Sadler and M. McCabe, eds. *Environmental Impact Assessment Training Resource Manual.* Geneva: UNEP.

Elnagheeb, A.H., and Bromley, D.W., 1994. Extensification of agriculture and deforestation: empirical evidence from Sudan. *Agicultural Economics*, 10(2), pp.193-200.

FAO, 2006 *Country Pasture/Forage Resource Profiles – Sudan.* Available at: http://www.fao.org/countryprofiles/ Accessed on April 4, 2011.

Gaiballa, A., 2011. *Expert consultation: Abdelaziz Gaiballa, Associate Prof., Sudan University of Science & Technology.*

GIEWS, 2011. GIEWS Country Brief: Sudan. GIEWS/FAO.

Hassan, S.F., 2008. Development of sugar industry in Africa. *Sugar Tech*, 10(3), pp.197-203.

Sudan Tribune, 2008. Sudan announces ambitious plan for sugar production. *Sudan Tribune*. 6 March.

UNEP, 2007. *Sudan Post-Conflict Environmental Assessment*. Nairobi: United Nations Environment Programme.

World Resource Institute, 2003. *Earth Trends Country Profiles, Agriculture and Food: Sudan*. Available at: http://earthtrends.wri.org Accessed on February 23, 2011.

I 21 Tanzania

Selected biofuel crops for Tanzania include sugarcane, oil palm and jatropha. As seen in Table 145, domestic biofuel production has not been possible to identify or estimate, for neither of the crops. No biofuels for the EU market in 2008 have been traced to Tanzania.

Table 145. Area used for production of Tanzania's selected biofuel crops, including areas used for domestic biofuel production and feedstock for biofuels on the EU market in 2008

Crop	Total harvested area in 2008 (kha)	Cropland used for domestic biofuel production in 2008		Cropland used for production of feedstock for EU biofuels in 2008	
		kha	% of total	kha	% of total
Sugarcane	23	-	-	-	-
Oil palm	5	-	-	-	-
Jatropha	18	-	-	-	-

Source: FAOSTAT (land data); Agra CEAS and Ecofys (biofuel production and trade data).

As seen in Figure 170, pastures constitute the largest share of the total agricultural area in Tanzania. Permanent crops are less common than annual crops, which are dominating the cultivated land. Sugarcane, oil palm and jatropha plantings were rather insignificant in 2008.

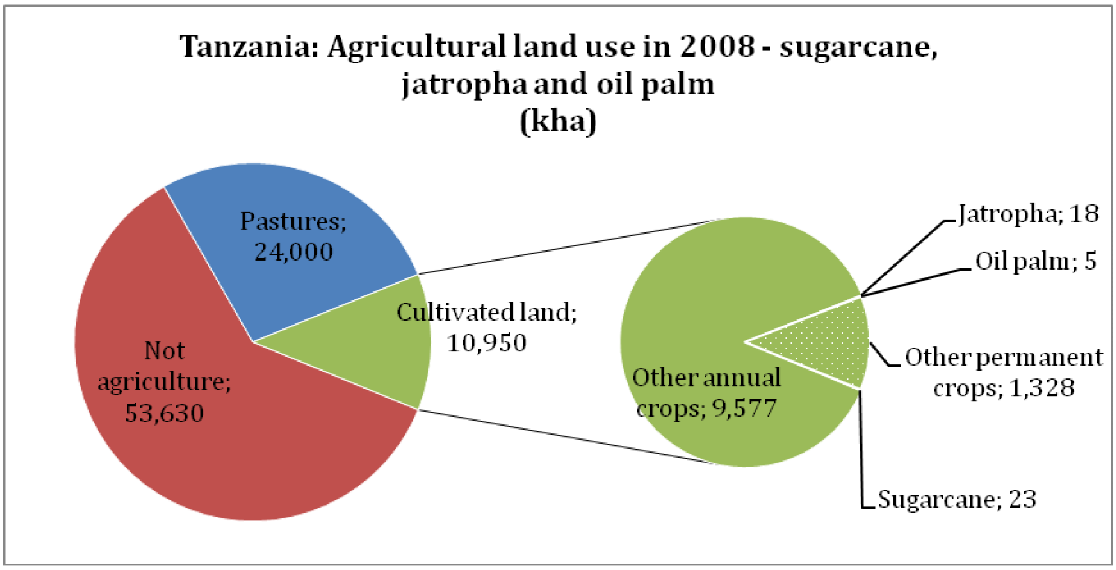


Figure 170. Agricultural land use in Tanzania in 2008, focused on sugarcane, oil palm and jatropha production.

Sugarcane

Historical developments

Between 1990 and 2008, sugarcane production in Tanzania increased by 80%. As seen in Figure 171, the increase has been made possible mainly by an increased harvested area (+50%), but also by increasing yields (+20%).

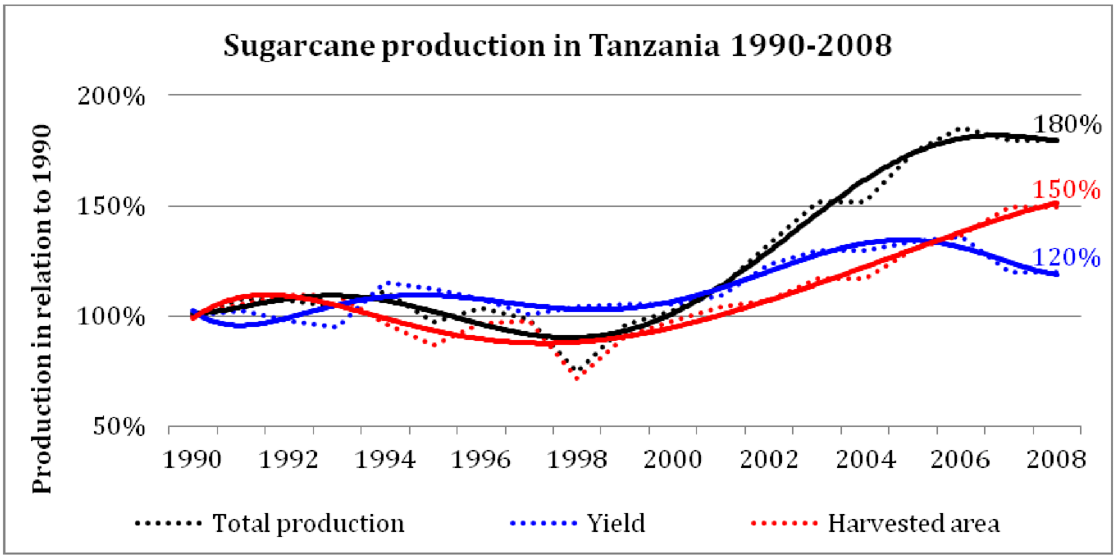


Figure 171. Change in sugarcane production, yields and harvested area in Tanzania, 1990-2008

Most sugarcane is produced in large-scale irrigated projects, although small-scale rainfed production also exists to a smaller extent (Sulle and Nelson, 2009). Much of the current large-scale cultivation is taking place in the Kilombero valley, in central/southern Tanzania.

Land-use dynamics from future production increases

According to Hella (2011), sugarcane expansion in Tanzania is not likely to occur on existing farmland. However, if that would happen, it would likely replace production of rice, maize and coconut, as well as small-scale sugarcane production for local purposes. Most likely expansion would take place on pastures and natural vegetation.

Most sugarcane production in Tanzania aims at producing sugar, not ethanol. However, there are currently a few large-scale projects planned where sugarcane will be produced for ethanol purposes (Sulle and Nelson, 2009). These projects are planned mainly along the coast in Bagamoyo and Rufiji. These areas are surrounded by forest areas and savannah (FAO, 2011a) and have a relatively high density of livestock, making it possible that the expansion will occur on pastureland, as well as forest areas and savannah.

Irrigation needed for an increased sugarcane production will, according to Hella (2011), be expensive. In addition, expansion in the Rufiji region is likely to substantially effect the Rufiji delta, both biologically and ecologically.

Oil Palm

Historical developments

Between 1990 and 2008, oil palm production in Tanzania increased by 30%. As seen in Figure 172, the increase has been made possible mainly by an increased harvested area (+21%), but to a smaller extent also by increasing yields (+7%).

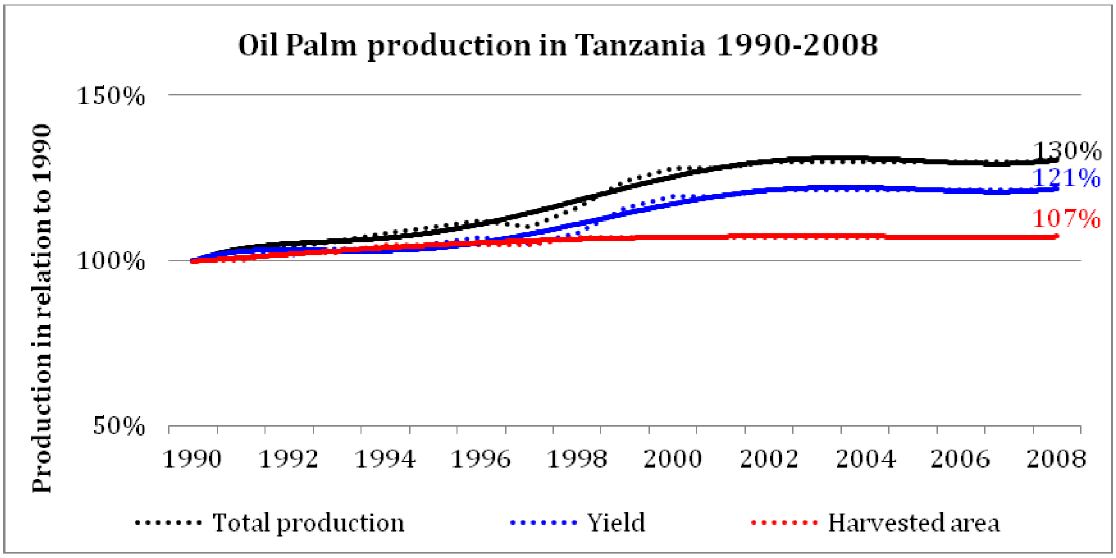


Figure 172. Change in oil palm production, yields and harvested area in Tanzania, 1990-2008

Oil palm has been cultivated in Tanzania for a long time. The Kigoma district in west Tanzania, near Lake Tangayika, has cultivated oil palm since 1920. The western parts of Tanzania are mainly covered by forest (FAO, 2011a), which was likely cleared when oil palm plantations were established.

The current production of oil palm in Tanzania is performed by smallholder farmers in the Kigoma region, the Mbeya region in southwestern Tanzania and to a smaller extent in the Tanga region on the east coast of Tanzania (Sulle and Nelson, 2009). All these areas are surrounded by forests (FAO, 2011a).

Land-use dynamics from future production increases

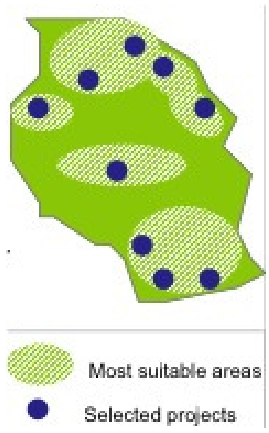
Oil palm production is very likely to replace farmland, but it is difficult to say if any particular crops would be replaced, according to Hella (2011). As for jatropha, smallholder systems are likely to be established, where smallholders plant oil palms where it fits into their farming system and then sell the oil palm fruit to a core company.

Hella (2011) argues that natural vegetation, such as woodlands and grasslands, would likely be used for expanding oil palm production. There are currently a few oil palm projects planned in the Kigoma region in the west and the Rufiji and Kilombero districts on the east coast (Sulle and Nelson, 2009). All areas are surrounded by forests and the two districts on the east coast are also surrounded by some savannah. This supports Hella's (2011) statement, although indicating that expansion may also occur on forests.

According to Hella (2011), pastures are not likely to be used for a potential palm oil expansion. Low livestock densities in the areas where oil palm production is planned supports this statement (FAO, 2011b).

Jatropha

Jatropha is widely cultivated in Tanzania; both on small and large scale and mainly on marginal lands (Sulle and Nelson, 2009). Almost all regions in Tanzania feature a climate that is well suited for Jatropha cultivation (see figure). Projects were mainly identified in the northern and southern part of the country (GEXI 2008).



Source: GEXI 2008

Jatropha has become increasingly popular and several new projects are planned (Sulle and Nelson, 2009). Most of these are located on the eastern and northeastern parts of Tanzania, close to forests (FAO, 2011a). There are also a few planned projects in the northern parts, south of Lake Victoria. These areas are mostly covered with savannah, other grasslands and some forests, but have little existing cropland. Hella (2011) reports that an expansion on natural vegetation is likely, particularly on woodlands.

Even though jatropha can grow on marginal lands, it thrives on fertile soil (Sulle and Nelson, 2009). A few of the planned projects are planned in fertile areas in the Mbeya region in the southwestern parts of Tanzania and in the Mpanda district and the Rukwa region in the western parts. These regions are important areas for food production, especially the Rukwa region where maize is produced. It is therefore likely that jatropha can replace production of food crops, such as maize, in these areas.

Hella (2011) reports that jatropha expansion is likely to occur on existing farmland, replacing maize, sorghum as well as coconut and pineapple production along the coast, and is very likely to occur on pastures. Expansion on degraded pastures may be beneficial, since jatropha can grow on such marginal lands.

Yield-gap and available land for cultivation of rainfed crops

According to the Deininger et al (2011), Tanzania's yield gap for rainfed crops is almost 85%. Therefore, by improving agricultural practices and/or intensifying cultivation, Tanzania has a theoretical potential to increase the total production of rainfed crops with almost 85%, without having to expand onto new land. Since unused land suitable for production of rainfed crops is still rather abundant (about 50% is under cultivation) (Deininger et al, 2011), there are no apparent incentives to increase yields. However, if expansion of cropland continues to increase, incentives to improve cropping practices will grow stronger.

Production system characteristics and local environmental impacts

Production system characteristics for sugarcane, oil palm and jatropha in Tanzania are summarised in Table 146.

Table 146. Production system characteristics for sugarcane, oil palm and jatropha in Tanzania

System component	Sugarcane	Oil Palm	Jatropha
Large scale	Dominating	Mostly at planning stage, large scale production combined with out grower schemes (with possible intercropping) 50-50 in area, in Kigoma 10 000 hectares and another 50-60 000 hectares suggested	
Small scale	Outgrowers	Dominant	Widely cultivated under out grower schemes
Mechanized farming system			
Manual farming system		Dominant	x
Tillage			
Reduced and no tillage		Perennial crop	Perennial crop
Irrigated	Dominating, large scale estates		
Rain fed			
Mono-cropping			
Multi-cropping			
Crop rotation		Perennial crop	Perennial crop
Mineral fertilizer used			
Chemical pesticides used			
GMO seeds for sowing			
Land preparation with fire			
By-products (from harvesting)	Tops and leaves from mechanical harvesting are left on the field		Poor quality wood and fruits (as fertilizer

Legend: Blue = occurring; orange = not occurring; white = occurrence unknown due to lack of information
Sources: (African Biodiversity Network, 2007; Cleaver, 2009; Henning, 2005; Kikula et al., 2003; Longschaap, 2007; Mkindi, 2007; Mkindi, 2008; Songela and Maclean, 2008; Sulle and Nelson, 2009; Tarimo and Takamura, 1998; UNEP, 2009).

Deforestation was observed in e.g. in Maligarasi area, during expansion of oil palm plantations (African Biodiversity Network, 2007). However, in areas like Kigoma, where expansion is taking place, large areas of forest have already been cleared due to the use of fuel wood for refugee camps. There are concerns about diverted water sources from food production if oil palm production is largely expanded. In order to attract more investors, the government of Tanzania have analysed many fertile regions of Tanzania. These regions are the ones with the best access to water, and are therefore usually the areas where farmers are already growing food.

Jatropha is the biofuel crop currently responsible for some of the largest land allocations to foreign-driven plantation schemes in Tanzania (Sulle and Nelson, 2009). The jatropha oil is produced both for domestic and export markets. The Dutch investor Bioshape has been accused of converting valuable land (Mkindi, 2008), resulting in loss, fragmentation and degradation of e.g. grasslands, miombo forests, wetlands and extensive agricultural areas, as well as blockage of wildlife migration routes around the Selous Game Reserve. In other areas, land has been acquired by jatropha investors, which was providing the surrounding community with access to fuel wood collections, medicinal plants, wild animal catching etc. A number of large-scale investors have acquired land for jatropha cultivation in relatively fertile areas. Examples include the Kapunga Rice Project replacing rice farms, and jatropha production in Rukwa Region - a significant producer of maize, the main staple food crop in Tanzania (Sulle and Nelson, 2009). Jatropha can grow in dry areas, however, like most crops, fertile and irrigated soils are more attractive for commercial production. A report from UNEP states that jatropha has a high global average water footprint (UNEP, 2009). On the other hand, jatropha can be used against erosion, thereby reducing siltation of rivers and lakes (Henning, 2005).

Observed local environmental impacts from sugarcane, oil palm and jatropha production in Tanzania are summarised in Table 147.

Table 147. Observed local environmental impacts from sugarcane, oil palm and jatropha production in Tanzania

Environmental impact	Sugarcane	Oil Palm	Jatropha
Deforestation			
Loss of agro-biodiversity			
Loss of biodiversity			Can be invasive to native species and agroforestry systems
Air pollution			
Water pollution			
GMO contamination			
Eutrophication			
Soil fertility decline			
Erosion			

Legend: Red = occurring; green = not occurring; white = occurrence unknown due to lack of information
Sources: (African Biodiversity Network, 2007; Cleaver, 2009; Henning, 2005; Kikula et al., 2003; Longschaap, 2007; Mkindi, 2007; Mkindi, 2008; Songela and Maclean, 2008; Sulle and Nelson, 2009; Tarimo and Takamura, 1998; UNEP, 2009).

Local environmental impacts allocated to domestic biofuel production

Since no production of domestic biofuels from sugarcane, oil palm or jatropha has been identified for 2008; no local environmental impacts from cultivation of these crops can be allocated to domestic biofuel production in Tanzania.

Local environmental impacts allocated to EU biofuel demands

Since no feedstock for EU biofuels in 2008 has been traced to sugarcane, oil palm or jatropha produced in Tanzania; no local environmental impacts from cultivation of these crops can be allocated to EU biofuel demands.

References

African Biodiversity Network, 2007. Agrofuels in Africa – The impacts on land, food and forests. Case Studies from Benin, Tanzania, Uganda and Zambia. African Biodiversity Network.

Cleaver, J., Schram, R. and Wanga, G., 2009. *Bioenergy in Tanzania - The Country Context*. Rome: FAO.

Deininger, K., Byerlee, D., Lindsay, J., Norton, A., Selod, H. and Stickler, M., 2011. *Rising global interest in farmland - can it yield sustainable and equitable benefits?* Washington DC: The International Bank for Reconstruction and Development/The World Bank.

FAO, 2011a. *FAO country profile: Tanzania. Map - Land cover*. Available at: http://www.fao.org/countryprofiles/ Accessed on April 4, 2011.

FAO, 2011b. *FAO country profile: Tanzania. Map – Livestock Bovine*. Available at: http://www.fao.org/countryprofiles/ Accessed on April 4, 2011.

GEXI, 2008. *Global Market Study on Jatropha Project Inventory: Africa*. The Global Exchange for Social Investment. Available at: http://www.jatropha-alliance.org/fileadmin/documents/GEXSI_Jatropha-Project-Inventory_AFRICA.pdf Accessed on May 12, 2011.

Hella, J., 2011. Expert consultation: Joseph Hella, Mwalimu at Sokoine University of Agriculture.

Henning, K. R., 2005. Jatropha Curcas L. in Africa - Assessment of the impact of the dissemination of "the Jatropha System" on the ecology of the rural area and the social and economic situation of the rural population (target group) in selected countries in Africa. Weissensberg: Global Facilitation Unit for underutilized species.

Kikula, I.S., Mnzava, E.Z. and Mung'ong'o, C., 2003. *Shortcomings of Linkages between Environmental Conservation Initiatives and Poverty Alleviation in Tanzania*. Dar es Salaam: Research on Poverty Alleviation (REPOA).

Longschaap, R.E.E., Corré, W.J., Bindraban, P.S and Brandenburg, W.A., 2007. *Claims and facts about Jatropha curcas L -Global Jatropha Curcas evaluation, breeding and propagation programme*. Wageningen: Plant Research International B.V.

Mkindi, A., 2007. The socio-economic and environmental impacts of a biofuel industry in Tanzania. London.

Mkindi, A., 2008. *Impact on Jatropha Trade in Tanzania*. Dar es Salaam: Envirocare.

Songela, F., and Maclean, A., 2008. Scooping Exercise (Situation Analysis) on the Biofuels Industry Within and Outside Tanzania. Dar es Salaam: WWF.

Sulle, E. and Nelson, F., 2009. Biofuels, land access and rural livelihoods in Tanzania. London: IIED.

Tarimo, A.J.P. and Takamura, Y.T., 1998. Sugarcane Production, Processing and Marketing in Tanzania. *African Study Monographs*, 19(1), pp.1-11.

UNEP, 2009. *Water and Bioenergy*. Paris: UNEP. Available at: http://www.uneptie.org/energy/bioenergy/issues/pdf/Issue%20Paper%20No.2_FINAL.pdf Accessed on May 30, 2011.

I 22 Uganda

Selected biofuel crops for Uganda include sugarcane, oil palm and jatropha. As seen in Table 148, domestic biofuel production has not been possible to identify or estimate, for neither of the crops. No biofuels for the EU market in 2008 have been traced to Uganda.

Table 148. Area used for production of Uganda's selected biofuel crops, including areas used for domestic biofuel production and feedstock for biofuels on the EU market in 2008

Crop	Total harvested area in 2008 (kha)	Cropland used for domestic biofuel production in 2008		Cropland used for production of feedstock for EU biofuels in 2008	
		kha	% of total	kha	% of total
Sugarcane	35	-	-	0	0%
Sorghum	321	-	-	0	0%
Jatropha	0 [1)]	-	-	-	-

1) Projects initiating

Source: FAOSTAT (land data); Agra CEAS and Ecofys (biofuel production and trade data).

Sugarcane

Historical developments

Between 1990 and 2008, sugarcane production in Uganda increased by 285%. As seen in Figure 173, the increase has been made possible mainly by increasing yields (+175%), but to a smaller extent also by increasing the harvested area (+40%).

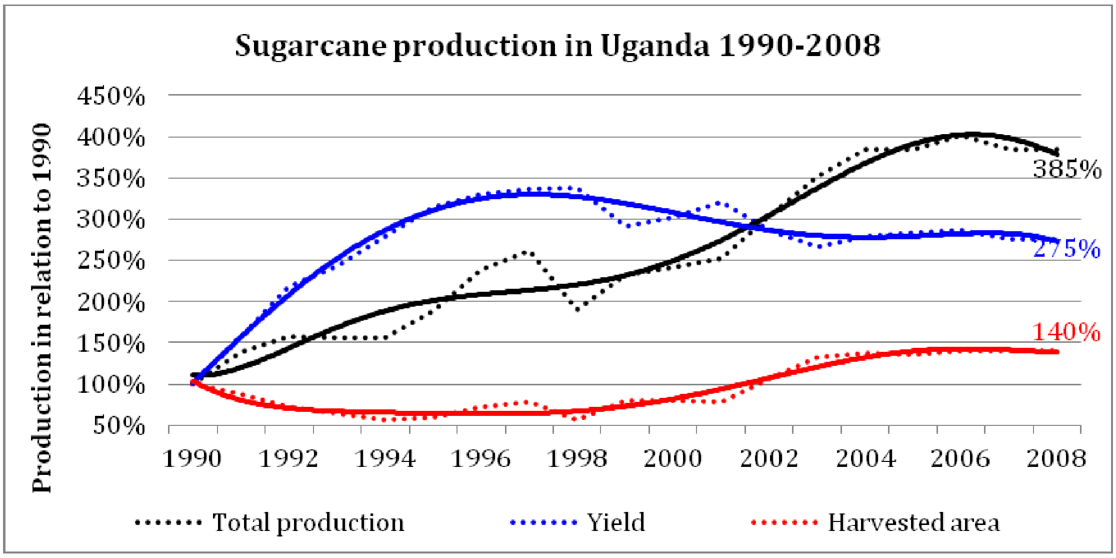


Figure 173. Change in sugarcane production, yields and harvested area in Uganda, 1990-2008

According to Uganda Sugar Cane Technologists' Association (USCTA) (2011), the main sugar producing companies in Uganda are located in Kakia near Lake Victoria in the southeastern part of Uganda, Masindi in the central/west part on Uganda near lake Lac Albert, Lugazi in Central Uganda near Lake Victoria and Rakai in southern Uganda, west of Lake Victoria. Most of these areas are located near woodland or shrubland (FAO, 2011a). It is therefore likely that such ecosystems have been cleared to establish existing plantations.

Land-use dynamics from future production increases

According to Kajubi (2011) it is likely that a potential sugarcane expansion could occur on existing farmland. If sugarcane is promoted as a biofuel crop, outgrowers would likely switch to produce it as a cash crop, instead of producing seasonal food crops such as cassava, maize, potatoes and beans. The area where sugarcane is produced today contains large areas of farmland (FAO, 2011a), which in case of an increased demand for sugarcane could be converted to sugarcane production.

All areas where sugarcane is currently being cultivated have irrigation capacities. Therefore, they can be subject to further expansion.

Kajubi (2011) reports that pastures are of high value for communities holding livestock. Pastures are therefore not likely to be converted to sugarcane production. The southern parts of Uganda have the highest densities of livestock (FAO, 2011b), while free grazing is more common in the northern parts (FAO, 2006a). It is common that farmers have mixed farming systems, where livestock and crop production is combined (FAO, 2006a), indicating that pastures are unlikely to be targeted for sugarcane expansion.

It is further likely that natural vegetation, such as shrubland, would be converted in case of a sugarcane expansion. Natural forests may also be subject for conversion, unless sufficiently monitored by local authorities (Kajubui 2011). Since existing cropland is located in areas with these types of vegetation (FAO, 2011a), that assumption seem to be plausible.

Sorghum

Sorghum is the third most important staple cereal food crop in Uganda after maize and millet, occupying 321,000 ha of arable land in 2008. It is mainly used for food and brewing.

Historical developments

Between 1990 and 2008, sorghum production in Uganda increased by 33%. As seen in Figure 174, the increase has been made possible by increasing the harvested area, while yields have remained rather unchanged.

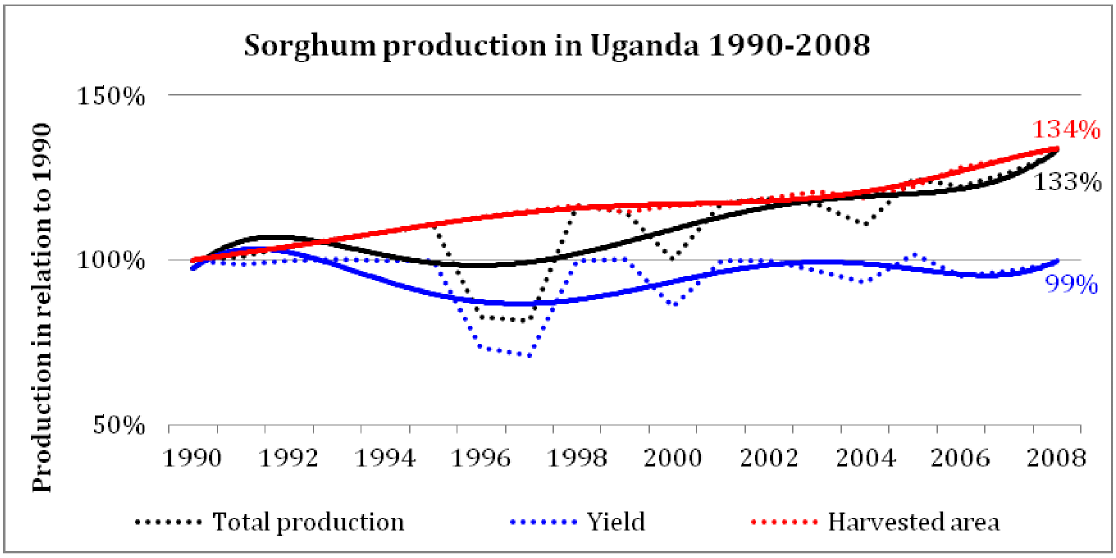


Figure 174. Change in sorghum production, yields and harvested area in Uganda, 1990-2008

Maize is the most commonly produced food crop in Uganda (GIEWS, 2011), while sorghum is cultivated primarily in the central and northern parts of the country (FAO, 2006d). According to Kajubi (2011), shrubland and forests have historically been cleared for cropland expansion, including sorghum.

Land-use dynamics from future production increases

There is little information available regarding sorghum as a potential biofuel crop in Uganda.

Kajubi (2011) reports that a potential expansion of sorghum is very likely to occur on existing farmland, replacing seasonal food crops such as maize, beans, potatoes and cassava. Livestock is uncommon in areas with this type of food crop production, making it unlikely that pastures would be targeted for sorghum production.

Natural vegetation is likely to be cleared in case of a sorghum expansion, particularly shrubland and forests (Kajubi (2011). The northern parts, where Sorghum is currently being cultivated (FAO, 2006d), contain large areas of savannah, indicating that savannah may be targeted for sorghum production.

Jatropha

Mainly two oil seed crops have historically been produced in Uganda; sesame and sunflower (FAO/WFP, 2008). Jatropha has been grown mainly as a support tree in small-holder vanilla farms. The oil production of the locally grown variety/cultivar of jatropha is not known. Its local name is Ekiroowa and farmers are "cursing the resilience of the plant that it is difficult to destroy as it will germinate almost anywhere". The variety/cultivar of jatropha grown locally is not known and therefore there is no information on its seed yield potential (Kyamuhangire 2008). In Uganda, the government is responsible for facilitating the development of biofuels sector through policies and regulations, the provision of incentives, extension advice, information and market infrastructure, however information on the results is not easily accessible. Nexus Biodiel LTD has planted over 400 hectares of jatropha, Nexus alone boasts of more than 2,000 registered outgrowers.

Current trends in Uganda are to use less productive land for jatropha production, indicating that farmland is unlikely to be targeted. However, if jatropha would be expanded onto existing farmland, it would likely replace maize, bulrush millet and sorghum, but also likely minor crops like peas and potatoes (Kajubi 2011).

Jatropha has been promoted in the northern part of Uganda, mainly in Karamoja (Kajubi 2011). Grasslands in the northern parts are used for grazing and are important pastures for semi-nomadic herders (FAO, 2006d). According to Kajubi (2011), cattle keepers in these areas are too fond of their livestock to start cultivating jatropha on their pastures, making an expansion of smallholder production on pastures unlikely. However, large-scale projects by international investors may still be approved unless land-rights are sufficiently respected by the decision-makers.

It is most likely that jatropha expansion would occur in the northern parts, where it is currently promoted. Nearly all land in the northern parts of Uganda is covered with Savannah, with small areas of shrubland in the northeastern part and some small forest patches (FAO, 2011i). Since it is unlikely that existing farmland or pastures will be used for an expansion, the most likely scenario is that natural vegetation will be targeted, most likely savannah. In other parts of the country, shrubland and forests are more likely to be targeted.

Yield-gap and available land for cultivation of rainfed crops

According to the World Bank (2011), Uganda’s yield gap for rainfed crops is about 75%, which is the lowest yield-gap among the assessed African countries. Therefore, by improving agricultural practices and/or intensifying cultivation, Uganda has a theoretical potential to increase the total production of rainfed crops with about 75%, without having to expand onto new land. Since unused land suitable for production of rainfed crops is rather scarce (about 90% is under cultivation) (World Bank 2011), incentives to increase yields should be strong.

Production system characteristics and local environmental impacts

Production system characteristics for sugarcane, sorghum and jatropha in Uganda are summarised in Table 149.

Table 149. Production system characteristics for sugarcane, sorghum and jatropha in Uganda

System component	Sugarcane	Sorghum	Jatropha
Large scale			
Small scale	Outgrowers		Outgrowers
Mechanized farming system	Some practices e.g. land preparation and transport	Very limited	
Manual farming system	Dominant, e.g. weeding		
Tillage			
Reduced and no tillage			Perennial crop
Irrigated	Limited scale, only by large scale estates		
Rain fed			
Mono-cropping			
Multi-cropping		E.g. cowpeas, pumpkins, groundnuts, sesame	Not commonly intercropped although possible for first 3 years, intercropped with vanilla
Crop rotation			Perennial crop
Mineral fertilizer used		Very limited	
Chemical pesticides used		Very limited	
GMO seeds for sowing			
Land preparation with fire			
By-products (from harvesting)	Tops and leaves from mechanical harvesting are left on the field		

Legend: Blue = occurring; orange = not occurring; white = occurrence unknown due to lack of information

Sources: (Cotula et al., 2008; FAO, 2006b; Howden, 2007; Johnston et al., 2007; Plant Genetic Resources Centre and NARO, 2010; Thomas and Kwong, 2001; William Kyamuhangire, 2008)

In Uganda, allocation of national forest reserves in Bugala and Mabira to foreign plantation companies for establishment of oil palm and sugarcane plantations elicited demonstrations in Kampala, court cases led by non-governmental organizations, a sugar boycott, petitions and a mobile-phone messaging campaign. The Ugandan Government subsequently withdrew plans to convert the Bugala forest reserve to sugarcane (Cotula et al., 2008), although so far not the plans for the Mabira forest reserve.

Observed local environmental impacts from sugarcane, sorghum and jatropha production in Uganda are summarised in Table 150.

Table 150. Observed local environmental impacts from sugarcane, sorghum and jatropha production in Uganda

Environmental impact	Sugarcane	Sorghum	Jatropha
Deforestation	red	red	red
Loss of agro-biodiversity	white	white	white
Loss of biodiversity	red	red	red
Air pollution	red	white	white
Water pollution	red	white	white
GMO contamination	green	green	white
Eutrophication	red	white	white
Soil fertility decline	red	red	green
Erosion	red	red	white

Legend: Red = occurring; green = not occurring; white = occurrence unknown due to lack of information
Sources: (Cotula et al., 2008; FAO, 2006b; Howden, 2007; Johnston et al., 2007; Plant Genetic Resources Centre and NARO, 2010; Thomas and Kwong, 2001; William Kyamuhangire, 2008)

Local environmental impacts allocated to domestic biofuel production

Since no production of domestic biofuels from sugarcane, sorghum or jatropha has been identified for 2008; no local environmental impacts from cultivation of these crops can be allocated to domestic biofuel production in Uganda.

Local environmental impacts allocated to EU biofuel demands

Since no feedstock for EU biofuels in 2008 has been traced to sugarcane, sorghum or jatropha produced in Uganda; no local environmental impacts from cultivation of these crops can be allocated to EU biofuel demands.

References

Cotula, L., Dyer, N. and Vermeulen, S., 2008. Fuelling exclusion? The biofuels boom and poor people’s access to land. Rome: FAO and IIED.

Deininger, K., Byerlee, D., Lindsay, J., Norton, A., Selod, H. and Stickler, M., 2011. *Rising global interest in farmland - can it yield sustainable and equitable benefits?* Washington DC: The International Bank for Reconstruction and Development/The World Bank.

FAO/WFP, 2008. Special report: FAO/WFP assessment of the impact of 2007 flood on food and agriculture in eastern and northern Uganda. FAO/WFP.

FAO, 2006a *Country Pasture/Forage Resource Profiles – Uganda.* Available at: http://www.fao.org/countryprofiles/ Accessed on April 4, 2011.

FAO, 2006b. *AQUASTAT- FAO's Information System on Water and Agriculture: Uganda*. Available at:

http://www.fao.org/nr/water/aquastat/countries/uganda/index.stm Accessed on February 21, 2011.

FAO, 2011a *FAO country profile: Uganda. Map - Land cover*. Available at: http://www.fao.org/countryprofiles/ Accessed on April 4, 2011.

FAO, 2011b. *FAO country profile: Uganda. Map – Livestock Bovine*. Available at: http://www.fao.org/countryprofiles/ Accessed on April 4, 2011.

GIEWS, 2011. GIEWS Country Brief: Sudan. GIEWS/FAO.

GEXI, 2008. *Global Market Study on Jatropha Project Inventory: Africa*. The Global Exchange for Social Investment. Available at: http://www.jatropha-alliance.org/fileadmin/documents/GEXSI_Jatropha-Project-Inventory_AFRICA.pdf Accessed on May 12, 2011.

Howden, D., 2007. African forest under threat from sugar cane plantation. *The Independent*, 10 July. Available at: http://www.independent.co.uk/environment/african-forest-under-threat-from-sugar-cane-plantation-456601.html Accessed on May 27, 2011.

Johnston, C., Meyer, R. and Curtis, A., 2007. Value Chain Governance and Access to Finance Maize, Sugarcane and Sunflower oil in Uganda. USAID.

Kajubi, L., 2011. Expert consultation: Lammeck Kabuji. *President/CEO: www.awe-engineers.com; www.pce-engineers.com, Registered Professional Engineer (PE), ERB/570, NEMA-Registered EIA Practitioner, NEMA-Registered Environmental Auditor, Certified Carbon Auditor (UK)*

Plant Genetic Resources Centre and NARO, 2010. *Country Report on the State of Plant Genetic Resources For Food and Agriculture – Uganda*. Entebbe: Plant Genetic Resources Centre – NARO.

Thomas, V. and Kwong. A., 2001. Ethanol as a lead replacement: phasing out leaded gasoline in Africa. *Energy Policy*, 29(13), pp.1133–1143.

William Kyamuhangire, P. 2008. *Perspective of Bioenergy and Jatropha in Uganda*. Rome: International Consultation on Pro-poor Jatropha Development.

USCTA, 2011. *Uganda Sugar Cane Technologists' Association (USCTA)*. Available at: http://test.imaginet.co.ug/usta/index.php Accessed on April 4, 2011.

Appendix J Baseline land cover for 2008 using MODIS data

J 1 Methods for quantifying land use patterns

Data selection process for assessing land cover/land use

Land cover is defined as the observed (bio)physical cover on the earth's surface, while *land use* is characterized by the arrangements, activities and inputs people undertake in a certain land cover type to produce, change or maintain it (Di Gregorio and Jansen 2000). The use of remotely sensed data can provide a cost effective way to analyse land cover patterns across a large number of countries, which can then be used with other information to derive information on land use. However, remote sensing data on its own has not been used widely to detect land use directly over large scales, although technologies combining medium-resolution imagery with limited ground data are emerging (Numata et al. 2007). The benefit of remote sensing is that it can deliver data in a transparent and repeatable fashion without bias, but it is important for users to understand the limitations of the data as well as potential differences among available global land cover products before they are used in monitoring, compliance and estimating conditions and trends (McCallum et al. 2006).

Baseline data serve as a reference for the future so that improvement or worsening of a sustainability aspect as a result of increasing biofuels or of a change in policy can be measured. To this end, there are at least four requirements of the baseline data:

- The data range considered should be sufficiently broad to enable estimation of global impacts;
- The baseline data should be correct, reliable, accurate and up to date;
- The data should be comparable across different countries of origin;
- The data gathering process should be reproducible in terms of both time and space.

We defined five criteria for evaluating the appropriateness of various land cover datasets for the purposes of monitoring for biofuels impacts: consistency, base year availability, land cover classification system, multi-year availability, and level of effort for assessing land cover and land cover change. (For more information on these criteria, refer to Winrock's Data Options Report, submitted April 2010). Of the nine remote sensing datasets evaluated, the MODIS collection 5 Global Land Cover Type product was chosen to quantify land cover trends (Table 151). Although there is large variation in the area within each land cover class across different datasets (Figure 175), for the purposes of evaluating baseline land cover in January 2008 and evaluating past and future land cover changes according to criteria laid out in the EU Directive, at present the only available option is the MODIS Global Land Cover Type (MOD12Q1) product (Table 151).

Table 151. Comparison of global and regional land cover products according to multiple criteria. The yellow highlighted row (MOD12Q1 collection 5) is the product recommended for the current analysis because it meets all criteria.

Land Cover Product	Spatial Coverage (Resolution)	Base year available?	Past Years Available?	Future Years Likely to be Available?	Classification System Compatible with Current Goals?	Level of Effort for Analysing Land Cover and Land Cover Change?
MOD12Q1 (collections 1-4)	Global (1-km)	No	Yes	No	Yes	Low
MOD12Q1 (collection 5)	Global (500 m)	Yes	Yes	Yes	Yes	Low
MOD12Q2 (collection 5)	Global (500 m)	Yes	Yes	Yes	No	High
MOD44B	Global (500 m)	No	Yes	Yes	No	Medium
FAO	Global (country aggregates)	No	Yes	Yes	Yes	Low
GLC2000	Global (1-km)	No	No	No	No	N/A (one year only)
GlobCover v.2.2	Global (300-m)	No	No	?	Yes	N/A (one year only)
CORINE	Regional (100 m, 250 m)	No	Yes	Yes	No	Low to High
Landsat Global Land Survey	Global (30 m)	No	Yes	Yes	Yes	Extremely High

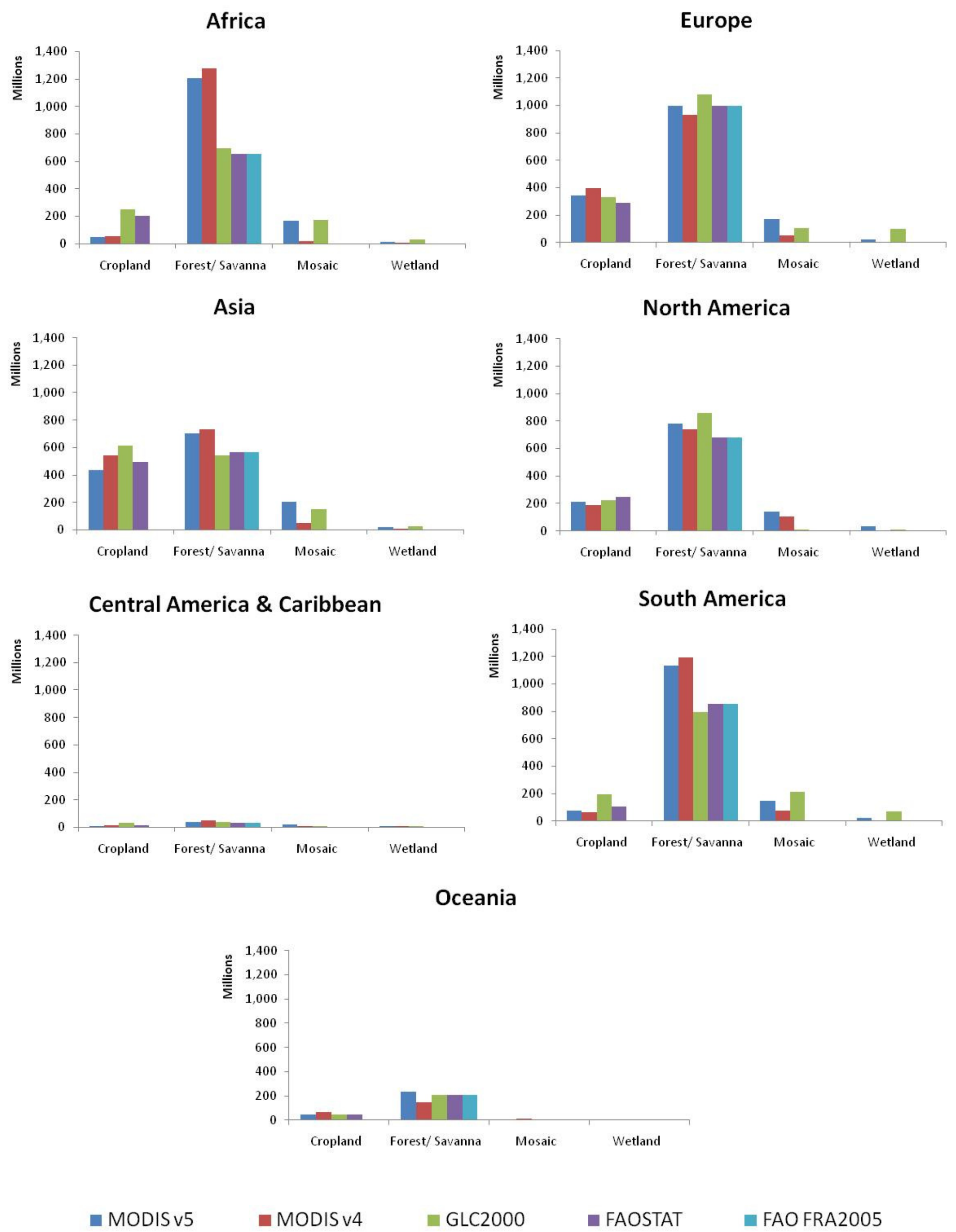


Figure 175. Comparison of total area of each land cover class in the year 2000/2001 according to various global land cover datasets.

Description of the MOD12Q1 dataset

For all countries included in the analysis, baseline land cover in January 2008 and land cover change between 2001 and January 2008 was estimated at the administrative unit scale using the MOD12Q1 collection 5 Global Land Cover Type Yearly product, available at 500-m resolution (25 ha pixels). MODIS imagery was chosen for the analysis due to its global, multi-year coverage, low cost and homogenous classification scheme that allows direct comparison across time and space. The MODIS sensor offers a unique combination of features: it detects a wide spectral range, it takes measurements at three spatial resolutions (levels of detail), it takes measurements all day, every day; and it has a wide field of view. MODIS is one of several sensors carried on both the Terra and Aqua satellites, managed by NASA. Terra was launched in December 1999 and Aqua was launched in May 2002. Both satellites complete a north to south orbit of the Earth in less than 2 days. The official MOD12Q1 version 5 data were publicly released at the ED DAAC in 2009. The data can be found at http://daac.ornl.gov.

The MOD12Q1 data are compiled from several sources to create an annual global land cover map. Inputs to the MOD12Q1 data used in this analysis include:

- Land/water mask that restricts classification to land regions and shallow water regions;
- The MODIS Land Bands (1-7);
- Spatial texture derived from Band 1;
- Directional reflectance information;
- MODIS Enhanced Vegetation Index (EVI);
- Snow cover;
- Land surface temperature;
- Terrain elevation information.

These data are composited over a 32-day cycle and values for land classification, change detection and mixture modelling are assigned by algorithms using decision tree and artificial neural network classifiers. Land cover classes are processed by continent. The 32-day products are used to produce the annual globally-consistent, multitemporal MOD12Q1 database on a 500-m grid.

Land cover classification systems used in the analysis

MODIS land cover datasets are published using the International Geosphere Biosphere Programme (IGBP) global land cover categories, consisting of a list of 17 cover classes. The IGBP land cover classification includes 11 classes of natural vegetation, 3 classes of developed and mosaic lands, and 3 classes of non-vegetated lands. The 11 natural vegetation classes distinguish evergreen and deciduous, broadleaf and needle-leaf forests, mixed forests, closed shrublands and open shrublands, savannas and woody savannas, grasslands, and permanent wetlands of large areal extent. The 3 classes of developed and mosaic lands distinguish among croplands, urban and built-up lands, and cropland/natural vegetation mosaics. Classes of non-vegetated lands cover units include snow and ice; barren land; and water bodies. The IGBP Land Cover categories are based on biophysical properties of the land and were initially for IGBP Global Land Cover Map (DIScover v.1.0) in 1997, derived from the Advanced Very High Resolution Radiometer (AVHRR) sensor on board several NOAA satellited. In addition to IGBP classification, the MODIS land cover data is presented using the 14 category classification developed by the University of Maryland. The IGBP classification scheme includes a larger number of categories and thus includes a higher level of detail; therefore it was selected appropriate for this analysis. It is also used widely across the remote sensing community as the dominant classification scheme for MODIS.

One advantage of starting with the most detailed classification system for remote sensing imagery is that the classes can be aggregated to suit the purposes of a given analysis. For this analysis, we first reclassified the 17 land use/land cover (LU/LC) categories included in the original MODIS product into 7 general classes:

- Forest (MODIS classes 1-5)
- Savannas/Shrub (MODIS classes 6-9)
- Grassland (MODIS class 10)
- Wetland (MODIS class 11)
- Cropland (MODIS class 12)
- Urban (MODIS class 13)
- Mosaic (MODIS class 14)

However, under the 2009 RED, sustainability standards require that biofuels be excluded as ineligible if they are sourced from the following lands having high carbon stocks in January 2008 and which no longer have this status:

- Wetlands, defined as land that is waterlogged for a significant part of the year;
- Continuously forested areas, i.e., land that is more than one hectare in size with trees higher than five metres and canopy cover of more than 30%, unless trees, fully grown, are expected to meet those requirements;
- Wooded savannas, i.e., land which is more than one hectare in size with trees higher than 5 metres and canopy cover of 10-30%, unless it can be shown that greenhouse gas conditions would be fulfilled even if the land was converted.

Therefore, based on conversations with Paul Hodson at the EC, we also reclassified the 17 land use/land cover (LU/LC) categories included in the original MODIS product based on the canopy cover and height thresholds:

- >30% canopy cover, >2 m height = "forest/woody savannas" (MODIS classes 1-5 and class 8);
- >10-60% canopy cover but <2 m tall OR 10-30% cover and >2 m tall = "savannas/shrubland" (MODIS classes 6,7, and 9);
- <10% canopy cover = "grassland" (MODIS class 10);
- Cropland (MODIS class 12).

The two classification systems were developed to provide maximum flexibility to users of the baseline data.

Quantifying baseline land cover, January 2008

Baseline land cover for each country in the study region in January 2008 was quantified using the MODIS 2007 Global Land Cover Type Yearly product. The scale of the quantification was done at an administrative unit level[86], i.e. one level below national scale (state, province, etc.). It is important to note that the 2009 RED specifies January 2008 as its baseline for assessing land cover patterns. Most global land cover products derived from remote sensing imagery are produced at an annual

[86] The Global Administrative Areas v1.0 (GADM) was used as the boundary file for countries and administrative units after customizing the file to account for errors in the original data.

time step, with the final land cover product derived from compositing monthly or sub-monthly images, i.e., images collected over the course of the year are compiled together to produce one annual product. This is done to account for seasonal and phenological differences in certain land cover types (e.g., presence or absence of snow/ice/cloud cover, changes in leaf out and leaf fall in deciduous forests, etc.) that would not be detected if only one image from the year in question were used for land cover classification.

Because the RED specifies a particular month for defining its sustainability standard (as opposed to simply the year 2008), the use of a 2008 yearly product to define land cover in January 2008 would be inappropriate, because 2008 global land cover products incorporate information derived from imagery collected after this date. Therefore, if January 2008 is to be used as the baseline, then a 2007 annual product that incorporates imagery collected between January and December 2007 is most appropriate.

Quantifying Baseline Land Cover Change, 2001 to January 2008

Although one task in this work is to define baseline land cover in January 2008, baseline land cover must also be linked to past and future years to evaluate land cover change through time. Therefore, historical land cover change in each administrative unit within the study region was analysed using 2001 and 2007 MODIS data. Land cover change per administrative unit was analysed separately using the two classification systems described above (by land cover type and by canopy cover/height thresholds).

Quantifying Cropland and Grassland Persistence through Time

For each country in the study region, at the administrative unit scale, we monitored the dynamics of land cover change by analysing a time series of land cover maps (2001, 2004 and 2007) to investigate what area of new cropland stays as cropland vs. the area that switches back and forth between cropland and grassland over time, reflecting a mixed land use pattern. Summary tables were created for each administrative unit to show these land cover dynamics (Table 152).

Table 152. Example of land cover change dynamics between grassland and cropland categories for Buenos Aires, Argentina.

Land cover change dynamic description	2001	2004	2007	Area (ha)
Persistent cropland	Crop	Crop	Crop	11,769,457
Recent change crop to grass	Crop	Crop	Grass	1,579,995
Mixed Land Use	Crop	Grass	Crop	531,302
"Permanent" change crop to grass	Crop	Grass	Grass	635,046
"Permanent" change grass to crop	Grass	Crop	Crop	487,211
Mixed Land Use	Grass	Crop	Grass	236,683
Recent change grass to Crop	Grass	Crop	Crop	107,458
Persistent Grassland	Grass	Grass	Grass	456,429

The blue rows reflect the area of cropland and grassland that remains unchanged through time. The orange rows reflect recent land cover change after persisting as another land cover type. The yellow rows reflect mixed land use, where crop and grass shift back and forth between years. The green rows reflect "permanent" changes from crop to grass or grass to crop.

Harmonization of data collection approaches

The use of remote sensing based methods for determining land cover types does not allow the identification of individual crop types, or the way in which land is being used (e.g., natural grassland vs. grazing land). Therefore, several options needed to be explored to identify such patterns of land use for biofuels. In-country consultants were hired to collect statistical information, including the total area of cropland within a country. It was envisioned that these statistical data could be compared to cropland area derived from remote sensing methods.

After preliminary analysis of consultant data, it became apparent that the data quality of national cropland statistics is unknown and often does not correspond well with cropland areas derived from remote sensing. Therefore, methods for harmonizing these different data sources need further investigation, but one potential solution is to use cropland statistics from remote sensing and the relative proportion of various crops from national statistics.

J 2 Methods for quantifying environmental impacts

In terms of quantifying environmental impacts of land use change, WI-ECO was tasked with estimating emission factors for various land conversions.

Emission factors were calculated as the sum of changes in aboveground and belowground biomass carbon stocks, annual changes in soil carbon stocks on mineral soils (assuming that soil carbon emission occur over 20 years), annual emissions from peat drainage on peat soils cleared for agriculture, annual foregone forest sequestration, and non-CO_2 emissions (CH_4, N_2O) resulting from land clearing with fire where applicable (Figure 176). Methane emissions from rice cultivation were excluded from the analysis. Emission factors were developed for a 20-year timeframe. Details of each component of the emission factor are outlined in the sections below. Further refinement to emission factors is ongoing, and thus the text below summarizes methodologies used to date but that are subject to change during the finalization process.

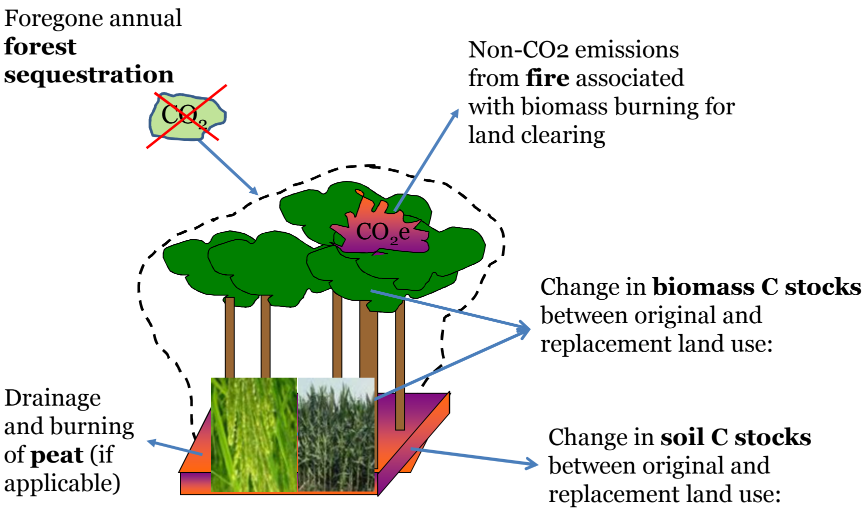


Figure 176. Components included in the emission factor analysis.

3.1 Changes in biomass carbon stocks

Initial changes in biomass carbon stocks on land converted to another land category (e.g., from forest to cropland) were calculated based on Equation 2.16 in the IPCC Guidelines for Agriculture, Forestry and Other Land Use (IPCC AFOLU):

$$\Delta C_{CONVERSION} = \sum_i (B_{AFTER_i} - B_{BEFORE_i}) \bullet CF$$

where:

$\Delta C_{CONVERSION}$ = initial change in biomass carbon stocks on land converted to another land category, tonnes C yr^{-1}

B_{AFTER_i} = biomass stocks on land type *i* immediately after the conversion, tonnes d.m. ha^{-1}

B_{BEFORE_i} = biomass stocks on land type *i* before the conversion, tonnes d.m. ha^{-1}

CF = carbon fraction of dry matter, tonne C (tonnes d.m.)$^{-1}$

i = type of land use converted to another land-use category

Wood products, including long-term storage and retirement, were not considered in the analysis. The conversion between biomass and carbon (1 ton dry biomass = 0.5 ton carbon) was done as a pre-processing step in the data compilation and therefore the CF term of the equation was ignored. Where default carbon stocks for the replacement land use were higher than the pre-existing land use, the change in biomass carbon stocks due to conversion was assumed to be zero.

Biomass carbon stocks for different land cover types were estimated using the most consistent and highest quality datasets available to date, summarized below.

<u>Forest Carbon Stocks</u>
Several options exist for estimating carbon stocks of forests around the world. Countries report their biomass carbon stocks to FAO every five years as part of the Forest Resources Assessment. However, the data sources behind these estimates are often of very low quality, particularly for tropical developing countries.

Forest biomass maps also exist, but the only globally consistent map available was derived using adjusted, biome-level Tier 1 default values from the IPCC rather than from country-specific data sources (Reusch and Gibbs 2008). Therefore, for this analysis, we used regional maps to estimate forest carbon stocks. Region-specific maps, though not directly comparable with each other, were preferred over the global map due to their inclusion of country-specific data and higher level of accuracy. Therefore, the global biomass product by Reusch and Gibbs (2008) was used only to fill in gaps where no other information on forest carbon stocks was available (Pakistan).

EU countries + Ukraine: Gallaun et al. (2009) used national forest inventory data for nearly 100,000 locations from 16 countries as well as remotely sensed data (MODIS) to produce pan-European maps of aboveground woody biomass. The approach is based on sampling and allows the direct combination of data with different measurement units. The map covers the whole European Union, the EFTA countries, the Balkans, Belarus, the Ukraine, Moldova, Armenia, Azerbaijan, Georgia and Turkey. The final biomass map was obtained from the authors and used to estimate area-weighted forest carbon stocks in each country.

Latin America, Africa and South and Southeast Asia: We estimated forest carbon stocks using a pantropical map for the early 2000s (Saatchi et al. in press). The methodology uses a combination of more than 4,000 *in situ* inventory plots and allometric equations to estimate carbon storage, >3 million satellite Lidar samples of forest structure, plus optical and microwave imagery (1 km resolution) to extrapolate over the landscape. The map presents a spatially refined and methodologically comparable carbon stock estimate across three continental regions and improves upon previous assessments based on often old and incomplete national forest inventory data and earlier spatial products.

United States: Blackard et al. (2008) generated a spatially-explicit dataset of aboveground live forest biomass from ground measured inventory plots for the coterminous U.S., Alaska and Puerto Rico. The plot data are from the USDA Forest Service Inventory and Analysis (FIA) program. The final biomass map was obtained from the authors and used to estimate area-weighted forest carbon stocks in the U.S.

Russia: Houghton et al. (2007) used regression-tree analyses to relate local Russian forest inventory data to data from the MODIS satellite Bidirectional Reflectance Distribution Function (BRDF) product (MOD43B4). Biomass was then converted to carbon stocks (carbon = biomass x 0.5). The final map (500-m resolution) of total above- and belowground forest biomass in Russia was obtained from the authors and used to estimate area-weighted forest carbon stocks.

Pakistan: Pakistan was not covered by any of the maps listed above, so the Reusch and Gibbs (2008) map was used to estimate forest carbon stocks.

<u>Cropland Carbon Stocks</u>
Carbon stocks for annual cropland were estimated to be 5 t C ha^{-1} based on Table 5.9 of the IPCC AFOLU. Although the MODIS land cover product does not differentiate between annual and perennial cropland, the emission factors differ depending on what crop is planted. Therefore, separate emission factors were estimated for land cover conversion to annual vs. perennial cropland. Perennial cropland in Indonesia and Malaysia was assumed to be oil palm, while perennial cropland in all other countries was assumed to be sugarcane. Time-averaged carbon stocks in oil palm plantations were estimated at 35 t C ha^{-1} based on a review of several data sources. Carbon stocks in sugarcane were assumed to be 44 t CO_2 ha^{-1}, derived from estimates in aboveground biomass (17 t C ha^{-1} or 62 t CO_2, Amaral et al. 2008) and in belowground biomass (7 t C ha^{-1} or 26 t CO_2 ha^{-1}, Smith et al. 2005) for a total of 88 t CO_2 ha^{-1}. We assumed a growth period of two years to achieve full carbon stocks, therefore the time-averaged stock in sugarcane was assumed to be 44 t CO_2 ha^{-1}.

<u>Grassland, Savannas and Shrubland Carbon Stocks</u>
Above- and belowground carbon stocks of grassland, savannas and shrublands in Brazil were estimated using values from de Castro and Kauffman (1998) who report biomass along a vegetation gradient from campo limpo (pure grassland), campo sujo (a savannas with a sparse presence of shrubs), campo cerrado (a dominance of shrubs with a grass understory), cerrado sensu stricto (a dominance of trees with scattered shrubs and a grass understory) and cerradão (a closed canopy forest) (Coutinho 1978, Eiten 1972, Goodland and Pollard 1973). Shrubland carbon stocks in Brazil were estimated as the average of biomass values reported for cerrado aberto and cerrado denso. Savannas carbon stocks in Brazil were estimated as the average biomass value reported for campo sujo and grassland carbon stocks in Brazil were estimated as the average value reported for campo limpo.

To maintain a consistent approach, for all countries except Brazil (explained in the paragraph above), carbon stocks in grasslands were estimated based on default biomass values given in Table 6.4 of the IPCC AFOLU. These default values are presented by ecological zone. Therefore, grassland C stocks within each administrative unit reflect the area-weighted value based on the proportions of each ecological zone present within each administrative unit. Carbon stocks of savannas and shrubland land cover types in all countries except Brazil were estimated using a proportional approach based on the Brazil dataset, which indicates and increasing trend in carbon stocks from grassland → savannas → shrubland in a ratio of 1 to 1.8 to 3.4. These ratios were applied to other countries for estimating carbon stocks in savannas and shrubland based on the estimated carbon stocks of grassland within each country.

Wetland, Barren and Mixed Carbon Stocks

According to the IGBP land cover description, the permanent wetlands category can consist of herbaceous and/or woody vegetation. However, after confirming that Indonesian peat swamp forests (a type of permanent forested wetland) are classified as forest and not wetland in the MODIS land cover maps, the carbon stocks of permanent wetlands in a given country or administrative unit were calculated as the average of carbon stocks in shrubland and grassland land cover categories. Carbon stocks on barren lands were assumed to be zero. In accordance with the IGBP land cover definitions, mixed carbon stocks were calculated as the average of forest, shrubland, grassland and cropland carbon stocks.

Changes in Soil Carbon Stocks

Changes in soil carbon stocks on land converted to cropland were calculated based on Section 5.3.3.4 of the IPCC AFOLU.

Soil carbon stocks after conversion to cropland were based on specific soil stock change factors for land use, management and inputs (F_{LU}, F_{MG}, F_I, respectively) listed in Table 5.10 of the IPCC AFOLU. Relevant factors are listed in Table x. Stock change factors were selected for each land cover type (before and after conversion) and multiplied by reference soil carbon stocks. Following the IPCC AFOLU guidelines, the total difference in carbon stocks before and after conversion was averaged over 20 years. Thus the average annual changes in soil carbon stocks due to land use conversion were calculated as:

$$\Delta SOC = \frac{(SOC_{\mathrm{Re}\,f} \bullet F_{LU,before} \bullet F_{MG,before} \bullet F_{I,before}) - (SOC_{\mathrm{Re}\,f} \bullet F_{LU,after} \bullet F_{MG,after} \bullet F_{I,after})}{20}$$

where:

ΔSOC = average annual change in carbon stocks in top 30 cm of soil; t C ha^{-1} yr^{-1}

$SOC_{\mathrm{Re}\,f}$ = reference carbon stocks in top 30 cm of soil; t C ha^{-1}

F_{LU} = land use factor before or after conversion

F_{MG} = management factor before or after conversion

F_I = input factor before or after conversion

However, emission factors were developed for a 20-year time period, which takes into account the full impact of land use conversion on soil carbon stocks, so the soil emission could be calculated as the numerator of the equation above. As default stock change factors (F_{LU}, F_{MG}, F_I) are all equal to one for forest soils and non-degraded grassland soils, soil carbon stocks were assumed to remain unchanged for all conversion types (conversion to shrubland, savannas, grassland) except conversion to annual cropland. The cropland land use factor (F_{LU}) was assumed to be for long-term cultivated crops and was not modified to incorporate the paddy rice values for those countries where paddy rice is expanding. Full tillage and medium inputs were assumed in all scenarios of cropland conversion.

Soil carbon stocks were estimated using the Harmonized Soil Map of the World version 1.1. This map has a resolution of 1-km but does not contain average pixel-level soil carbon stock values. Values are included instead for bulk density (g cm^{-3}) and carbon content (%C) in both the top 30 cm and top meter of soil in each grid cell. Therefore, we calculated average soil carbon stocks in the top 30 cm of soil – assumed to be the depth to which soil carbon stocks would be affected when converted to agriculture – by multiplying the volume of soil in a given hectare (1 ha x 30 cm depth = 3,000 m^3) by the bulk density to calculate the mass of soil in a given hectare, then multiplied the soil mass by the carbon content to derive an average soil carbon stock per hectare (t C ha^{-1}).

Peat emissions

For countries containing peat soils (Indonesia and Malaysia), emission factors for conversion to cropland accounted for annual losses of CO2 due to peat drainage. Emission factors were based on a regional dataset from Southeast Asia that correlates peat drainage depth with annual peat CO2 emissions. These data serve as the basis for the following equation (from Hooijer et al. 2006, Couwenberg et al. 2009):

$$Y = 0.91X$$

Where:

Y = CO_2 emissions from drained peat, t CO_2 ha^{-1} yr^{-1}
X = drainage depth, cm

Drainage depth was assumed to be 80 centimetres, which is the minimum likely peat drainage estimate for conversion to large-scale croplands (such as oil palm) cited in Hooijer et al. (2006). Thus the annual emission factor from drained peat soils was estimated as 80 x 0.91 = 72.8 t CO_2 ha^{-1} yr^{-1}.

Emission factors for draining peat soils were estimated for land use conversions originating from forest and grassland only, based on the assumption that in Southeast Asia, the only land cover types on peat are intact or degraded peat swamp forests or already deforested peatland that has revegetated to *Imperata* grasslands.

Land use change emission factors vary based on whether the land use conversion occurred on mineral soils or peat soils; emissions from peat soils are much higher than emissions from mineral soils due to continued oxidation of peat through time via drainage. Therefore, for purposes of reporting emission factors on an administrative unit scale, soil emission factors were weighted based on the proportions of peat vs. non-peat area in each administrative unit.

Foregone forest sequestration

Forest sequestration rates were estimated using data from recent papers that summarize long-term monitoring plots in old growth tropical forests across the tropics. Lewis et al. (2009) published long-term aboveground carbon sequestration rates of 0.63 t C ha^{-1} yr^{-1} for African "closed canopy mature forest" (assumed moist or rain forest) based on long-term monitoring plots. This is similar to the IPCC default rate for >20 yr old African tropical moist deciduous forests (0.65 t C ha^{-1} yr^{-1}) but lower than for >20 yr old African tropical rain forests (1.55 t C ha^{-1} yr^{-1}). Baker et al. (2004) also report an annual Amazonian C sequestration rate of 0.61 t C ha^{-1} yr^{-1}, which is lower than the IPCC default of 1.0 t C ha^{-1} yr^{-1} for >20 yr old tropical moist deciduous forests and 1.55 t C ha^{-1} yr^{-1} for >20 yr old tropical rain forests of South America. After combining all standardized inventory data from Africa, tropical America and Asia together, Lewis et al. (2009) estimate carbon sequestration across all tropical intact old growth forests as **0.49** t C ha^{-1} yr^{-1}. We have used this estimate for foregone sequestration across the tropics, but this is a definite underestimate of the carbon sink capacity of these forests. The rate of carbon sequestration used in this analysis assumes that all tropical forests are old-growth forests and disregards the fact that many tropical forests are recovering secondary forests that have much higher rates of annual carbon sequestration.

Myneni et al. (2001) and Nabuurs (pers. comm.) also estimated the carbon sink of temperate and boreal forests in various countries, and these values were generally higher than sequestration in tropical forests, with rates of approximately 3-4 t CO_2 ha^{-1} yr^{-1} on average but extending up to 7-8 t CO_2 ha^{-1} yr^{-1} in Norway and Switzerland. These data reflect the long-term carbon sink capacity of forests, which have long been understood to be the case in temperate forests and have more recently been illustrated also for old-growth tropical forests.

Fire Emissions

Non-CO_2 emissions [methane (CH_4), nitrous oxide (N_2O)] were calculated in the emission factor analysis for regions where fire was assumed to be used as a means of site preparation for cropland conversion. Fire emissions were calculated following IPCC Guidelines (Equation 2.27) as the product of initial biomass stocks available for combustion, a combustion factor (a measure of the proportion of fuel that is actually combusted; estimated as a function of the size and architecture of the fuel load, the moisture content of the fuel and the type of fire) and a GHG emission factor (the amount of a particular greenhouse gas emitted per unit of dry matter combusted; varies as a function of the carbon content of the biomass and the completeness of combustion). Combustion and emission factors were estimated per land cover type using information in de Castro and Kaufmann (1998) as well as default values presented in Tables 2.5 and 2.6 in the IPCC AFOLU. We assumed that countries along the tropical belt use fire to clear land for agricultural production.

J 3 Results

Baseline land cover, 2008

Baseline land cover for each country in the study region in January 2008 was quantified using the MODIS 2007 Global Land Cover Type Yearly product. The distribution of land cover types varied among countries (Figure 177 section J 6-I). Malaysia and Indonesia had the highest percentage of land in forest (82% and 74%, respectively), although Russia and Brazil had the largest forest cover on an absolute basis (609 and 373 million hectares, respectively). Most African nations are covered primarily by savannas/shrubland, and all countries except Indonesia, Malaysia, Peru and Ukraine had at least 25% of land area in this land cover type. Cropland made up a significant portion of land area in India, Ukraine and Pakistan.

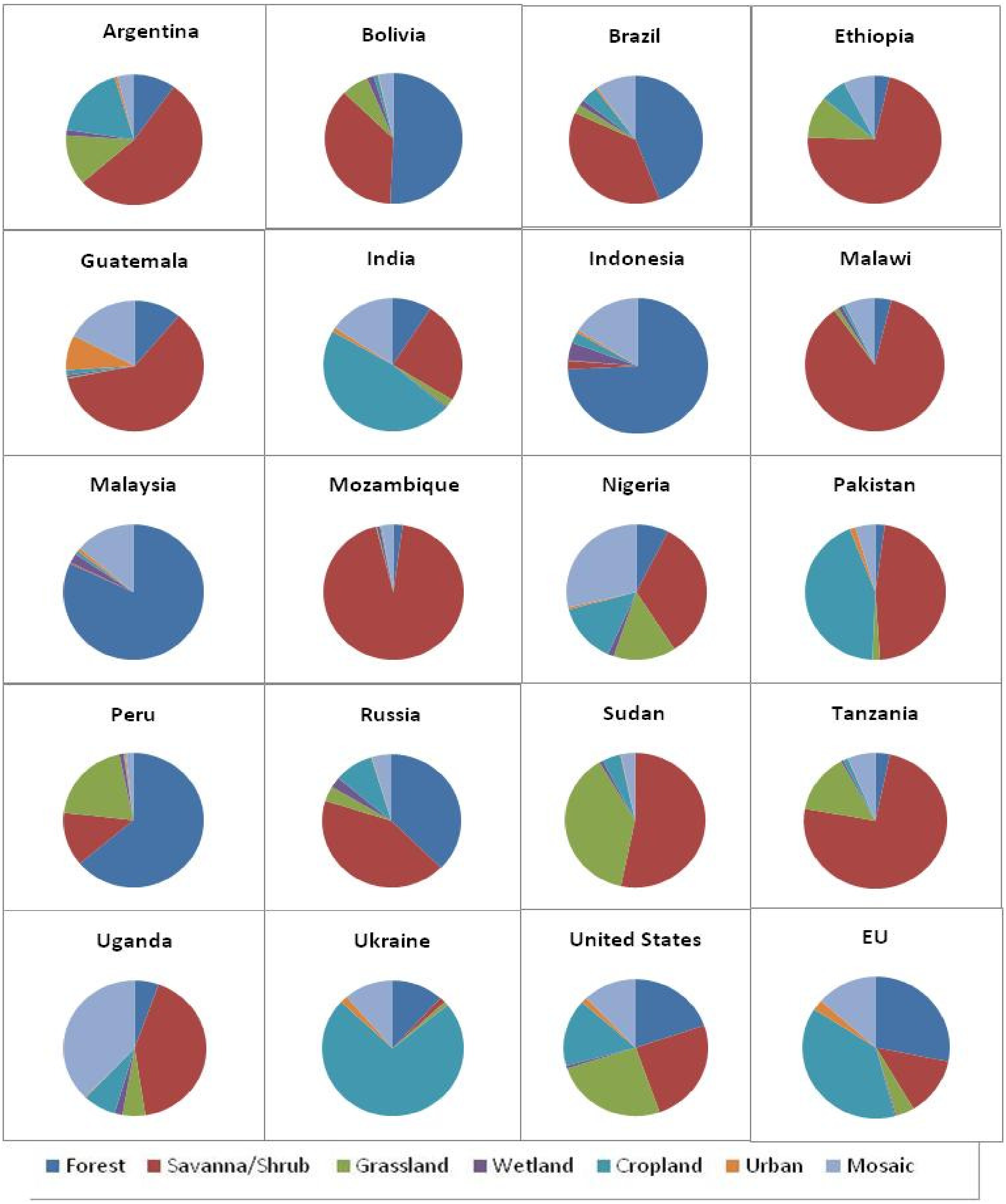


Figure 177. Baseline distribution of land cover types in January 2008 for target countries according to MODIS 2007 land cover data.

Land cover change, 2001 to 2008

The degree of persistence (i.e., land that stayed in the same land cover category) versus land cover change (gains and losses) between December 2001 and January 2008 varied among countries, with all countries showing both gains and losses in different land cover classes (Figure 178 and section J 6-II).

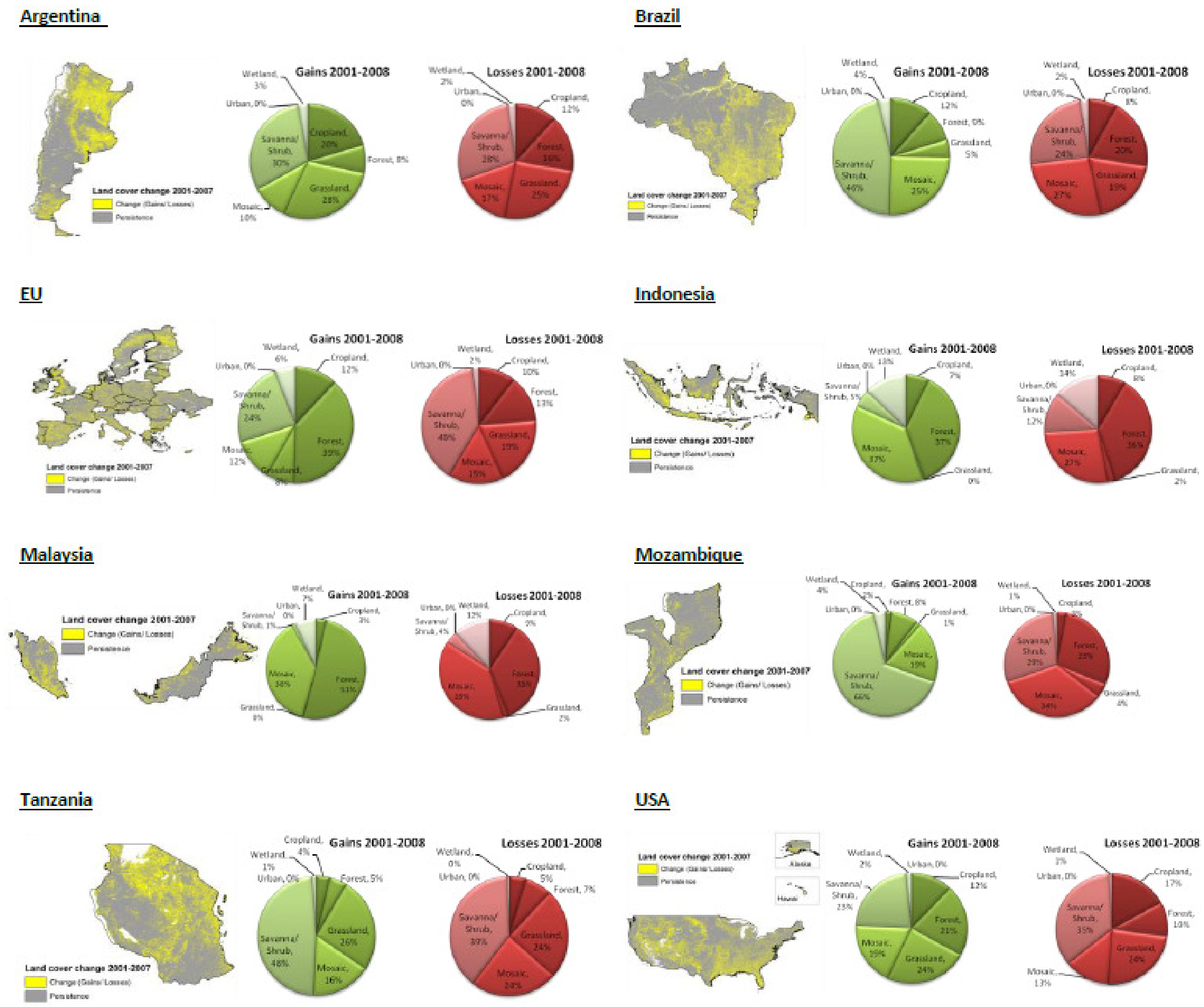


Figure 178. Land cover change between 2001 and 2007 for key countries according to MODIS land cover data.

Cropland and Grassland Land Cover Dynamics

The cropland and grassland land cover classes were analysed at sub national level for all EU and non EU countries for two periods of time (1) from December 2001 to December 2004 and (2) from December 2004 to January 2008. The results showed where within a country cropland to grassland dynamics were predominant and where the cropland or grassland persistence was observed. Figure 179 show the cropland (top graph) and the grassland (bottom graph) dynamics for all sub national units in Argentina. Sub national units such as Chubut, Buenos Aires and Cordoba showed little or no switch between cropland and grassland for the two time periods, while the large portion of the cropland in 2001 for Corrientes, Misiones and Santa Cruz experience switch between cropland and grassland and back (see top graph). For the analyzed period, the grassland persistence was more stable, with more than 60 % of the initial grassland in Santa Fe and Buenos Aires switched to cropland and back (see bottom graph).

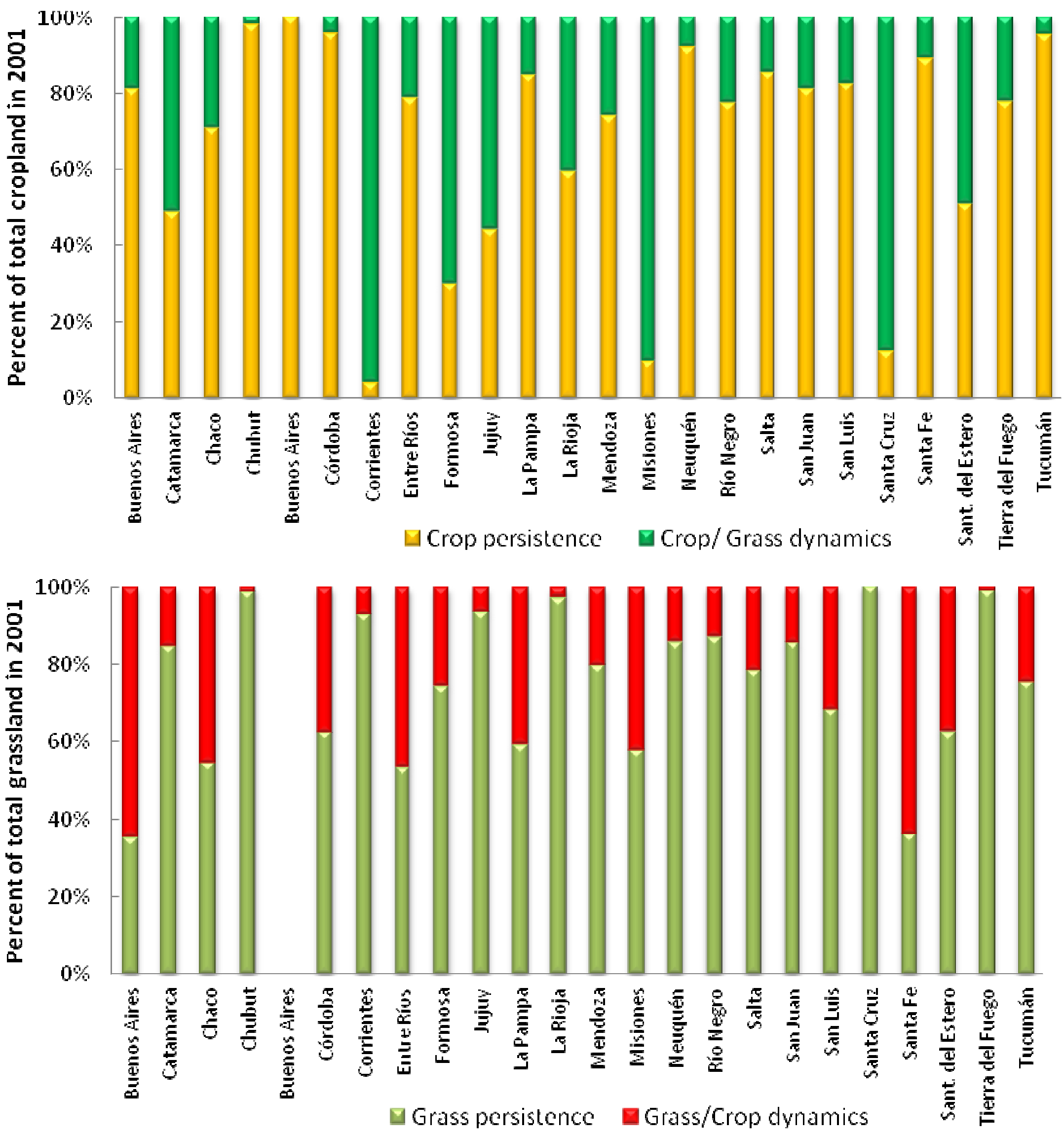


Figure 179. Cropland and grassland dynamics at sub national level for Argentina, expressed as percent persistence and chance from th initial area in 2001.

GHG emissions from land cover changes

It was indicated by EC that their interest is focused at the 7 key countries - Argentina, Brazil, Indonesia, Malaysia, Mozambique, Tanzania and the continental United States in terms of reporting GHG emissions from land cover changes. Therefore, the emissions from land cover changes were estimated at sub national level for these key biofuels production countries and at national level for the remaining countries except the EU countries.

All datasets are presented and available in Excel file along with an automated Excel tool for estimating emissions from different land cover conversions was created for reporting purposes. Here in the report we present the results for only two land cover conversions (1) forest to cropland (accounting for high emissions) and (2) grassland to cropland (accounting for low emissions).

For forest conversions, the largest component of the emission factor was the initial change in biomass from forest to the new land cover type. The large emissions for conversion from forest to cropland were observed across Indonesia, India, Peru and Brazil, with a maximum of 1,199 t CO_2e ha^{-1} in Papua, Indonesia (Figure 180). The lowest emissions were observed at sub national level across Argentina and at national level for Ukraine and Sudan. The rest of the country showed medium emissions at national or sub national level in regards to forest to cropland conversion.

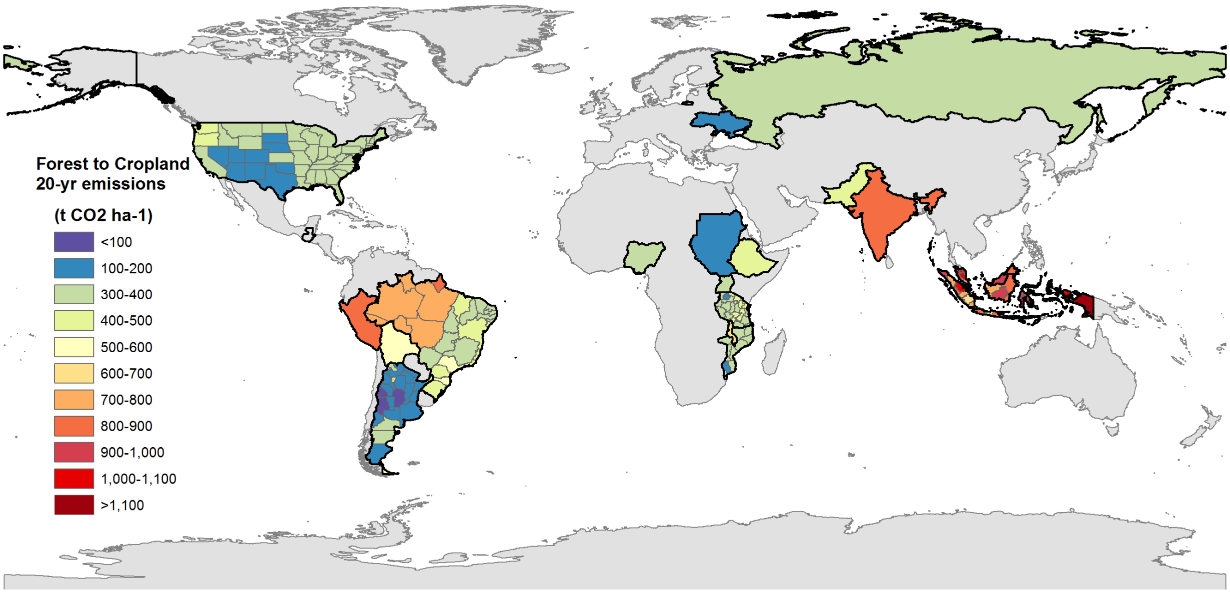


Figure 180. Distribution of immediate emissions (t CO_2e ha^{-1}) from forest to cropland conversion (high emissions) across selected countries

Significantly low emissions for conversion from grassland to cropland are observed at sub national and national level. Soil emissions made up a higher proportion of the total emission factor when non-forest land cover types were converted to cropland. In general the emission factors for grassland to cropland conversions were lower than the emission factors for forest conversions, with a highest of 726 and 446 t CO2e ha-1 for Indonesian provinces of Riau and Papua, and bellow 100 t CO2e ha-1 for majority of countries/ sub national units (Figure 181).

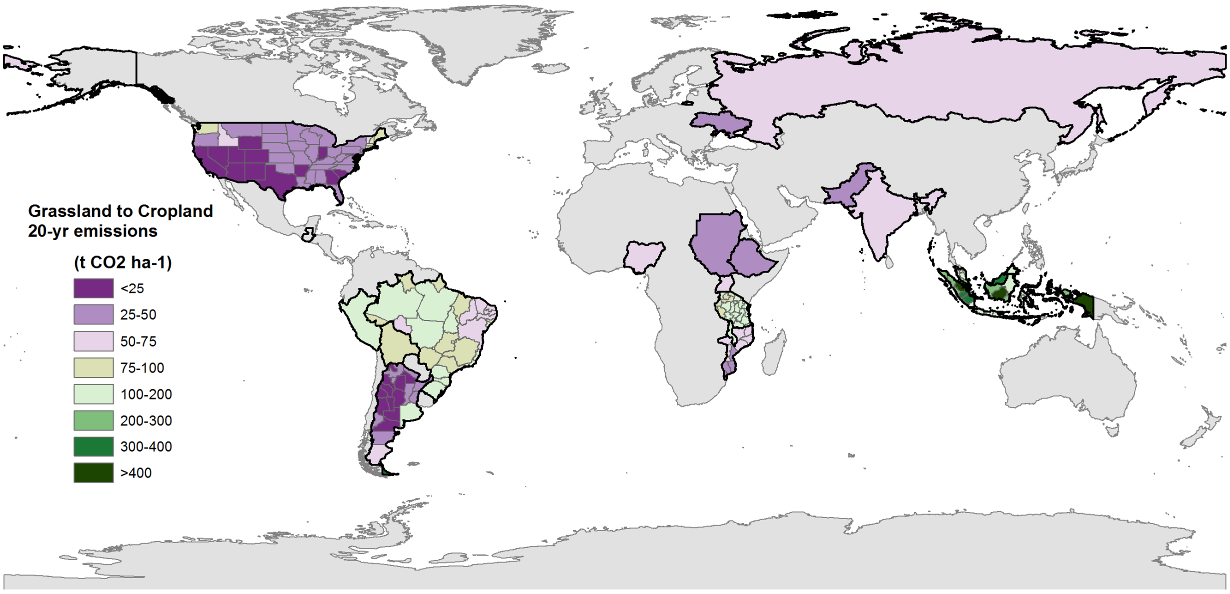


Figure 181. Distribution of immediate emissions (t CO_2e ha^{-1}) from grassland to cropland conversion (low emissions) across selected countries

J 4 Conclusions

The analysis presented here summarizes emission factors and land use change at the national scale (and sub national scale for key countries). Depending on the extent and scale of land cover change, and the level of detail of input parameters used in emission factor calculations, this approach could oversimplify a given land use change scenario.

According to land cover change from MODIS data analysed at the country level, some countries such as Argentina, Brazil and the EU experienced a net gain in cropland area while other countries such as Indonesia, Malaysia, and the US showed a net decrease in total cropland area (Figure 178). Our analysis highlights some of the issues with using global, coarse-resolution remote sensing products to assess specific land cover changes in isolation. For example, these products do not capture well the transition between forest and perennial cropland such as palm oil plantations.

Some would argue that MODIS is not designed to be applied at sub national or even national scales and that MODIS is most valuable for performing global comparative analyses. However, given the available datasets, MODIS products are the only consistent dataset that can be used to analyze land cover change in a relatively recent time period across large regions. Further studies may include analyzing land cover change using higher resolution imagery such as Landsat or SPOT in 'hotspot' areas and developing correction factors to apply to the MODIS global scale data. However, this approach has not been tested and therefore may produce results that offer little additional information compared to the original MODIS analysis.

J 5 References

Amaral W. A. N., J.P. Marinho, R. Tarasantchi, A. Beber, and E. Giuliani. 2008, Environmental sustainability of sugarcane ethanol in Brazil. In: Zuurbier P.; van de Vooren J. (eds) Sugarcane ethanol: Contribution to climate change mitigation and the environment. Wageningen Academic, Wageningen, pp 121-124.

Baker, T.R., O.L. Phillips, Y. Mahli, S. Almeida, L. Arroyo, A. Di Fiore, T. Erwin, N. Higuchi, T.J. Killeen, S.G. Laurance, W.F. Laurance, S.L. Lewis, A. Monteagudo, D.A. Neill, P. Nuñez Vargas, N.C.A. Pitman, J.N.M. Silva, R.V. Martínez. Increasing biomass in Amazonian forest plots. Philosophical Transactions of the Royal Society of London: Biological Sciences 359: 353-365.

Couwenberg, J., R. Dommain, and H. Joosten. 2009. Greenhouse gas fluxes from tropical peatlands in south-east Asia. Global Change Biology, doi: 10.1111/j.1365-2486.2009.0216.x

Di Gregorio A. and Jansen, LJM. LCCS: Land cover classification system. 2000. FAO, Rome, Italy

Hooijer, A., M. Silvius, H. Wösten and S. Page. 2006. PEAT-CO2, Assessment of CO_2 emissions from drained peatlands in SE Asia. Delft Hydraulics report Q3943 (2006)

Lewis, S.L., G. Lopez-Gonzalez, B. Sonké, K. Affum Bafoe, T.R. Baker, L.O. Ojo, O.L. Phillips, J.M. Reitsma, L. White, J.A. Comiskey, et al. 2009. Increasing carbon storage in intact African tropical forests. Nature 457: 1003-1006.

McCallum, I., M. Obersteiner, S. Nilsson, and A. Shivdenko (2006), A spatial comparison of four satellite derived 1 km global land cover datasets, Int. J. Appl. Earth Obs. Geoinformation, 8, 246–255, doi:10.1016/j.jag.2005.12.002.

Mokany, K., R.J. Raison, and A.S. Prokushkin. 2006. Critical analysis of root:shoot ratios in terrestrial biomes. Global Change Biology 12: 84-96.

Myneni, R.B., D. Jong, C.J. Tucker, R.K. Kaufmann, P.E. Kauppi, J. Liski, L. Zhou, V. Alexeyev, and M.K. Hughes. 2001. A large carbon sink in the woody biomass of Northern forests. PNAS 98: 14784-14789.

Numata, I., D.A. Roberts, O.A. Chadwick, J. Schimel, F.R. Sampaio, F.C. Leonidas and J.V. Soares. 2007. Characterization of pasture biophysical properties and the impact of grazing intensity using remotely sensed data. Remote Sensing of Environment 109: 314-327.

Ruesch, A. and H.K. Gibbs. 2008. New IPCC Tier-1 Global Biomass Carbon Map For the Year 2000. Available online from the Carbon Dioxide Information Analysis Center *[http://cdiac.ornl.gov]*, Oak Ridge National Labouratory, Oak Ridge, Tennessee.

Saatchi, S.S., N.L. Harris, S. Brown, M. Lefsky, E. Mitchard, W. Salas, B. Zutta, W. Buermann, S. Lewis, S. Hagen, S. Petrova, L. White, M. Silman and A. Morel. [in press]. Benchmark map of forest carbon stocks in tropical regions across three continents. PNAS.

Smith, D.M., N.G. Inman-Bamber and P.J. Thorburn. 2005. Growth and function of the sugarcane root system. Field Crops Research 92: 169-183.

J 6 Appendixes

I. **Baseline** area (ha), as of January 2008 reported by MODIS 2007 land cover data.

	Area in January 2008 for							
Country	Forest	Savanna/Shrub	Grassland	Wetland	Cropland	Urban	Mosaic	Total
	ha							
Argentina	25,679,320	138,339,568	31,982,987	3,699,922	46,151,492	1,735,838	10,140,005	257,729,131
Bolivia	52,264,649	37,597,235	6,611,016	1,688,162	1,035,235	192784.98	3,625,092	103,014,173
Brazil	373,045,309	318,429,760	19,038,767	12,672,011	34,743,219	3951115.4	82,773,554	844,653,735
Ethiopia	3,823,587	76,271,048	11,210,765	100,353	6,530,884	73692.332	8,013,596	106,023,925
Guatemala	24,793	134,527	558	1,224	2,683	19147.556	38,510	221,442
India	26,753,128	72,056,611	5,997,199	1,003,701	137,597,794	3123305.6	45,656,102	292,187,841
Indonesia	123,218,537	3,308,556	202,831	7,158,245	4,396,060	1049165.9	26,685,468	166,018,863
Malawi	366,766	8,158,018	99,451	94,965	70,558	8436.0869	664,819	9,463,014
Malaysia	26,972,767	86,357	21,230	752,400	274,613	285989.79	4,519,360	32,912,717
Mozambique	1,653,967	73,065,807	132,573	562,921	200,491	81012.193	2,125,937	77,822,709
Nigeria	6,696,471	30,213,684	12,923,248	1,247,403	12,823,196	462525.1	25,849,780	90,216,308
Pakistan	917,537	20,006,427	698,285	28,872	18,525,196	584794.7	1,955,348	42,716,459
Peru	75,681,102	15,336,699	23,662,000	1,143,659	256,946	406391.85	2,024,682	118,511,480
Russia	608,721,328	692,267,052	59,499,270	41,731,047	149,264,838	2581829	74,411,717	1,628,477,081
Sudan	124,073	72,136,700	51,934,139	1,155,422	5,728,468	252867.95	4,359,010	135,690,680
Tanzania	2,940,567	66,128,940	12,492,922	505,414	944,219	79445.185	5,639,363	88,730,869
Uganda	1,138,657	8,695,845	1,082,910	375,889	1,552,519	40978.346	7,789,771	20,676,570
Ukraine	6,915,359	771,011	523,638	70,988	42,848,130	1025789.5	6,636,603	58,791,519
United States	175,728,692	219,456,343	226,647,796	5,764,380	139,494,175	12025095	107,615,275	886,731,756
EU	134,243,279	63,891,337	19,363,181	1,434,070	182,497,589	11,322,302	64,306,766	477,058,525

II. Distribution of **persistence**, **loss** and **gain** per land cover class for December 2001 to January 2008 reported according to MODIS land cover data

Land cover class	Persistence	Losses 2001-08	Gains 2001-08	Total in 2001	Total in 2008
Argentina			*ha*		
Cropland	31,548,474	8,487,833	14,609,197	40,036,307	46,157,671
Forest	20,120,798	11,279,474	5,668,383	31,400,272	25,789,181
Grassland	11,755,783	18,141,104	20,307,249	29,896,887	32,063,032
Mosaic	2,922,792	11,914,326	7,212,887	14,837,118	10,135,679
Savanna/ Shrub	117,435,075	20,104,333	21,710,793	137,539,408	139,145,868
Urban	1,730,643	2,639	2,101	1,733,282	1,732,744
Wetland	1,728,024	1,566,401	1,985,500	3,294,425	3,713,524
Total	187,241,589	71,496,110	71,496,110	258,737,699	258,737,699
Percent	72%	28%	28%		

Land cover class	Persistence	Losses 2001-08	Gains 2001-08	Total in 2001	Total in 2008
Bolivia			*ha*		
Cropland	134,592	273,884	900,081	408,476	1,034,673
Forest	46,390,599	5,812,248	5,874,091	52,202,847	52,264,690
Grassland	3,684,037	3,244,949	2,934,879	6,928,986	6,618,916
Mosaic	1,225,809	2,402,373	2,395,997	3,628,182	3,621,806
Savanna/ Shrub	29,705,586	9,253,292	8,282,306	38,958,878	37,987,892
Urban	192,614	322	107	192,936	192,721
Wetland	585,845	503,801	1,103,408	1,089,646	1,689,253
Total	81,919,082	21,490,869	21,490,869	103,409,951	103,409,951
Percent	79%	21%	21%		

Land cover class	Persistence	Losses 2001-08	Gains 2001-08	Total in 2001	Total in 2008
Brazil			*ha*		
Cropland	12,840,324	15,035,400	21,906,347	27,875,724	34,746,671
Forest	356,672,819	36,968,863	16,447,410	393,641,682	373,120,229
Grassland	9,310,415	36,092,409	9,737,147	45,402,824	19,047,562
Mosaic	35,364,226	50,430,365	47,417,292	85,794,591	82,781,518
Savanna/ Shrub	231,847,216	45,885,106	86,613,133	277,732,322	318,460,349
Urban	3,930,937	13,352	5,065	3,944,289	3,936,002
Wetland	5,887,015	4,695,568	6,994,669	10,582,583	12,881,684
Total	655,852,952	189,121,063	189,121,063	844,974,015	844,974,015
Percent	78%	22%	22%		

Land cover class	Persistence	Losses 2001-08	Gains 2001-08	Total in 2001	Total in 2008
Canada			*ha*		
Cropland	40,243,891	7,480,982	7,639,401	47,724,873	47,883,292
Forest	252,853,525	21,501,741	69,861,487	274,355,266	322,715,012
Grassland	12,736,239	16,268,231	8,526,996	29,004,470	21,263,235
Mosaic	10,376,986	17,994,839	6,903,468	28,371,825	17,280,454

Savanna/ Shrub	235,825,014	62,505,093	26,083,327	298,330,107	261,908,341
Urban	855,931	1,158	257	857,089	856,188
Wetland	14,996,079	13,194,786	19,931,894	28,190,865	34,927,973
Total	567,887,665	138,946,830	138,946,830	706,834,495	706,834,495
Percent	80%	20%	20%		

Land cover class	Persistence	Losses 2001-08	Gains 2001-08	Total in 2001	Total in 2008
Ethiopia			*ha*		
Cropland	1,680,197	3,372,865	4,853,282	5,053,062	6,533,479
Forest	3,255,556	1,670,922	568,740	4,926,478	3,824,296
Grassland	3,868,149	6,552,009	7,354,100	10,420,158	11,222,249
Mosaic	3,232,373	6,446,135	4,783,605	9,678,508	8,015,978
Savanna/ Shrub	65,503,103	10,862,999	11,277,222	76,366,102	76,780,325
Urban	73,542	42	21	73,584	73,563
Wetland	14,574	21,441	89,443	36,015	104,017
Total	77,627,494	28,926,413	28,926,413	106,553,907	106,553,907
Percent	73%	27%	27%		

Land cover class	Persistence	Losses 2001-08	Gains 2001-08	Total in 2001	Total in 2008
Guatemala			*ha*		
Cropland	61,091	195,914	388,050	257,005	449,141
Forest	4,663,397	901,106	611,837	5,564,503	5,275,234
Grassland	5,537	61,469	18,002	67,006	23,539
Mosaic	1,436,645	1,193,992	907,275	2,630,637	2,343,920
Savanna/ Shrub	1,717,269	526,875	948,226	2,244,144	2,665,495
Urban	27,734	21	21	27,755	27,755
Wetland	23,289	24,120	30,086	47,409	53,375
Total	7,934,962	2,903,497	2,903,497	10,838,459	10,838,459
Percent	73%	27%	27%		

Land cover class	Persistence	Losses 2001-08	Gains 2001-08	Total in 2001	Total in 2008
India			*ha*		
Cropland	109,261,192	25,827,797	28,364,529	135,088,989	137,625,721
Forest	21,247,241	6,453,435	5,558,563	27,700,676	26,805,804
Grassland	989,851	5,515,010	5,145,925	6,504,861	6,135,776
Mosaic	22,348,185	21,412,975	23,304,250	43,761,160	45,652,435
Savanna/ Shrub	48,811,242	27,379,677	24,011,854	76,190,919	72,823,096
Urban	3,121,545	1,714	2,186	3,123,259	3,123,731
Wetland	478,987	335,614	538,915	814,601	1,017,902
Total	206,258,243	86,926,222	86,926,222	293,184,465	293,184,465
Percent	70%	30%	30%		

Land cover class	Persistence	Losses 2001-08	Gains 2001-08	Total in 2001	Total in 2008
Indonesia			*ha*		
Cropland	1,815,689	3,062,427	2,580,215	4,878,116	4,395,904

Forest	109,543,276	13,322,510	13,630,101	122,865,786	123,173,377
Grassland	39,647	821,378	163,202	861,025	202,849
Mosaic	13,159,394	9,838,429	13,526,441	22,997,823	26,685,835
Savanna/ Shrub	1,408,848	4,444,014	1,902,609	5,852,862	3,311,457
Urban	1,043,541	6,032	4,593	1,049,573	1,048,134
Wetland	2,180,482	5,027,798	4,715,427	7,208,280	6,895,909
Total	129,190,877	36,522,588	36,522,588	165,713,465	165,713,465
Percent	78%	22%	22%		

Land cover class	Persistence	Losses 2001-08	Gains 2001-08	Total in 2001	Total in 2008
Malawi	*ha*				
Cropland	3,971	61,253	66,478	65,224	70,449
Forest	201,457	151,893	164,935	353,350	366,392
Grassland	13,115	306,033	86,130	319,148	99,245
Mosaic	176,404	663,184	488,148	839,588	664,552
Savanna/ Shrub	7,112,824	725,349	1,052,300	7,838,173	8,165,124
Urban	8,414	21	21	8,435	8,435
Wetland	33,057	18,515	68,236	51,572	101,293
Total	7,549,242	1,926,248	1,926,248	9,475,490	9,475,490
Percent	80%	20%	20%		

Land cover class	Persistence	Losses 2001-08	Gains 2001-08	Total in 2001	Total in 2008
Malaysia	*ha*				
Cropland	69,312	550,812	205,147	620,124	274,459
Forest	23,950,460	2,055,677	3,001,464	26,006,137	26,951,924
Grassland	2,531	99,147	18,524	101,678	21,055
Mosaic	2,283,066	2,288,497	2,235,734	4,571,563	4,518,800
Savanna/ Shrub	12,837	231,597	74,418	244,434	87,255
Urban	285,132	1,847	921	286,979	286,053
Wetland	284,724	713,798	405,167	998,522	689,891
Total	26,888,062	5,941,375	5,941,375	32,829,437	32,829,437
Percent	82%	18%	18%		

Land cover class	Persistence	Losses 2001-08	Gains 2001-08	Total in 2001	Total in 2008
Mozambique	*ha*				
Cropland	22,624	254,628	162,132	277,252	184,756
Forest	928,720	2,418,236	724,947	3,346,956	1,653,667
Grassland	11,657	373,551	120,079	385,208	131,736
Mosaic	501,357	2,946,362	1,621,060	3,447,719	2,122,417
Savanna/ Shrub	67,432,282	2,507,192	5,655,137	69,939,474	73,087,419
Urban	80,927	21	21	80,948	80,948
Wetland	200,943	103,742	320,356	304,685	521,299
Total	69,178,510	8,603,732	8,603,732	77,782,242	77,782,242
Percent	89%	11%	11%		

Land cover class	Persistence	Losses 2001-08	Gains 2001-08	Total in 2001	Total in 2008

Nigeria	*ha*				
Cropland	5,227,883	3,425,794	7,594,085	8,653,677	12,821,968
Forest	4,105,843	5,455,324	2,581,329	9,561,167	6,687,172
Grassland	11,093,820	8,001,999	1,810,493	19,095,819	12,904,313
Mosaic	13,060,092	6,591,975	12,779,783	19,652,067	25,839,875
Savanna/ Shrub	22,435,226	9,334,323	7,775,191	31,769,549	30,210,417
Urban	461,858	1,717	578	463,575	462,436
Wetland	370,005	580,512	850,185	950,517	1,220,190
Total	56,754,727	33,391,644	33,391,644	90,146,371	90,146,371
Percent	63%	37%	37%		

Land cover class	Persistence	Losses 2001-08	Gains 2001-08	Total in 2001	Total in 2008
Pakistan	*ha*				
Cropland	14,163,180	1,765,094	4,368,733	15,928,274	18,531,913
Forest	516,597	104,431	419,656	621,028	936,253
Grassland	392,739	1,520,083	428,009	1,912,822	820,748
Mosaic	918,461	1,807,663	1,034,995	2,726,124	1,953,456
Savanna/ Shrub	19,106,534	3,429,496	2,356,374	22,536,030	21,462,908
Urban	584,795	21	0	584,816	584,795
Wetland	5,472	8,175	27,196	13,647	32,668
Total	35,687,778	8,634,963	8,634,963	44,322,741	44,322,741
Percent	81%	19%	19%		

Land cover class	Persistence	Losses 2001-08	Gains 2001-08	Total in 2001	Total in 2008
Peru	*ha*				
Cropland	41,258	444,446	216,288	485,704	257,546
Forest	74,004,532	2,002,229	1,622,234	76,006,761	75,626,766
Grassland	18,555,936	4,135,590	5,122,179	22,691,526	23,678,115
Mosaic	958,602	1,288,013	1,065,678	2,246,615	2,024,280
Savanna/ Shrub	10,583,835	4,987,037	4,917,592	15,570,872	15,501,427
Urban	407,999	1,371	493	409,370	408,492
Wetland	654,253	575,108	489,330	1,229,361	1,143,583
Total	105,206,415	13,433,794	13,433,794	118,640,209	118,640,209
Percent	89%	11%	11%		

Land cover class	Persistence	Losses 2001-08	Gains 2001-08	Total in 2001	Total in 2008
South Africa	*ha*				
Cropland	2,960,660	2,426,850	5,617,536	5,387,510	8,578,196
Forest	1,893,611	1,503,129	950,444	3,396,740	2,844,055
Grassland	9,254,194	12,874,243	8,155,700	22,128,437	17,409,894
Mosaic	2,177,261	5,978,993	3,181,847	8,156,254	5,359,108
Savanna/ Shrub	71,111,102	9,840,471	14,601,106	80,951,573	85,712,208
Urban	780,670	858	106	781,528	780,776
Wetland	32,606	48,746	166,551	81,352	199,157
Total	88,210,104	32,673,290	32,673,290	120,883,394	120,883,394

Percent	73%	27%	27%

Land cover class	Persistence	Losses 2001-08	Gains 2001-08	Total in 2001	Total in 2008
Sudan			*ha*		
Cropland	1,869,977	2,318,272	3,867,143	4,188,249	5,737,120
Forest	71,760	228,871	52,805	300,631	124,565
Grassland	31,468,388	5,055,789	20,616,595	36,524,177	52,084,983
Mosaic	2,217,961	9,421,094	2,147,788	11,639,055	4,365,749
Savanna/ Shrub	65,807,918	17,155,136	6,880,882	82,963,054	72,688,800
Urban	252,781	0	0	252,781	252,781
Wetland	337,336	205,534	819,483	542,870	1,156,819
Total	102,026,121	34,384,696	34,384,696	136,410,817	136,410,817
Percent	75%	25%	25%		

Land cover class	Persistence	Losses 2001-08	Gains 2001-08	Total in 2001	Total in 2008
Tanzania			*ha*		
Cropland	68,132	1,090,142	872,062	1,158,274	940,194
Forest	1,839,195	1,712,524	1,104,089	3,551,719	2,943,284
Grassland	6,494,867	5,643,459	5,987,619	12,138,326	12,482,486
Mosaic	1,822,711	5,585,392	3,815,604	7,408,103	5,638,315
Savanna/ Shrub	55,019,578	9,046,121	11,109,809	64,065,699	66,129,387
Urban	78,994	107	42	79,101	79,036
Wetland	206,737	113,027	301,547	319,764	508,284
Total	65,530,214	23,190,772	23,190,772	88,720,986	88,720,986
Percent	74%	26%	26%		

Land cover class	Persistence	Losses 2001-08	Gains 2001-08	Total in 2001	Total in 2008
Uganda			*ha*		
Cropland	690,902	793,300	861,023	1,484,202	1,551,925
Forest	969,739	830,741	170,193	1,800,480	1,139,932
Grassland	209,915	565,786	866,985	775,701	1,076,900
Mosaic	5,638,354	2,791,630	2,147,654	8,429,984	7,786,008
Savanna/ Shrub	6,057,754	1,844,770	2,637,093	7,902,524	8,694,847
Urban	40,977	21	21	40,998	40,998
Wetland	174,645	47,286	190,565	221,931	365,210
Total	13,782,286	6,873,534	6,873,534	20,655,820	20,655,820
Percent	67%	33%	33%		

Land cover class	Persistence	Losses 2001-08	Gains 2001-08	Total in 2001	Total in 2008
United States			*ha*		
Cropland	115,062,666	34,277,196	24,430,370	149,339,862	139,493,036
Forest	133,616,756	20,302,053	42,011,756	153,918,809	175,628,512
Grassland	179,141,506	48,199,158	48,267,466	227,340,664	227,408,972
Mosaic	70,082,007	26,383,549	37,536,721	96,465,556	107,618,728
Savanna/ Shrub	176,476,413	70,082,144	45,481,258	246,558,557	221,957,671

Urban	11,981,496	8,132	11,848	11,989,628	11,993,344
Wetland	2,406,433	1,758,663	3,271,476	4,165,096	5,677,909
Total	688,767,277	201,010,895	201,010,895	889,778,172	889,778,172
Percent	77%	23%	23%		

III. Immediate emissions from **Forest** to **Cropland** conversion per country/ sub national unit

Country/Sub National Unit	20-yr emission factor (t CO2 ha-1)	Contribution of each EF component: Change biomass	Change soil	Lost seq.	Fire
Argentina	207	61	22	17	0
Buenos Aires	146				
Catamarca	189	71	10	19	0
Chaco	178	68	11	20	0
Chubut	233	68	16	15	0
Ciudad de Buenos Aires	40				
Corrientes	176	62	17	20	0
Entre Ríos	187	56	24	19	0
Formosa	194	63	18	19	0
Jujuy	364	82	8	10	0
La Pampa	108	44	23	33	0
La Rioja	150	71	5	24	0
Mendoza	84	44	13	43	0
Misiones	444	83	9	8	0
Neuquén	133	49	24	27	0
Río Negro	223	71	13	16	0
Salta	193	62	20	19	0
San Juan	93	51	10	39	0
San Luis	108	55	11	33	0
Santa Cruz	158	36	41	23	0
Santa Fe	185	63	17	19	0
Santiago del Estero	168	64	15	21	0
Tierra del Fuego	511	27	66	7	0
Tucumán	280	76	11	13	0
Bolivia	549	72	15	7	7
Brazil	756	76	12	5	7
Acre	799	79	9	5	8
Alagoas	344	57	27	10	6
Amapá	847	79	9	4	8
Amazonas	777	73	15	5	7
Bahia	439	68	17	8	7
Ceará	287	60	21	13	6
Distrito Federal	274	47	35	13	5
Espírito Santo	402	60	25	9	6
Goiás	217	42	36	17	5

Maranhão	464	71	15	8	7
Mato Grosso	744	73	15	5	7
Mato Grosso do Sul	262	51	30	14	5
Minas Gerais	326	56	27	11	6
Paraná	483	64	22	7	6
Paraíba	290	58	23	12	6
Pará	771	76	12	5	7
Pernambuco	292	60	21	12	6
Piauí	300	65	16	12	7
Rio de Janeiro	412	61	24	9	6
Rio Grande do Norte	219	50	29	16	5
Rio Grande do Sul	462	59	27	8	6
Rondônia	710	79	8	5	8
Roraima	734	77	10	5	7
Santa Catarina	552	61	26	7	6
Sergipe	402	62	23	9	6
São Paulo	504	71	15	7	7
Tocantins	236	41	40	15	5
Ethiopia	423	73	11	9	7
Guatemala	671	65	23	5	6
India	878	82	6	4	8
Indonesia	833	73	16	4	7
Aceh	996	70	20	4	7
Bali	918	65	25	4	6
Bangka-Belitung	481	42	46	7	4
Banten	492	66	20	7	7
Bengkulu	1,031	67	23	3	6
Gorontalo	1,114	80	9	3	8
Irian Jaya Barat	1,020	64	27	4	6
Jakarta Raya	214	37	42	17	4
Jambi	719	44	47	5	4
Jawa Barat	809	67	22	4	6
Jawa Tengah	689	67	21	5	6
Jawa Timur	827	70	19	4	7
Kalimantan Barat	745	56	34	5	5
Kalimantan Selatan	811	60	30	4	6
Kalimantan Tengah	903	47	44	4	5
Kalimantan Timur	850	72	17	4	7
Kepulauan Riau	369	46	40	10	5
Lampung	773	67	22	5	6
Maluku	705	72	16	5	7
Nusa Tenggara Barat	973	73	16	4	7
Nusa Tenggara Timur	782	63	26	5	6
Papua	1,199	55	36	3	5
Riau	1,099	29	65	3	3

Sulawesi Barat	936	77	12	4	7
Sulawesi Selatan	933	76	13	4	7
Sulawesi Tengah	907	77	11	4	7
Sulawesi Tenggara	902	78	11	4	7
Sulawesi Utara	814	75	13	4	7
Sumatera Barat	897	61	29	4	6
Sumatera Selatan	664	38	53	5	4
Sumatera Utara	760	63	26	5	6
Yogyakarta	701	72	16	5	7
Malawi	382	63	22	9	6
Malaysia	812	78	10	4	7
Johor	759	55	35	5	5
Kedah	1,090	82	7	3	8
Kelantan	1,017	80	9	4	8
Melaka	391	63	22	9	6
Negeri Sembilan	824	79	9	4	8
Pahang	1,064	74	15	3	7
Perak	1,079	75	14	3	7
Perlis	685	75	12	5	7
Pulau Pinang	381	62	22	9	6
Sabah	845	75	13	4	7
Sarawak	999	60	31	4	6
Selangor	980	52	40	4	5
Trengganu	979	79	10	4	8
Mozambique	304	64	18	12	7
Cabo Delgado	284	63	17	13	7
Gaza	195	51	25	18	6
Inhambane	256	61	18	14	6
Manica	315	66	16	11	7
Maputo	279	65	16	13	7
Nampula	262	60	20	14	6
Nassa	293	65	16	12	7
Sofala	317	66	15	11	7
Tete	307	65	17	12	7
Zambezia	307	64	18	12	6
Nigeria	372	69	15	10	7
Pakistan	465	74	11	8	7
Peru	834	73	16	4	7
Russia	386	76	16	8	0
Sudan	105	25	37	34	4
Tanzania	388	56	29	9	6
Arusha	467	51	37	8	5
Dar-Es-Salaam	176	36	39	20	4
Dodoma	354	53	31	10	5
Iringa	418	58	28	9	6

Kagera	352	55	29	10	6
Kaskazini-Pemba	140	18	53	26	3
Kaskazini-Unguja	288	52	30	12	5
Kigoma	315	56	27	11	6
Kilimanjaro	449	66	20	8	7
Kusini-Pemba	132	14	57	27	3
Lindi	359	55	30	10	6
Manyara	426	60	26	8	6
Mara	243	43	38	15	5
Mbeya	389	52	34	9	5
Morogoro	418	60	26	9	6
Mtwara	290	48	34	12	5
Mwanza	127	10	60	28	2
Pwani	331	51	33	11	5
Rukwa	319	57	26	11	6
Ruvuma	348	56	28	10	6
Shinyanga	307	53	30	12	5
Singida	381	54	31	9	5
Tabora	331	52	32	11	5
Tanga	407	60	26	9	6
Zanzibar South and Central	277	53	28	13	6
Zanzibar West	169	23	52	21	3
Uganda	385	65	19	9	7
Ukraine	198	36	27	37	0
United States	294	69	14	16	0
Alabama	228	65	14	21	0
Arizona	106	36	18	46	0
Arkansas	242	67	13	20	0
California	389	81	7	12	0
Colorado	179	58	15	27	0
Connecticut	356	63	23	14	0
Delaware	298	76	7	16	0
District of Columbia	340	77	9	14	0
Florida	267	67	15	18	0
Georgia	217	64	14	22	0
Idaho	275	59	24	18	0
Illinois	288	69	14	17	0
Indiana	288	74	10	17	0
Iowa	255	63	18	19	0
Kansas	202	55	21	24	0
Kentucky	261	69	13	19	0
Louisiana	221	63	15	22	0
Maine	313	55	29	15	0
Maryland	315	76	9	15	0
Massachusetts	356	61	26	14	0
Michigan	265	66	16	18	0

Minnesota	207	56	21	23	0
Mississippi	276	72	11	18	0
Missouri	247	66	14	20	0
Montana	234	63	17	21	0
Nebraska	192	57	18	25	0
Nevada	109	40	15	44	0
New Hampshire	365	64	22	13	0
New Jersey	284	69	14	17	0
New Mexico	130	48	15	37	0
New York	294	68	15	16	0
North Carolina	347	77	9	14	0
North Dakota	207	55	22	23	0
Ohio	260	70	11	19	0
Oklahoma	172	51	21	28	0
Oregon	424	78	11	11	0
Pennsylvania	320	72	12	15	0
Rhode Island	324	59	27	15	0
South Carolina	227	66	13	21	0
South Dakota	174	49	23	28	0
Tennessee	283	72	11	17	0
Texas	158	51	19	31	0
Utah	141	46	20	34	0
Vermont	355	67	20	14	0
Virginia	307	74	11	16	0
Washington	482	73	17	10	0
West Virginia	327	72	13	15	0
Wisconsin	250	66	15	19	0
Wyoming	202	64	12	24	0

IV. Immediate emissions from **Grassland** to **Cropland** conversion per country/ sub national unit

Country/Sub National Unit	20-yr emission factor (t CO2 ha-1)	Contribution of each EF component			
		Change biomass	Change soil	Lost seq.	Fire
Argentina	42	-6	106	0	0
Buenos Aires	107				
Catamarca	14	-36	136	0	0
Chaco	24	15	85	0	0
Chubut	32	-18	118	0	0
Ciudad de Buenos Aires	14				
Corrientes	40	23	77	0	0
Entre Ríos	44	-3	103	0	0
Formosa	40	12	88	0	0
Jujuy	22	-33	133	0	0
La Pampa	17	-46	146	0	0
La Rioja	2	-227	327	0	0

Mendoza	3	-229	329	0	0
Misiones	50	19	81	0	0
Neuquén	27	-15	115	0	0
Río Negro	22	-31	131	0	0
Salta	32	-18	118	0	0
San Juan	2	-332	432	0	0
San Luis	5	-171	271	0	0
Santa Cruz	58	-12	112	0	0
Santa Fe	34	6	94	0	0
Santiago del Estero	21	-16	116	0	0
Tierra del Fuego	340	0	100	0	0
Tucumán	26	-26	126	0	0
Bolivia	79	-6	105	0	1
Brazil	100	5	93	0	2
Acre	80	12	85	0	3
Alagoas	95	1	98	0	2
Amapá	92	10	87	0	3
Amazonas	132	7	91	0	2
Bahia	75	-2	100	0	2
Ceará	61	-2	100	0	2
Distrito Federal	106	9	89	0	2
Espírito Santo	113	8	90	0	2
Goiás	91	10	87	0	3
Maranhão	79	12	85	0	3
Mato Grosso	122	8	90	0	2
Mato Grosso do Sul	89	10	87	0	3
Minas Gerais	97	7	91	0	2
Paraná	115	6	92	0	2
Paraíba	65	-4	102	0	2
Pará	102	9	89	0	2
Pernambuco	60	-5	103	0	2
Piauí	53	3	93	0	3
Rio de Janeiro	110	8	90	0	2
Rio Grande do Norte	61	-5	102	0	2
Rio Grande do Sul	132	4	94	0	2
Rondônia	72	13	84	0	3
Roraima	86	10	87	0	3
Santa Catarina	151	4	95	0	1
Sergipe	100	4	94	0	2
São Paulo	84	10	88	0	3
Tocantins	105	9	89	0	2
Ethiopia	46	-7	105	0	3
Guatemala	166	4	95	0	1
India	58	-1	98	0	3
Indonesia	142	6	92	0	2

Aceh	210	4	94	0	1
Bali	241	4	95	0	1
Bangka-Belitung	232	4	95	0	1
Banten	110	9	89	0	2
Bengkulu	245	4	95	0	1
Gorontalo	116	8	90	0	2
Irian Jaya Barat	282	3	96	0	1
Jakarta Raya	102	9	88	0	2
Jambi	346	3	97	0	1
Jawa Barat	187	5	94	0	1
Jawa Tengah	159	6	93	0	1
Jawa Timur	171	5	94	0	1
Kalimantan Barat	263	4	96	0	1
Kalimantan Selatan	257	4	95	0	1
Kalimantan Tengah	409	2	97	0	1
Kalimantan Timur	154	6	92	0	1
Kepulauan Riau	158	6	93	0	1
Lampung	182	5	94	0	1
Maluku	125	7	91	0	2
Nusa Tenggara Barat	169	6	93	0	1
Nusa Tenggara Timur	218	4	95	0	1
Papua	446	2	98	0	0
Riau	726	1	98	0	0
Sulawesi Barat	120	8	90	0	2
Sulawesi Selatan	130	7	91	0	2
Sulawesi Tengah	116	8	90	0	2
Sulawesi Tenggara	111	8	89	0	2
Sulawesi Utara	119	8	90	0	2
Sumatera Barat	269	3	96	0	1
Sumatera Selatan	362	3	97	0	1
Sumatera Utara	212	4	94	0	1
Yogyakarta	124	8	91	0	2
Malawi	82	-2	100	0	2
Malaysia	96	10	88	0	2
Johor	278	3	96	0	1
Kedah	87	11	86	0	3
Kelantan	99	9	88	0	2
Melaka	97	10	88	0	2
Negeri Sembilan	86	11	86	0	3
Pahang	175	5	93	0	1
Perak	167	6	93	0	1
Perlis	94	10	88	0	2
Pulau Pinang	95	10	88	0	2
Sabah	124	8	91	0	2
Sarawak	322	3	96	0	1
Selangor	400	2	97	0	1

Trengganu	106	9	89	0	2
Mozambique	55	-1	98	0	3
Cabo Delgado	56	9	88	0	3
Gaza	46	-7	105	0	3
Inhambane	44	-8	105	0	3
Manica	51	-3	100	0	3
Maputo	42	-8	105	0	3
Nampula	57	6	91	0	3
Nassa	56	12	84	0	4
Sofala	48	-5	103	0	3
Tete	51	-6	104	0	2
Zambezia	67	14	83	0	3
Nigeria	53	-6	103	0	2
Pakistan	47	-8	105	0	3
Peru	129	-5	104	0	1
Russia	55	-8	108	0	0
Sudan	37	-9	106	0	3
Tanzania	109	-3	102	0	1
Arusha	169	-2	101	0	1
Dar-Es-Salaam	80	12	85	0	3
Dodoma	109	-3	102	0	1
Iringa	115	-2	101	0	1
Kagera	107	4	94	0	2
Kaskazini-Pemba	86	11	86	0	3
Kaskazini-Unguja	83	-4	103	0	2
Kigoma	91	4	94	0	2
Kilimanjaro	89	-1	100	0	2
Kusini-Pemba	86	11	86	0	3
Lindi	115	6	92	0	2
Manyara	107	-3	102	0	1
Mara	90	-3	102	0	1
Mbeya	135	1	98	0	1
Morogoro	110	0	98	0	1
Mtwara	106	5	94	0	2
Mwanza	76	-3	101	0	2
Pwani	114	2	96	0	2
Rukwa	82	-3	102	0	2
Ruvuma	107	8	90	0	2
Shinyanga	89	-4	103	0	1
Singida	115	-3	102	0	1
Tabora	103	-3	102	0	1
Tanga	101	-4	103	0	1
Zanzibar South and Central	89	11	87	0	3
Zanzibar West	101	9	88	0	2
Uganda	72	-3	101	0	2

Ukraine	48	-12	112	0	0
United States	35	-19	119	0	0
Alabama	37	13	87	0	0
Arizona	12	-63	163	0	0
Arkansas	25	-30	130	0	0
California	20	-36	136	0	0
Colorado	19	-35	135	0	0
Connecticut	88	6	94	0	0
Delaware	17	-30	130	0	0
District of Columbia	37	17	83	0	0
Florida	48	19	81	0	0
Georgia	25	-18	118	0	0
Idaho	59	-11	111	0	0
Illinois	40	0	100	0	0
Indiana	22	-23	123	0	0
Iowa	46	-3	103	0	0
Kansas	35	-22	122	0	0
Kentucky	36	8	92	0	0
Louisiana	35	7	93	0	0
Maine	97	5	95	0	0
Maryland	23	-24	124	0	0
Massachusetts	97	5	95	0	0
Michigan	48	11	89	0	0
Minnesota	38	-12	112	0	0
Mississippi	33	13	87	0	0
Missouri	27	-28	128	0	0
Montana	32	-22	122	0	0
Nebraska	28	-26	126	0	0
Nevada	9	-76	176	0	0
New Hampshire	87	6	94	0	0
New Jersey	43	5	95	0	0
New Mexico	12	-61	161	0	0
New York	50	9	91	0	0
North Carolina	26	-20	120	0	0
North Dakota	38	-19	119	0	0
Ohio	29	-1	101	0	0
Oklahoma	27	-28	128	0	0
Oregon	38	-19	119	0	0
Pennsylvania	44	10	90	0	0
Rhode Island	91	6	94	0	0
South Carolina	22	-31	131	0	0
South Dakota	34	-21	121	0	0
Tennessee	32	5	95	0	0
Texas	23	-27	127	0	0
Utah	21	-34	134	0	0
Vermont	75	7	93	0	0

Virginia	31	-7	107	0	0
Washington	76	-9	109	0	0
West Virginia	46	6	94	0	0
Wisconsin	43	12	88	0	0
Wyoming	18	-36	136	0	0

Appendix K Water modelling

K 1 Introduction

As for many other industrial activities, the process of biomass conversion to various biofuels can require a substantial volume of water. Most of this water is returned to rivers and other water bodies and is therefore available for further use. Unless suitable equipment is installed, negative impacts can occur due to chemical and thermal pollution loading the aquatic systems. This problem is not restricted to the biofuels industry; it is a general problem in countries with less strict environmental regulations or limited law enforcement capacity.

However, biofuel production is unique in that feedstock production can require much more water than the subsequent processing to products. The total water requirement for biofuel production can be several hundred times larger than when fossil based transport fuels are produced. Water use in biofuel feedstock production is also different to water use in processing in that much of the water is evapotranspirated back to the atmosphere and is therefore no longer available for further use until it returns as precipitation. For this reason, this appendix concentrates on the feedstock production and its consequences for water.

To characterize the impacts on water resources, various criteria and indicators under different frameworks are being used. The growing literature characterizing bioenergy-water links – using indicators such as "embedded water," "water footprint", or "consumptive water use" of bioenergy – has helped to raise awareness of the increasing water demand to meet bioenergy production (Berndes 2002, 2008; Bonnet and Lorne 2009; Gerbens-Leenes et al. 2008; Hoekstra et al. 2009; NRC 2007). However, generally valid quantifications of the influence of bioenergy on water are complicated because of the multitude of existing and rapidly evolving bioenergy sources; complexities of physical, chemical, and biological conversion processes; feedstock diversity and variability in site specific conditions. Drawing sufficiently general understanding of the impact of bioenergy on water from existing literature is hampered by the differences in their scope, system boundaries, definitions of water use, and methods employed.

Evaluation of impacts on water will be an important component of any assessment of energy from biomass in the future. For a meaningful evaluation, complementary indicators should be used and evaluation frameworks need to take into consideration the distribution of freshwater sources as well as the temporal and spatial (local, regional, watershed, etc.) scales, which play a significant role in the assessment.

It was beyond the scope of the work reported here to take account of the wide range of studies that have been done in different locations and with different scope and methodology approach. This appendix uses selected approaches to evaluate water use with the aim to improve the understanding of water implications of EU biofuels use, including also a view of the future to inform about possible water implications of different development trajectories.

Selected water-use metrics used in literature are given in Section K 6, where also references are provided that discusses limits of presently used approaches and needs for future development of evaluation frameworks.

K 2 The global water situation and future stress

Freshwater is already scarce in some regions of the world and under the impact of population growth and climate change the population at risk of water stress could increase substantially. Estimates show that in 2005, about 35% of the world population lived in areas with chronic water shortage (Kummu et al. 2010) and water shortages are already beginning to constrain economic growth in several places in the world, including California, China, Australia, and India (UNESCO 2009). By 2025, two-thirds of the global population will be living in areas experiencing water stress, i.e., where periodic or limited water shortages can be expected (UNEP 2007).

Agriculture accounts for about 70% of freshwater withdrawals from rivers, lakes and aquifers – up to more than 90% in some developing countries (UNESCO 2009). Climate changes render agricultural production a risky business as intra seasonal droughts and dry spells are predicted to increase in the future. Noting that agriculture is already the biggest water user, it is clear that the future state of water resources may be strongly influenced by the strategies established for bioenergy expansion and vice versa (Berndes 2002; Lotze-Campen et al. 2010).

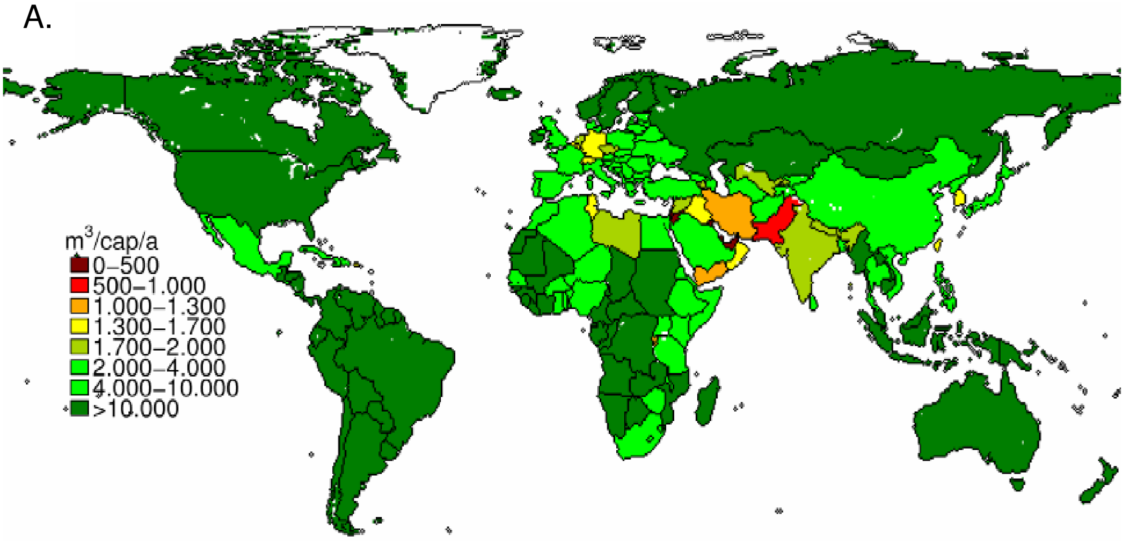
In this context it is important to stress that it is the infiltrated rainwater forming soil moisture that sustains the lion share of biomass production in terrestrial ecosystems, including agricultural systems. Irrigation water, on the other hand, constitutes a small proportion of the total water use in most agricultural systems globally, although sometimes a very important part.

Figure 182 illustrates water availability per capita for crop production now and in 2050. To produce an adequate human diet, approximately 1300 m^3 cap^{-1} yr^{-1} is required (Falkenmark and Rockström, 2004). This number obviously varies with dietary composition and where the food is produced, but – acknowledging these shortcomings – we can still use this number as a first indicator of water scarcity for food production.

Using a 1300 m^3 cap^{-1} yr^{-1} as an indicator for minimum dietary water requirements, the analysis shows that currently there are only a few countries, predominantly located in the Middle East / North Africa (MENA) region, which do not have enough water to meet food demands (Map A in Figure 182). Thus, from a water perspective there seems to be possibilities to cultivate biofuel crops in many regions of the world without out-competing basic human food requirements.

However, the situation can be different in 2050, where many more countries will not be able to meet national food requirements (i.e., they have less than 1300 m^3 cap^{-1} yr^{-1} of freshwater), predominantly as a consequence of population increase (Map B in Figure 182). These countries are located in the MENA region, South Asia and sub-Saharan Africa. According to the modeling behind the maps presented in Figure 182, more than a third of the global population in 2050 will live in countries where water limits food production and where the economic situation is such that the resulting food shortage cannot be met by trade alone. This is likely to put severe pressure on the ecosystems in these regions.

A.



B.

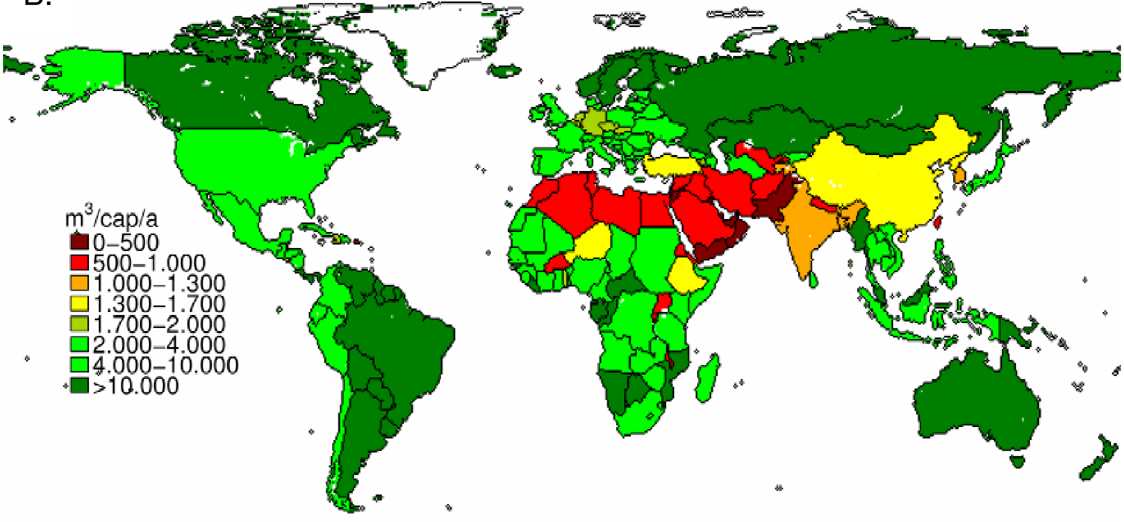


Figure 182. LPJmL-simulated per capita green plus blue water availability for the countries of the world for a) present conditions and b) 2050, assuming both climate and demographic change. From Rockström et al., 2009.

K 3 Water-use for current biofuel production

For assessments of long term sustainable water use it is the flows (expressed for example as km^3 yr^{-1}) and not the reservoirs of water that are relevant to consider; however, reservoirs fill an important buffering function at the landscape scale. Based on information about share of specific crops in different countries that is used for biofuel production for the EU (Section 2.5 in the main text), water impacts associated with EU biofuel import demand was quantified. The initial quantifications were made using the physically based ecosystem model LPJmL, which was calibrated against agricultural yield data from the Food and Agricultural Organisation (FAO) for the period 1999-2003. The results from the modeling were aggregated to the national level for clarity.

LPJ is a dynamic global simulation model of vegetation biogeography and vegetation/soil biogeochemistry. Taking climate, soil and atmospheric information as input, it dynamically computes spatially explicit transient vegetation composition in terms of plant functional groups, and their associated carbon and water budgets. In this specific study, we used a version of this tool, LPJmL (mL for managed lands), which additionally simulates the carbon and water budgets of agricultural lands and of land use change. It takes as inputs land use and land management data. In the current assessment, we used the average values for the simulation period 1998 – 2003. Furthermore, we assumed that biofuel feedstocks were managed in the same way as other agricultural crop in the respective country, and that they were evenly distributed over all cropland in a country.

The quantifications presented here can easily be reproduced by using the same climatic data, soil and crop information, and biofuel feedstock estimates. To assess the water requirements for these crops, a biophysical model is needed that 1) can operate on a global scale, 2) has a spatial resolution that enables assessments of downstream impacts of upstream water withdrawals, 3) estimates both biomass growth (yields) and hydrological flows including evapotranspiration (i.e. consumptive water flows). Currently, there are a handful of models that fulfill these criteria (for an overview, see Hoff et al., 2010), with various strengths and weaknesses. The competitive strength of LPJmL to other similar tools lies in its' explicit estimation of consumptive water flows, which was the key output in this assessment.

The LPJ model is developed and maintained at the Potsdam Institute for Climate research (PIK). For a detailed description of the database included in the model, see the model homepage (www.pik-potsdam.de/research/cooperations/lpjweb).

K 4 Looking into the future – key findings and remaining knowledge gaps

The assessment of water use for the current EU biofuel consumption has provided a basis for showing the consequences of this water use in relation to the current, national agricultural water use and potential future water scarcity situation. Water productivities vary with crop types, which makes careful crop selection an opportunity for water savings in water scarce regions, and illustrate opportunities for concurrent yield and water productivity improvements arising from better agricultural management practices in general. Another promising opportunity to increase biofuel production without compromising environmental sustainability or food production needs is the potential for conversions of wastelands into biofuel plantations.

Varying local conditions will result in different combinations of crop choices, land management or land-use options being attractive in different locations. It may also be that sustainability requirements lead to tradeoffs between different objectives in production. For instance, in water scarce areas production systems having lower yield levels may be preferred since high yielding systems might reduce downstream water availability, leading to the need to balance upstream benefits and downstream costs.

There is a need for improved assessments both at the regional and global scale outlining scenarios for future biofuel production in relation to food production needs, biodiversity requirements, carbon sequestration potential in terrestrial biomes, freshwater use and nutrient cycles, to ensure that our current development trajectory is one in which we stay within the safe operating space for humanity, i.e. that ecosystems remain within their desirable ecosystem states to the degree where they continue to deliver the ecosystem services that our well-being depend upon.

Current water use for biofuel consumption is small in comparison to water use for food production. However, this may change drastically in the future, depending on the choice of development trajectories for biofuel demand. Hence, expanding the current analysis to encompass future biofuel demand scenarios, including scenarios for food requirements with increasing population and GDP, is crucial to accurately address the opportunities and risks of different policies impacting on biofuel demand.

K 5 References

Achten, W.M.J., Maes, W.H., Aerts, R., Verchot, L., Trabucco, A., Mathijs, E., Singh, V.P., Muys, B. 2010. Jatropha: From global hype to local opportunity. Journal of Arid Environments 74: 164–165.

Ball, B.C., Bingham, I., Rees, R.M., Watson, C.A., Litterick, A. 2005. The role of crop rotations in determining soil structure and crop growth conditions. *Canadian Journal of Soil Science*, **85**, pp. 557-577.

Berndes, G. 2002. Bioenergy and water--the implications of large-scale bioenergy production for water use and supply. *Global Environmental Change* **12**, 253-271.

Berndes, G. 2008. Water demand for global bioenergy production: trends, risks and opportunities. WBGU, Berlin, 2008.

Blanco-Canqui, H., Lal, R., Post, W.M., Izaurralde, R.C., Owens, L.B. 2006. Rapid Changes in Soil Carbon and Structural Properties Due to Stover Removal from No-Till Corn Plots. *Soil Science*, **171**(6), pp. 468-482.

Blanco-Canqui, H., Lal, R. 2009. Corn Stover Removal for Expanded Uses Reduces Soil Fertility and Structural Stability. *Soil Sci Soc Am J*, **73**(2), pp. 418-426.

Bonnet, J.-F., Lorne, D. 2009. Water and Biofuels in 2030: Water Impacts of French Biofuel Development at the 2030 Time Horizon. N°19/2009. Les cahiers du CLIP, 98 p.

Castiglioni, P., Warner, D., Bensen, R.J., Anstrom, D.C., Harrison, J., Stoecker, M., Abad, M., Kumar, G., Salvador, S., D'Ordine, R., Navarro, S., Back, S., Fernandes, M., Targolli, J., Dasgupta, S., Bonin, C., Luethy, M.H., Heard, J.E. 2008. Bacterial RNA Chaperones Confer Abiotic Stress Tolerance in Plants and Improved Grain Yield in Maize under Water-Limited Conditions. *Plant Physiol.*, **147**(2), pp. 446-455.

Dale, B.E., Allen, M.S., Laser, M., Lynd, L.R., 2009. Protein feeds coproduction in biomass conversion to fuels and chemicals. *Biofuels, Bioproducts and Biorefining*, **3**(2), pp. 219-230.

Dale, B.E., Bals, B.D., Kim, S., Eranki, P. 2010. Biofuels Done Right: Land Efficient Animal Feeds Enable Large Environmental and Energy Benefits. *Environmental Science & Technology*, **44**(22), pp. 8385-8389.

da Schio, B., 2010. *Jatropha curcas* L., a potential bioenergy crop. On field research in Belize. M.Sc. dissertation. Padua University, Italy and Wageningen University and Research centre, Plant Research International, the Netherlands.

Divakara, B. N., Upadhyaya, H. D., Wani, S. P. & Gowda, C. L. L. 2010. Biology and genetic improvement of Jatropha curcas L: A review. *Applied Energy* **87**, 732–742.

Falkenmark, M., Rockström, J. 2004: Balancing Water for Humans and Nature. The New Approach in Ecohydrology. Earthscan, London, 247 pp.

Fischer, G., Hizsnyik, E., Prieler, S., Shah, M., van Velthuizen, H. 2009. *Biofuels and Food*
Security. The OPEC Fund for International Development (OFID) and International Institute of
Applied Systems Analysis (IIASA), Vienna, Austria, 228pp.

De Fraiture, C., Giordano, M., Yongsong, L. 2008. Biofuels and implications for agricultural water use: blue impacts of green energy. Water Policy 10 Supplement 1. pp. 67-81.

Gerbens-Leenes, P. W., Hoekstra, A. Y., van der Meer, T. H. 2008. The water footprint of bioenergy. *Proceedings of National Academy of Science* **106**, 10219-10223.

Godfray, H.C.J., Toulmin, C., Beddington, J.R., Crute, I.R., Haddad, L., Lawrence, D., Muir, J.F., Pretty, J., Robinson, S., Thomas, S.M. 2010. Food Security: The Challenge of Feeding 9 Billion People. *Science*, **327**(5967), pp. 812-818.

Hoekstra, A. Y., Chapagain, A. K., Aldaya, M. M., Mekonnen, M. M. 2009. Water Footprint Manual. Water Footprint Network, Enschede, The Netherlands.

Hoff, H., Falkenmark, M., Gerten, D., Gordon, L., Karlberg, L. and Rockström, J., 2010. Greening the global water system. *Journal of Hydrology*, 384 (3-4): 177-186.

Kummu, M., Ward, P., de Moel, H., Varis, O. 2010. Is physical water scarcity a new phenomenon? Global assessment of water shortage over the last two millennia. Environ. Res. Lett. 5 (July-September 2010) 034006.

Lal, R., 2008. Crop residues as soil amendments and feedstock for bioethanol production. *Waste Management*, **28**(4), pp. 747-758.

Lal, R., Pimentel, D. 2007. Bio-fuels from crop residues. *Soil & Tillage Research*, **93**(2), pp. 237-238.

Lotze-Campen, H., Popp, A., Beringer, T., Müller, C., Bondeau, A., Rost, S., Lucht, W. 2010. Scenarios of global bioenergy production: The trade-offs between agricultural expansion, intensification and trade. Ecological Modelling 221:2188-2196.

Molden (ed.) 2007. Water for Food, Water for Life: A Comprehensive Assessment of Water Management in Agriculture. Earthscan, London and International Water Management Institute, Colombo.

Nelson, D.E., Repetti, P.P., Adams, T.R., Creelman, R.A., Wu, J., Warner, D.C., Anstrom, D.C., Bensen, R.J., Castiglioni, P.P., Donnarummo, M.G., Hinchey, B.S., Kumimoto, R.W., Maszle, D.R., Canales, R.D., Krolikowski, K.A., Dotson, S.B., Gutterson, N., Ratcliffe, O.J., Heard, J.E. 2007. Plant nuclear factor Y (NF-Y) B subunits confer drought tolerance and lead to improved corn yields on water-limited acres. *Proceedings of the National Academy of Sciences*, **104**(42), pp. 16450-16455.

Neumann, K., Verburg, P.H., Stehfest, E., Müller, C. 2010. The yield gap of global grain
production: A spatial analysis. *Agricultural Systems*, **103**(5), pp. 316-326.

NRC, 2007. Water implications of biofuels production in the United States. National Research Council, The National Academies Press, Washington, D.C.

Phalan, B. 2009. The social and environmental impacts of biofuels in Asia: An overview. Applied Energy 86: S21–S29.

Rockström, J., Gordon, L., Folke, C., Falkenmark, M., Engwall, M. 1999. Linkages among water vapor flows, food production, and terrestrial ecosystem services. Conservation Ecology 3 (2), 5.

Rockström, J., Falkenmark, M., Karlberg, L., Hoff, H., Rost, S. and Gerten, D. 2009. Future water availability for global food production: the potential of green water for increasing resilience to global change. Water Resources Research, 45, W00A12.

Sathaye J., Makundi W., Andrasko K. 2001. Management of Forests for Mitigation of Greenhouse Gas Emissions. Mitigation and Adaptation Strategies for Global Change 6(3-4):183-184.

Sparovek, G., Berndes, G., Egeskog, A., de Freitas, F.L.M., Gustafsson, S., Hansson, J. 2007. Sugarcane ethanol production in Brazil: an expansion model sensitive to socioeconomic and environmental concerns. *Biofuels, Bioproducts and Biorefining*, **1**(4), pp. 270-282.

Sreedevi, T.K., Wani, S.P., Srinivasa Rao, CH., Chaliganti, R., Reddy, R.L. 2009. *Jatropha* and Pongamia rainfed plantations on wastelands in India for improved livelihoods and protecting environment. 6th international biofuels conference. March 4-5, 2009.

Srivastava, P. 2005. Poverty targeting in India. In: Weiss, J. (ed.) Poverty targeting in Asia. Cheltenham: Edward Eigar Publishing Limited: pp. 34-78.

Trabucco, A., Achten, W.M.J., Bowe, C., Aerts, R., Orshoven, J. V., Norgrove, L., Muys, B. 2010. Global mapping of Jatropha curcas yield based on response of fitness to present and future climate. GCB Bioenergy 2: 139–151

UNEP, 2007. Global Environmental Outlook 4. Environment for Development, United Nations Environment Programme, Nairobi, Kenya.

UNESCO, 2009. World Water Assessment Programme. 2009. The United Nations World Water Development Report 3: Water in a Changing World. Paris: UNESCO, and London: Earthscan.

Wani, S.P., Sreedevi, T.K. 2005. Pongamia's Journey from forest to Micro-enterprise for improving livelihood. International Crop Research Institute for the Semi-Arid Tropics. Research Report, Global Theme of Agroecosystems

Wani, S.P., Osman, M., D'Silva, E., Sreedevi, T.K. 2006. Improved livelihoods and environmental protection through biodiesel plantations in Asia. Asian Biotechnology and Development Review: 8(2): 11-29.

Wani, S.P., Sreedevi, T.K., Marimuthu, S., Kesava Rao, A.V.R., Vineela, C. 2009. Harnessing the potential of *Jatropha* and Pongamia plantations for improving livelihoods and rehabilitating degraded lands. 6th international biofuels conference. March 4-5, 2009.

Wilhelm, W.W., Johnson, J.M.F., Hatfield, J.L., Voorhees, W.B., Linden, D.R. 2004. Crop and Soil Productivity Response to Corn Residue Removal: A Literature Review. *Agron J*, 96(1), pp. 1-17.

Wilhelm, W.W., Johnson, J.M.E., Karlen, D.L., Lightle, D.T. 2007. Corn stover to sustain soil organic carbon further constrains Biomass supply. *Agronomy Journal*, 99, pp. 1665-1667.

References to Appendix Table

Berndes, G. 2002. Bioenergy and water-the implications of large-scale bioenergy production for water use and supply. *Global Environ Chang* **12**:253–271.

Bonnet, J.-F., Lorne, D. 2009. Water and Biofuels in 2030: Water Impacts of French Biofuel Development at the 2030 Time Horizon. N°19/2009. Les cahiers du CLIP, 98 p.

Chapagain, A.K., Orr, S. 2009. An improved water footprint methodology linking global consumption to local water resources: A case of Spanish tomatoes. *J Environ Manage* 90:1219–1228.

Chiu, Y.-W., Walseth, B., Suh, S. 2009. Water embodied in bioethanol in the United States. *Environ Sci Technol* 43:2688–2692.

Dominguez-Faus, R., Powers, S.E., Burken, J.G., Alvarez, P.J. 2009. The water footprint of biofuels: A drink or drive issue? *Environ Sci Technol* 43:3005– 3010.

Gerbens-Leenes, P. W., Hoekstra, A. Y., van der Meer, T. H. 2008. The water footprint of bioenergy. *Proceedings of National Academy of Science* 106, 10219-10223.

King, C.W., Webber, M.E. 2008. Water intensity of transportation. *Environ Sci Technol* 42:7866–7872.

Mishra, G., Yeh, S. 2011. Lifecycle water consumption and withdrawal requirements of ethanol from corn grain and residues *Environ Sci Technol*, re-submitted March, 2011.

Pfister, S., Koehler, A., Hellweg, S. 2009. Assessing the Environmental Impacts of Freshwater Consumption in LCA. *Environ Sci Technol*.

Ridoutt, B.G., Pfister, S. 2010. A revised approach to water footprinting to make transparent the impacts of consumption and production on global freshwater scarcity. *Global Environ Chang* 20:113120.

K 6 Appendix: Selected water use metrics*

Indicator	Description (studies can use slightly different definitions)	Selected relevant literature
Water use indicators		
Water withdrawal (off-stream use)	Water removed from the ground or diverted from a surface-water source for use.	King and Webber 2008; Dominguez-Faus et al. 2009.
Consumptive water use	Includes water use due to evaporation, transpiration and product incorporation. When the water use during a products life cycle is assessed, evaporative losses during post harvest processing can be included (see Lifecycle water use). Can also include water withdrawal not returning to the same catchment area or not returning in the same time period.	Includes 'green water' and 'blue water' consumptive use. King and Webber 2008; Chiu et al. 2009; Pfister et al. 2009; Berndes 2002. Referred to as blue and green water footprint by Gerbens-Leenes et al.2008
Degradative water use	Withdrawal and discharge into the same watershed after the quality of the water has been (significantly) degraded.	Pfister et al. 2009
Grey water use	The volume of freshwater that is required to assimilate the load of pollutants based on existing ambient water quality standards.	Gerbens-Leenes et al. 2008
Lifecycle water use	Water consumed/withdrawn throughout the lifecycle of biomass based fuels (including their end use). May credit bioenergy due to co-products produced.	Chapagain and Orr 2009, Mishra and Yeh 2011, Ridoutt and Pfister 2010
Effects on water flows balances		
Crop water balance	Evaluates the water balance of cultivated soils. Indicators are expressed in flux per unit surface area, in mm/period, or in (m^3/ha) per period.	
Hydrologic balance	Express various elements of water balance of land or water basin (m^3/yr). Indicators include hydric deficit, annual/dry-period withdrawal and annual/winter drainage.	Bonnet and Lorne 2009

* Source: Yeh, S., Berndes, G., Mishra, G.S., Wani, S.P., Neto, A.E., Suh, S., Karlberg, L., Heinke, J., Garg, K. 2011. Evaluation of Water Use for Bioenergy at Different Scales. Biofuels, Bioproducts and Biorefining, Accepted for publication.

Appendix L Biodiversity

L 1 Biodiversity indicators

The general term "biodiversity indicators" used here and by the Convention on Biological Diversity [www.cbd.int] covers more than a direct measure of biodiversity, such as species populations or the extent of ecosystems. It also includes actions to ensure biodiversity conservation and sustainable use, the creation and management of protected areas and the regulation of the harvesting of species and pressures or threats to biodiversity such as habitat loss.

An assessment of biodiversity indicators is also dependent on their use and the issues of concern that they are intended to address. The Biodiversity Indicators Partnership, formed in response to the charge to the Convention on Biological Diversity (CBD) to halt biodiversity loss by 2010, developed a universal list of indicators that could best be monitored on national, regional and global scales. Some are still under development, while others are already being used and tested. These are similar to the set of European Biodiversity indicators, known commonly as the SEBI 2010 indicators, developed by the European Commission [http://www.eea.europa.eu]. In both sets the indicators track impacts on different biodiversity components (abundance and distribution of species), reflect key threats to biodiversity (invasive species), monitor sustainable use (fish stocks and wild commodities), and keep abreast of ecosystem integrity (water quality, forest fragmentation). The Economics of Ecosystems and Biodiversity [2009] recognizes in its report for national policy makers that measuring ecosystem conditions is time-consuming (and expensive). It concurs that establishing a global framework with a set of key attributes makes the most sense, and then monitoring these building on national-level indicators.

Table 153 provides a broad qualitative assessment of the broader (more global) list of indicators according to several attributes. These indicators could be applied and periodically monitored on a national scale relative to economic development policy. The exercise should be regarded as illustrative and guided by the discussion above that indicators are purpose-dependent. Monitoring them and devising the assessments that analyze them (see the next section) are case sensitive. In general terms, the "better indicators" relevant to the selected attributes in the table are those with the higher numbers. That is, an indicator with attribute ratings of 5s, 4s, and 3s would be more preferable than those with lower numbers.

Table 153. Qualitative assessment of biodiversity conservation indicators[1].

Indicator [2]	Relevance to biofuel impact evaluation	Responsiveness to change	Analytical soundness	Availability & measurability	Ease of interpretation	Cost effectiveness
Extent of forests and forest types	3	4	5	5	5	4
Extent of assorted habitats	3	3	5	4	4	5
Living Plant Index	2	3	4	3	4	3
Global Wild Bird Index	2	3	4	3	4	3
Coverage of Protected Areas	2	4	4	5	5	4
Overlays with biodiversity	3	3	4	3	4	4
Management effectivenesss	4	3	4	2	2	4
Red List Index and Sampled Red List Index	2	3	4	3	4	3
Ex situ crop collections	4	2	2	4	4	2
Genetic diversity of terrestrial domesticated animals	2	2	2	3	3	1
Area of forest under sustainable management: certification	2	4	3	5	5	3
Area of forest under sustainable management: degradation and deforestation	4	4	4	5	5	4
Area of agricultural ecosystems under sustainable management	4	4	4	5	5	3
Proportion of fish stocks in safe biological limits	2	3	3	3	3	3
Status of species in trade	1	3	3	3	3	3
Wild Commodities Index	3	3	4	2	3	3
Ecological Footprint and related concepts [3]	5	3	4	3	3	2
Nitrogen Deposition	5	3	3	3	3	3
Trends in Invasive Alien Species	4	3	3	3	2	3
Marine Trophic Index	2	3	3	2	2	3
Water Quality Index for Biodiversity	3	4	4	4	3	4
Forest fragmentation	4	4	5	3	4	4
River fragmentation and flow regulation	2	4	4	3	4	4
Health and well-being of communities directly dependent on ecosystem goods and services [3]	3	3	3	2	3	5
Nutritional status of biodiversity [3]	2	2	2	1	2	2
Biodiversity for food and medicine [3]	3	3	3	2	1	2

1) Follows the Convention on Biological Diversity where an indicator is a measure or metric based on verifiable data that conveys information about more than itself. The score indicates increasing importance or effectiveness.
2) Biodiversity Indicators Partnership 2010.
3) Indicator still requires additional work.

L 2 Participation in International Conventions and Protocols

Table 154 illustrates the participation by country in the International Convention on Biodiversity (CBD) and several protocols and treaties relevant to biodiversity. The extensive participation (a 95 percent participation rate across the seven conventions) indicates a broad official/national awareness of biodiversity and the environment in the assessed countries.

Table 154. Participation of selected countries in international conventions and protocols related to biodiversity.

	Central/South America					Africa							Asia				Europe/North America		
International protocols, conventions and treaties relevant to biodiversity	Argentina	Bolivia	Brazil	Guatemala	Peru	Ethiopia	Malawi	Mozambique	Nigeria	Sudan	Tanzania	Uganda	India	Indonesia	Malaysia	Pakistan	EU	Ukraine	USA
Convention on Biological Diversity (CBD)	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	[1]
Convention on Wetlands of International Importance (RAMSAR)	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■[2]	■	■
Convention on International Trade of Endangered Species (CITES)	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Cartagena Protocol (biosafety)		■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	
UN Convention to Combat Desertification (UNCCD)	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	
UN Framework Convention on Climate Change (UNFCCC)	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
United Nations Forum on Forests			■	■	■	■	■		■	■	■	■	■	■	■	■	■	■	■

1) Signed in 1993, but not ratified
2) Individual EC countries sign

L 3 Literature sources

Documents, Reports, Papers

2010 Biodiversity Indicators Partnership. 2010. Guidelines for national biodiversity indicator development and use. UNEP/World Conservation Monitoring Centre, Cambridge, UK. 40p.

Camphuasen, A. 2004. Review of literature in methodology for biodiversity assessments and recommendations for forest management in Peninsular Malaysia. GTZ, Sustainable Forest Management and Conservation Project. Technical Document No. 48. 30p

Collen, B., J. Loh, L. MacRae and J. Latham. 2009. Living Planet Index. *Presented at*: Biodiversity monitoring and conservation: Bridging the gaps between global commitment and local action, 18-19 June 2009. Zoological Society of London.

Delbaere, B., A. Nieto Serradilla, M. Snethlage (Eds) 2009. *BioScore: A tool to assess the impacts of European Community policies on Europe's biodiversity.* ECNC, Tilburg, the Netherlands

European Initiative on Business and Biodiversity. 2007. Business-related biodiversity assessments. EU Presidency Conference on European Business and Biodiversity, 12-13 November 2007, Lisbon, Portugal. 30p.

International Association for Impact Assessment. 2005. Biodiversity in impact assessment. Fargo,ND. IAIA Special Publication Series No. 3. 4p.

Millenium Ecosystem Assessment. 2005. Ecosystems and human well-being: Biodiversity Synthesis. World Resources Institute, Washington, DC. 16p.

Secretariat of the Convention on Biological Diversity. 2006. Biodiversity in impact assessment—background document for the CBD decision VIII/28: voluntary guidelines on biodiversity-inclusive impact assessment. Montreal, Canada. CBD Technical Series No. 26. 72 p.
http://www.cbd.int/doc/publications/cbd-ts-26-en.pdf

The Economics of Ecosystems and Biodiversity. 2009. The Economics of Ecosystems and Biodiversity for national and International Policy Makers – Summary: Responding to the Value of Nature. 39p. http://www.teebweb.org

The Energy and Biodiversity Initiative. 2011. Biodiversity indicators for monitoring impacts and conservation actions. Oil, Gas, and Mining Sustainable Community Development Fund, Washington, DC, International Finance Corporation. 31p.

World Business Council for Sustainable Development. 2011. Guide to Corporate Ecosystem Valuation. Geneva, Switzerland. 73p.

Internet Websites

2010 Biodiversity Indicators Partnership, accessed Apr 2011
http://www.bipindicators.net/

Biodiversity Information System for Europe (BISE), accessed Mar 2011
http://www.biodiversity.europa.eu

Convention on Biological Diversity, accessed Mar 2010, Sep 2010
http://www.cbd.int/wgri/

EEA website on SEBI 2010 biodiversity indicators, accessed Mar/Apr 2011
http://www.eea.europa.eu/themes/biodiversity/indicators

Integrated Biodiversity Assessment Tool, accessed Apr 2011
https://www.ibat-alliance.org/ibat-conservation
[Protected Area and Key Biodiversity Area data downloaded from the Integrated Biodiversity Assessment Tool (IBAT). Provided by BirdLife International, Conservation International, IUCN and UNEP-WCMC. Please contact ibat@birdlife.org for further information.]

Millennium Policy Scorecard, accessed Apr 2011
http://www.mcc.gov

UNEP/World Conservation Monitoring Center, accessed Oct 2010
http://www.unep-wcmc.org/

Appendix M Socio-economic impacts

M 1 Introduction

The Renewable Energy Directive [2009/28/EC] obligates the EC to report on several socio-economic aspects in the EU and third countries that are a significant source of raw material for EU biofuels consumption, amongst others on (Article 17.7):

- Wider development issues;
- The respect of land-use rights;
- The status of Conventions of the International Labour Organisation.

The purpose of this appendix is to review the data available to monitor these socio-economic issues, in a selection of countries that are, or may become important for the supply of biofuels in the EU.

The report is divided into the following sections:

Topic		Section
Wider development issues	Job creation	M 3
	Gender issues	M 4
	Smallholder involvement in biofuels feedstock production	M 5
ILO compliance		M 6

M 2 Methodoloy for data collection

For the data collection 17 expert consultants on the bionenergy field worked in the selected countries. The level of effort was limited. Some countries with more available information (e.g. Malaysia, Indonesia, Brazil and Argentina) proved to be a challenge to gather the information in such a short period of time as it was reported during the workshops organized for the project.

Datacollector's instructions

The data collectors were provided with a guideline and a template in excel format to fill the information in it. The guidelines specified to gather data from public sources using 2008 as the baseline and for some categories, data was requested for 2007, 2008, and 2009. The collectors were also instructed to provide information to ensure the replicability of the data; the collectors had to cite all data sources and where no data was found they needed to provide an explanation of attempts to find it and the reasons for not finding it (e.g. not available, not public, not available in years requested). Additionally, they were to collect at least 1 EIA statement related to biofuels projects, if available.

The topics selected for the data collection included:

1. General data on biofuels production
    - Data on up to 5 main feedstocks used or with potential for biofuels (yields, area)

- Data on up to 3 main biofuels production (amount produced, national use, export)
- Data on up to 5 main staple food crops (yield, area, prices, imports, exports)

2. Land cover: both in general and specific to biofuels
3. Biodiversity
   - Legal/policy/governance related data
   - Geographic/land use data
   - Biological/physical data
4. Socio-economic
   - Labour and gender issues
   - Small farmers and land rights
   - Social conditions for sustainability and monitoring.
5. Sustainability
   - International certification schemes applied in the country
   - Programmes related to sustainable biofuels production.
6. Other environmental data
   - Water, air, and environmental quality data sets;
   - Water governance
   - Soil carbon models

M 3 Job creation

Job creation related to biofuels feedstock production may be in the form of self-employment, contract farming, off-farm small business enterprise, or small scale farming. This section reviews employment in the biofuels sector (complete supply chain) of the targeted countries. Information is based on national statistics, industry data and information from labour organisations and information locally collected within the country. Overall there is a scarcity of information on the number of jobs created from growing feedstocks and producing biofuels.

Regional findings in Latin America: Data collected from the targeted countries (Argentina, Bolivia, Brazil, Guatemala and Peru) indicates job creation from biofuels having increased or expecting to increase. Of the biofuels reviewed (sugar cane for ethanol, palm oil and jatropha), jatropha and sugar cane were the most prevalent biofuel crops.

Brazil - In 2005, the recorded number of jobs created in sugarcane planting and harvesting (414,668) was a 16% increase from 2000 records (356,986) [Brazilian Ministry of Labour, 2005]. The MOL report also indicates an increase in ethanol (47%) and sugar manufacturing (102%) between 2000 and 2005 figures[87]. While the number of jobs increased for sugarcane planting/harvesting and ethanol production during this time, the density of jobs in agriculture decreased, [Macedo, 2005]. Additionally due to environment and social concerns, by 2021, biofuel

87 Ethanol/manufacturing (200) 68,138; Ethanol/manufacturing (2005): 128,363; Sugar/manufacturing (2000): Sugar/manufacturing 217,724. (2005): 439,573.

production in Brazil, specifically with harvesting sugarcane, will be 100% mechanized, [Brazilian Ministry of Labour].

Argentina – From a consultant's interview with the Director of the National Bioenergy Program in 2008, the biofuel industry created an average of 5,000 jobs, the most of which were as indirect labour versus for direct operations, [Hilbert, 2010]. Over the next 15 years, it is estimated that the industry will generate 60-70,000 new jobs. As only 18% of the soybean seed yields oil, soybean production is more lucrative for creation of animal meal than as a biofuel. Thus, predicts Osvaldo Bakovich, Director of the Biofuels Program at the Secretary of Energy, most job creation in the industry will be driven by demand for animal meal derived from increased soybean production not necessarily for soybean oil [Bakovich, 2010].

Bolivia - No data exists on the amount of jobs created by biofuel production or biofuel feedstock however the consultant did collect information on workers' wages planting biofuels in 2007 and child labour estimates. Earnings per day for workers (contract, seasonal, of cooperatives and large corporations) in 2007 all averaged $2.56. Migrant workers, generally sugarcane harvesters during the 6 month season, are paid by the amount of cane they cut. Wages per ton are typically $2.06 to $2.50 with a harvester cutting 3 to 4 tons per day, hence a harvester earning $6 to $10 per day [OIT/UNICEF, 2004].

Guatemala – Sugar cane production generates 1.3 permanent jobs/ha in Guatemala [Asociacion De Azucareros De Guatemala (AZASGUA)]. The consultant indicated that there is no data available for the number of jobs created by palm oil production.

Peru – For areas producing biofuel feedstock, the estimated average number of jobs/ha for male and female small farmers are as follows: jatropha: 0.36 job/ha; palm oil: 0.164 job/ha; and dry land sugar cane: 0.263 job/ha [SNV Latin America].

Others

USA – No data was found on the amount of jobs created by biofuel production/feedstock but noted that national annual urban and rural salaries increased from 2007 to 2008 ($30,000 and $31,000; $41,000 and $42,000 respectively). The most recent figures found on the US Department of Agriculture site state that in 2000/02, 1.9 percent of employed labour force worked in agriculture (2000) and; representing agricultural GDP (0.7 percent) as a share of total GDP (2002).

Ukraine - No information was found on the amount of amount of jobs created from biofuels. Fifteen percent of the total work force (22.3 million) is engaged in agriculture, [DOS, Ukraine].

Regional findings Asia:

Indonesia – While the data did not specify amounts of jobs created by biofuels, re-harvesting and harvesting jobs exist for both bioethanol, (derived from cassava) and biodiesel (from jatropha). Employment at the production level, however, only exists with biodiesel. [Information Book on Bio Ethanol, published by Ministry of Energy and Mineral Resources, 2007]. The consultant's data did not include the number of jobs attributable to specific biofuels. However, information did exist on the approximate amount of estimated child labour and more specifically child labour in agriculture. An estimated six percent (3.5 million) of the 58.8 million children between the ages of 5-17 are engaged in child labour; an estimated 57.2 percent (2.02 million) of the 3.5 million work in agriculture. There is no data to determine whether the percentage of child labour for biofuels feedstocks is higher or lower than for agriculture as a whole.

Malaysia – The consultant's baseline survey data from June 2010 indicates a 20+ hectare palm oil plantation employed nearly 68,000 local and 212,000 foreign migrant workers. Employees hired through contractors, numbered 8,400 and approximately 23,000, respectively. The majority of workers are hired to plant palm oil solely for vegetable oil and oleochemical production.

India - Data from the study indicates that areas producing biofuel feedstock generates 311 workdays/hectares (Planning Commission Document).

Pakistan –The consultant's data had no numbers for jobs created due to biofuel planting/ production. According to the data, there are no migrant workers in the agriculture sector; Animal husbandry takes precedence over the agricultural sector which consists predominately of private farmers. Farmers who reported being attracted to biofuel production were only interested if it earned more than their current crops.

Regional findings in Africa: In the African countries surveyed (Ethiopia, Malawi, Mozambique, Nigeria, Sudan, Tanzania and Uganda) statistics related to job creation are still nascent. None of the consultants reported on the number of jobs created by the biofuel industry. However, in nearly all of the targeted countries, more than 50% of the population is engaged in agriculture.

Ethiopia – No data is recorded on the number of jobs created by biofuel. However, demand from commercial companies for castor and jatropha seeds has led to small holders serving as contract farmers. Information from 2009 indicates that agriculture employs 85% of the population (80 million) or roughly 68 million individuals, [DOS, Ethiopia].

Malawi – While the consultant's data provided no information on the amount of biofuel job creation in Malawi, agriculture supports 85 percent [sangonet.com] of the 2010 population figure of 15,447,500 [DOS, Malawi]. According to Sangonet.com, smallholder farming (3.42 million households) contributes 75 percent of agricultural production.

Mozambique – The consultants' report does not provide an actual figure on the number of families working for wage labour on biofuel farms, but does state that more families are engaged in the practice as they lack the capital to comply with biofuel certification guidelines to establish their own farm [Lerner]. While Jatropha is projected to be more lucrative than traditional cash crops, the market does not yet exist in country [FAO, 2009]. Overall, 81 % of the work force (9.4 million est. 2006) is engaged in agriculture [DOS, Mozambique].

Nigeria - No information exists on the amount of biofuel job creation according to the consultant's report. 2009 figures from the State Department website however indicate that agriculture accounts for 33% of the country's $339 billion GDP, [DOS, Nigeria].

Sudan – No information was available on the amount of jobs created from biofuel, [DOS, Mozambique].

Tanzania – Data from the consultant's report indicates that Jatropha is only profitable when production is above 2000 kg/ha or it is intercropped with sunflowers. Only 2% of small holders receive credit at a high interest rate of 16-20% and other than seed collection, most of the jobs created are on the production side; oil extraction and soap production. According to workers personal accounts collected by the consultant, wages for jobs related to growing biofuel feedstock were governed by the minimum wage and remained the same for 2008 as 2007; large plantation workers earned the most ($3.5/day) with seasonal farmers and migrant workers earning the least ($1.3/day). Agriculture constitutes 80% of the workforce and 2010 figures estimate the mainland's population to be 41.8 million.

Uganda – Data stated that there was no information existed on biofuel job creation as biofuel production/biofuel feedstock did not yet exist in Uganda. Additionally, there was no information on the amount of people working in agriculture.

Job Creation Data Limitations

Across all countries surveyed, the lack of information on the number of jobs created from biofuel feedstock/production makes it difficult to discern the prevalence of biofuels and their impacts. The absence of figures for the approximate number of jobs in agriculture, GDP and other industries eliminates the possibility to create a proxy analysis.

Job Creation Data Recommendations

Biofuels currently play a nominal role as a source of labour production. In places like Malaysia, job creation at the plantation level could be an entry point for humane production of biofuels and feedstock. The example of sound standards by large scale corporations has the potential to attract EU (and other foreign investment) and create a model for smallholders and cooperatives to mirror [88] Countries like Malawi, where no information on monitoring systems of child/forced labour exists, might benefit from modeling a similar country context like Mozambique. The small African country may provide insight on what market mechanisms could work to ensure safe and human biofuel related jobs elsewhere on the continent. Aggregating information received on the status of forced/child labour by employer (e.g. plantation, small holder, domestic) would be helpful in determining if there is a relationship between earnings and working conditions. Based on this information, government could intervene in situations where most prevalent cases of worst cases of child labour take place. Policies initiated at the national level can be replicated at the regional and local levels.

M 4 Gender Issues

Gender issues in relation to feedstock production for biofuels concern women's rights, land tenure, and special benefits or encouragement of biofuels on women farmers and families. Positive or negative impacts on employment and gender will depend on crop types and business models for biofuels. This is highly useful for understanding more about the actual constraints of women in production in terms of access to land and legal rights. It is often noted, that while land tenure is an issue for both genders, and property ownership is a low priority in many agriculture situations, there are laws that protect land rights and ownership for women and farmers. There is however a lack of awareness about those laws and how to apply them to benefit the farmer.

Rights and responsibilities of men and women in land titling and inheritance procedures are largely reflected in agricultural activities related to biofuel and feedstock production. That is, if women were exempt from owning / inheriting / determining land use, they are likely to be less engaged than men in working the land or working beyond subsistence farming.

Regional findings in Latin America: Civil society is highly engaged and citizens possess labour rights in Latin America. Peru, for example, has the right to organize.

Brazil – Household biofuel usage: Growing biofuel feedstock for ethanol and biodiesel is considered a man's job so women are relegated to harvesting wood for household heating and cooking, [Brazilian Ministry of Environment]. **Woman land rights:** The constitution, reformed in 1988, guarantees men and women inheritance rights (whether women are married to their spouse or not), equal land title ownership and land use rights. That said, implementation of the law is slow and as the father is usually head of household, he normally inherits an estate and transmits his patrimony to the next generation. The majority of land is concentrated amongst

[88] Some data collectors noted that private investments had set examples for corporate engagement and follow good labou practices. It was noted that several companies (e.g. in Mozambique) which plan to export to the EU are aware of the EU legislation and sustainability criteria.

a few large land holders who do not recognize the land distribution laws in place as the demand for biofuel generation has raised land values.

Argentina – Household biofuel usage: Most households that can afford highly subsidized electricity obtained their lighting through the main power grid. Those who utilize generators mostly used diesel fossil fuel to power it. During 2006-2008 biofuels in Argentina were only used as transport fuels with natural gas serving as the predominant fuel used for cooking, [Bakovich, 2010]. **Woman labour:** Peak income earning period for labourers is age 35-49 with no information as it relates to gender. Men and women have equal inheritance rights and are reported to earn equal wages.

Bolivia – Woman labour: While in theory, women and men earn equal wages, women, especially those with increased levels of education, make less; resigned to work in the informal sector in urban areas and agriculture in rural areas, [ILO, 2007]. **Household biofuel usage:** There is no domestic biofuels production in Bolivia - of ethanol, biodiesel or vegetable oils - there is no household use of biofuels in the country. **Woman land rights:** Government is reforming the current land tenure law which limits how much land women can own. Tensions exist between native populations and commercial land owners as their definitions of land value differ: to indigenous peoples, land has purposes beyond production while companies are more concerned with the profit to be gained from selling the cultivated products.

Guatemala – Woman labour: In traditional cultures, predominately in rural settings, women manage the household while men engage in more labour intensive physical work, including agriculture. **Household biofuel usage**: There are no records of biofuels being used in Guatemala for household use as most of national production is for industry, exports and a minimal amount for research purposes, [Ministry of Energy and Mines]. **Woman Land rights:** Men and women have equal access to land titles and credit.

Peru – There is limited information on biofuel use at the household level. **Woman land rights:** Women and men benefit from equal access to land rights and credit.

Regional findings in Asia: Much of the feedstock are cultivated by women but without proper inputs, technologies or output markets. Awareness of women's rights and land tenure is low across the region. Despite serving as household manager, women have limited access to 1) land/land titles and in turn 2) credit as inheritance rights tend to align with men. Inheritance rights are governed by the agricultural reform acts, land ceiling acts, tenancy acts, as well as region specific religious norms. Land tenure issues exist throughout the region. Women are key producers and were identified to need improved cook stoves and work with biofuels at the household level. The significance of this is that women may be highly encouraged to create income generation from biofuels for export as well as for domestic use if they can gain business and market skills. Closely linked to land tenure issues are challenges that women continue to fact in their roles as agriculturalists and primary domestic producers of food. Rural women produce half of the world's food and, in developing countries, between 60 percent and 80 percent of food crops. New directions in development assistance and agricultural investments must recognize and support women's involvement in the full agricultural value chain from production to processing to marketing [Rekha Mehra and Mary Rojas, 2010].

Indonesia – No information was found on impacts of biofuel production or small farmers' biofuels use. Also, no information was found on gender issues for biofuel crops or household benefits from use of feedstock/biofuel production. **Woman land rights:** Indonesian men are more likely to inherit land than women, twice as likely, if they are Muslim.

Malaysia – No information was found on small farmer's biofuels use at the household level and/or gender issues for biofuel crops as not applicable. No information on land rights other than inheritance lies with men for Muslim women.

India – **Woman labour:** Despite the equal pay law, women are paid less for agricultural work than men. **Household biofuel usage:** women burn biofuels, but the fuel is poor and there is no health improvement as it is burned in traditional stoves [Sen, 2003]. Women comprise only about 10% of small farmers throughout the region and where they direct the use of income from productive land women tend to spend the money to meet the basic nutritional, welfare, and educational needs of their children and family. While profit can be gained from growing jatropha on degraded land, more money can be earned from working on non-jatropha farms. Money earned from working the land is spent to meet household needs. If women do work in agriculture outside the home, it is as hired labour for agriculture. **Woman land rights:** As agricultural land and in turn, access to credit, is usually in the name of male family members, women do not hold land titles. Women play an important but often unappreciated role in family farms and there is a recent trend of promoting self help groups and micro finance targeting women.

Pakistan – **Household biofuel usage:** Information from a 1998 census report stating that natural gas was used more for fuel than wood, suggests that women are enduring less physical burdens with respect to cooking and heating [Government of Pakistan census report, 1998]. **Woman land rights:** Although there is a law citing that women gain land through inheritance, in practice women are generally excluded from ownership. Men manage and cultivate land, hiring local women only for short term work.

Regional findings in Africa: There is a high prevalence of women working in feedstock such as sugar and palm oil, and production of biofuels is predominately for household use, especially improved cook stoves. Land titles/inheritance rights in Africa are tied to credit and predominately favour men though even very few men utilize their land rights and ownership to access credit or generate capital to meet their productive (Guest, 2004). While inheritance laws have traditionally favoured men, there are many laws in place that are more equitable for women but cultural barriers continue to dominate and access remains limited which also means access to credit and inputs is not sufficient to produce for export standards or volume. This is an opportunity that taken could encourage women in the production and marketing of biofuels for export and increasing employment and incomes along the value chain. While Liberia is not one of the selected countries, transformation of palm oil through simple technologies such as the Freedom Mill used to extract locally processed palm oil and transitioning to mechanization for the small holder (Winrock, 2007). Women's legal rights to land can be fostered through awareness raising campaigns, finding champions in local settings to promote and train communities in accessing titles; and public private partnerships to support women's small to medium enterprises and expert businesses.

Ethiopia – **Household biofuel usage:** Government and NGOs want to replace wood with jatropha seeds as an energy source to lessen the physical burden and air pollution burdens women bear [HOAREC/N, 2010]. The main biofuel crops cultivated in Ethiopia are jatropha, castor and sugarcane. Jatropha and castor seeds are currently not used as fuel in any part of Ethiopia (except in exceptional cases where the seeds themselves are burned on a stick to give off light). Ethanol was used by about 2000 households as cooking fuel in one refugee camp in the east of Ethiopia. Ethanol availability was a problem after 2008 and its use for cooking has ended. Fuel prices recorded from 2007-09 increased nominally and it is not certain how this effects the market for biofuel production/use. **Woman land rights:** No data was found on inheritance rights for men and women.

Malawi – No information was found on land rights, gender impacts or small farmer's biofuels use of biofuels/feedstock.

Mozambique – **Woman labour:** Men and women both work on plantations, but women at the farm level work longer, resulting in less leisure time. The increased income women receive (especially from plantation work) allows them to purchase and plant their own biofuel seeds and later sell for cash. **Household biofuel usage:** Of those who took part in pilot studies, a small number of households reported using biofuels for cooking. Other biofuel uses include jatropha oil to power lamps, and for soap production. Jatropha is grown as a hedge around fields to protect animals. Increased income from biofuel plantations has also led to improved nutrition and family health, [Peters, 2009]. While there are matrilineal and patrilineal inheritance rights, the constitution states that all land and inclusive natural resources belong to the state, [Ndege, 2007].

Nigeria – **Household biofuel usage:** Palm oil is used for cooking, ethanol is used for direct consumption and fuel wood is used for cooking in most households. **Woman land rights:** While women farmers are in the majority in Nigeria, the traditional inheritance law forbids women owning land in most parts of the country. The inability to own land translates into inability to access credit [www.nigeria-law.org].

Sudan – No information was found on gender impacts, small farmer's biofuels use or land/inheritance rights for men and women.

Tanzania - **Household biofuel usage:** No data was found on household benefits from biofuels, however it is assumed that women's health would improve if biofuels replaced wood as an energy source. Wood collection is physically taxing on women, but alternative cook stoves which operate via biofuel are too expensive to change this practice. More men work in the formal sector than women. They work less hours but earn more than women and have control (in the fields or via land titles/inheritance) of higher value crops than than women have. **Woman land rights:** Access to land is also linked to men as they are head of the household. A customary right of occupancy is inheritable and transmissible by will and land is usually passed to sons. Tanzanian law currently denies land rights to agro-investors, a decision that informants feel hampers Tanzania's economic growth. Interviewees suggested the need for a land management plan that implements and ensures benefit sharing for local inhabitants.

Uganda - **Woman land rights:** Little data exists from Uganda regarding biofuel feedstock/production. Women represent 80% of the production but only have access to 8% to ownership of the land [World Bank, 2005]. Because of the increase in food prices, the farmers involved in biofuels crops abandoned them and went back to producing food crops. No information was found on land/inheritance rights for men and women.

Summary

Across the country case studies, regardless of whether laws existed or not, the majority of women did not share equal inheritance rights as men. Additionally, land rights were linked to credit, posing another disadvantage for females in relation to males. Women who worked in agriculture at a subsistence level or outside the home had greater exposure to biofuels (whether it be in production or planting) and as in the case of Mozambique, were more likely to purchase and plant seeds for sale than women of the other targeted countries. More men were found to work in agriculture and processing related to biofuels in the target counties than women. Where women did work in the fields alongside men, they tended to work longer hours and after leaving the offsite facility or household farm, then performed work related to the home. At the household level data on the use of biofuel varied from no recorded use to use of palm oil for heat and cooking purposes and jatropha for vehicle transport or lighting. For the majority of the countries, biofuel use at the household level is still in the nascent stages and in some countries like Ethiopia and India, air pollution caused from burning jatropha can equally as hazardous to one's health as traditional wood burning.

M 5 Involvement of small farmers in producing biofuel feedstocks

This section provides an overview on how smallholders and average citizens are affected by biofuels production in their respective countries. A qualitative assessment of small farmer encouragement[89] based on quantitative data, when available, on gross margins ($/ha) for biofuel crops vs. other crops and access to capital.

Regional findings in Latin America – The major source of biofuels is sugar cane, soy and jatropha. Small farmers, including women farmers, can be encouraged to change from sugar cane production to jatropha which typically does not reflect a high incidence of child labour and can be more environmentally sensitive. In Latin America, large sugar exporters to the EU (Brazil and Bolivia) are both identified as using heavily child labour and forced labour which is harmful to the producers and farmers and violates their codes of conduct codes of conduct. Efforts are being made to encourage biofuels in jatropha and work in partnership with the governments to invest private funds in inspections, awareness-raising, and good labour practices in sugar and jatropha.

Brazil – The biodiesel market in Brazil is subsidized and government mandates that large companies buy 30% of feedstock from small holders, (Brazilian Ministry of the Environment)[90]. Some large producers have taken issue, feeling that their demand is not being met while others are not as concerned as even with the low interest loan (2%) the government offers small holders, high production costs often outweigh profits. Sugar cane agricultural input investment for ethanol production decreases each year, but it is a recurring cost, that when compounded with a more expensive capital investment - $3000-4000/ha vs. other oilseeds $400-$2000 – and a fluctuating profit margin, engagement is not enticing, [Cooperativa dos Produtores de Cana Porto Xavier Ltda (COOPERCANA)]. Farmers that do produce biofuel feedstock crops tend to be small holders who have been contracted by sugar mills with distilleries to produce sugar for ethanol or an oil crop such as soy or cotton seed for biodiesel producers. Moreover, soy and cotton are not produced only for biodiesel feedstock. Based on her field experience in rural Brazil, Dr. Daniele Cesano's opinion is that soy oil production is a small percentage of total soy production. According to the consultant's interview with Cesano, much of the profit derives from the soy cake used to make animal feed or for human consumption. The same applies for cotton, which yields oil, also supplying feedstock for the textile industry. Brazilian Biodiesel Program (PNPB) is a model for a mature market with established government policies and procedures in place (e.g. impunity/incentives/mandates to encourage inclusion/shared economic benefits).

Argentina – Argentina uses significant agricultural land for livestock, i.e. cattle raising and animal feed; biofuel production from soy is a value added income stream. The most significant actors engaged in biofuel production are large

[89] Encouragement was a variable used in the study to indicate social and economic incentives for growing feedstock for biofuels. It includes, policies, access to land, industry contributions, etc.

[90] www.mme.gov.br

companies whose product is destined to a foreign market. Most agriculture production is done on land rented by farmers. The owner either benefits from the rent or a portion of the production and agriculture inputs given up front to the renter [Hilbert 2010].

Bolivia – No lands at the small or large farm level are dedicated to biofuel production as sugar cane, sunflower and soy are all agro-industrial crops. Moreover, the data indicated no encouragement for other biofuel crops or facilities in place to process the feedstock despite jobs in oilseeds (from soy and sunflower).

Peru - Despite existing government programs promoting biofuel crops/production, it is not clear from the data if small holder farmers are encouraged by the prospect of biofuel production. Farmers only expressed to researchers from the National Agrarian University that they wanted to be assured there will be a market for their entire crop. Most work comes from working on private sector farms and families that do have land do not use their land or rent it out. While market conditions are friendly to large-scale farmers/plantations, there are no government incentives in place to scale up and engage mid-level farmers.

Guatemala – While there is a large capital investment ($3,800) for establishing and maintaining biofuel plantations ($800 - $1,200), palm oil producers in the north, encourage small to medium land holders - via technical assistance, credit, future prices- to switch production to palm oil, [Interview with GREPALMA and AZASUGA]. Similar incentives are offered to farmers by sugarcane mills.

Others

United States – Small farmers receive federal incentives (via tax credit and grants) to produce biofuels. Improved Energy Tech loans are given to projects that reduce air pollution and green house gases and support early commercial use of advanced technology like biofuels and alternative fuels. Animal farms generate energy which supports operations and contributes to the national grid.

Ukraine - The consultant's report contained no information on farmer encouragement of biofuel feedstock/production. Nevertheless, some incentives are provided for bioenergy crops production.

Regional findings in Asia - Throughout the region, jatropha is attractive to farmers as it is less labour intensive than traditional cash crops. Jatropha, castor, sugarcane, palm oil are also viable feedstock options. Land and encouragement of farmers in terms of employment is with contract farming or agricultural subsidies.

Indonesia - Access to credit exists for palm oil and sugar cane, however small businesses do not have the required collateral. Additionally, despite a 10% interest rate offered specifically for plantation farmers, only 10% of farmers take advantage of the offer. Government incentives via credits, policy initiatives (making it mandatory to intercrop) and subsides encouraged small holder investment and crop conversion to biofuels. Although biofuel production encouragement as renewable energy production exceeds fossil fuels production, due to increased costs, decreased government funding and infrastructure, biofuel slowed production from 2007-2008, [Ministry of Agriculture; Biofuel Development Team].

Malaysia – No data was reported of farmer encouragement for biofuel/crop production via government incentives or opportunity costs related to engaging or transitioning to biofuels. More contextual information such as GDP and basis of the economy would be useful.

India - Seventy percent of farms are small and marginal (less than 1 ha). Fair trade labelling has started in India on a small scale and farmers have certified over 300,000 hectares across all crops [Srivastava R., 2005]. In states like Chattisgarh, where jatropha is being promoted extensively by the state government (over 500 mill seedlings were distributed in 3 years leading up to 2008), farmers are mostly growing on bunds or underutilized lands, with some displacement of minor millets. According to the consultant's report, for incentives, some concessional loans have been made for raising Jatropha plantations with a repayment period of 4 years.

Pakistan – Animal husbandry takes precedence over the agricultural sector which consists predominately of private farmers. Farmers have access to credit from many financial institutions and from money lenders which they utilize for all crops. Still, farmers who reported being attracted to biofuel production were only interested if it earned more than their current crops [Government of Pakistan census report, 1998]. There is limited recorded data on the demographics/characteristics of the Pakistani agriculture workforce to suggest why employment, and child labour, exists for the production of ethanol and not additional biofuels (such as palm oil and cotton).

***Regional findings in Africa*-** Companies and organizations are investing in feedstock such as jatropha, palm oil, sugarcane and cassava for farmer encouragement. This approach could potentially lead to decentralization and democracy for developing rural economies. In a study on Mapping Food and Bioenergy in Africa (Diaz-Chavez, et al, 2010) it is noted that by 2004, 400 million *Jatropha curcas* L. trees were planted on 45,000 ha in North West Province of the Republic of South Africa. The South African Government then called for a moratorium on further commercial planting until it was convinced that (a) the plant was not at risk of becoming an invasive alien species, and; (b) its toxicity does not pose an environmental and health risk. Commercial plantings were given the go-ahead in 2007. Some companies have invested in jatropha in Africa." Additional opportunities for African countries may lie in jatropha as a replacement of sugarcane and palm oil.

Ethiopia – The Department for Biofuel Program Coordination of the Ministry of Mines and Energy revealed that 65 companies are registered to produce biofuels, but only 10 do so. Both the Ethiopian government and NGOs support replacing wood, which is a time and health burden upon women, with seeds as a source of household energy [HOAREC/N, 2010].

Malawi – Bio Energy Resources Ltd (BERL) is applying for biofuel certification but overall the lack of data from the consultant creates an uncertainty as to which biofuels are produced and if there is a large scale demand.

Mozambique – While farmers lack capital to comply with certification guidelines, microfinance institutions (MFIs) are providing credit to small farmers. Traditionally only engaged in subsistence farming, more women, and their families are working for wage labour on biofuel farms. The high level of public participation and established SME presence already providing agricultural inputs (pesticides) and services (machinery) are two important components for scaling up biofuel production, [Interview with Center for Promotion of Agriculture (CEPAGRI)].

Nigeria – Cassava seems to yield a higher profit margin for biofuels than for creation of other products. Government encouragement of cassava production for industrial use has led to greater land dedication – especially among women – to cassava for ethanol production. According to the consultant's data, while the state offers incentives to investors in the form of tax breaks, waived import fees and access to land, access to credit is low for small farmers, most of whom cannot afford the 6-25% interest rate. Some banks have started offering loans via a Federal Government program [Kwara State Government].

Sudan – No information was found on small farmer encouragement of biofuel production/planting.

Tanzania - Small farmers can be encouraged to plant biofuel if the price is good and the market is more reliable than other cultivated crops. No information existed in the consultant's report on the price per hectare for feedcrops and biofuel production, however based on gross margins for biofuel crops vs. other crops, sugarcane for ethanol yielded more than sorghum or cassava. According to the consultant's report, with respect to biofuel production, palm oil production yielded more liters per hectare (2,500 – 6,000) than jatropha, (400-2200). Intercropping in biofuel production is an incentive for female small holders as they can use the profits they earn from selling the jatropha they grow to buy food.

Uganda – There is no data on encouragement of farmers to engage in biofuel production. While there is interest in biofuel production, high food costs force farmers to devote land for subsistence farming.

Summary

The biofuel market in many of the countries studied is driven by foreign demand. According to Goldman Sachs[91], jatropha and sugar cane are the most efficient crops for biofuel however these crops are produced in the southern hemisphere and trade barriers prevent a free flow to other parts of the world. We see from the baseline that Africa and Latin America are the largest producers of these biofuel feedstocks and crops they still remain a small amount of the proportion of overall agricultural production.

In the majority of the studied countries, biofuel production is an emerging market and has not yet gained traction as a viable stand-alone economic driver. Also, while data indicates that there are varying degrees of farmer incentives (in the form of low interest rates for inputs, seeds and machinery) growing feedstocks for biofuels is often not as attractive as growing similar feedstocks for other products. For instance, in some countries, sugarcane for production of beverages has a greater share of the market than production of sugar cane or molasses for ethanol. There is also little reference to certification or supply chain issues which indicates two important opportunities to positively impact practices in biofuel supply chains.

M 6 International Labour Organization (ILO) Conventions; the Renewable Energy Directive (RED) Requirements and Voluntary Standards

Article 17.7 of the Renewable Energy Directive (2009/28/EC), states amongst others report whether countries, that are a significant source of raw material for biofuel consumed within the Community, have ratified and implemented each of the following Conventions of the International Labour Organization:

- Convention concerning Freedom of Association and Protection of the Right to Organize (No 87);
- Convention concerning the Application of the Principles of the Right to Organize and to Bargain Collectively (No 98);
- Convention concerning Equal Remuneration of Men and Women Workers for Work of Equal Value (No 100);
- Convention concerning the Abolition of Forced Labour (No 105);
- Convention concerning Discrimination in Respect of Employment and Occupation (No 111);
- Convention concerning Minimum Age for Admission to Employment (No 138);
- Convention concerning the Prohibition and Immediate Action for the Elimination of the Worst Forms of Child Labour (No. 182)[92].

While many developing countries have ratified the above Conventions, signing into law, enforcement, and implementation are considered steps towards meaningful

[91] Goldman Sachs http://www.gceholdings.com/pdf/GoldmanReportFoodFeedFuel.pdf

[92] Further research should include reference to Convention 184 which concerns Safety and Health in Agriculture (ILO Convention 184 2001).

implementation and less likely to be in place in developing countries[93]. Among the major challenges is prevalence of child labour in agriculture and lack of awareness among communities, parents, and employers of the legal parameters of minimum age for working and hazards associated with working children 5-14 and for legally working children 15-17. For future measurement of child labour in the target countries, indicators such as lists of hazards, National Legislation and Action Plans against child labour, and compulsory education are elements that can start to understand and enforce good labour practices. Contract farming, especially of migrants, (and often trafficking occurs seasonally) can be a hidden form of child labour where parents bring their children to the fields to work to assist with meeting quotas.

In addition, "an ILO supported survey on child labour, which was implemented by Statistics Indonesia, indicated that around 1.7 million child labourers aged 5 to 17 years old in Indonesia in 2009. Around 750,000 out of 1.7 million children are those in the age range of 15 to 17 years old. While minimum age for working in Indonesia is 15 years old, these children fall under the category of child labour because they are working in hazardous works. Due to the social economic factors, there are still quite a lot of children aged 15 to 17 years old in the work force and many are working in hazardous conditions. One of the approaches in eliminating hazardous work for children under 18 years old but already reaching the minimum age for working is by improving working conditions or application of occupational safety and health (OSH) principles. Application of OSH standards becomes a practical way to reduce child labour" [ILO Jakarta, 2011].

Table 155 (below) captures the status of ILO ratification in the selected countries. Topics are based on key issues for areas identified for the project and data sources for obtaining information to both assist in understanding baseline situations and impacts of biofuels. Sources of data for the monitoring methodology are identified. Below is a brief summary of findings per region and country.

[93] For example, President Clinton signed the ILO Convention No 182 in December 1999, following its ratification by the US Senate on November 5, 1999. http://www.asiantribune.com/news/2010/07/12/united-states-violates-ilo-convention-182-allowing-child-labor-%E2%80%93-investigative-report

Table 155. Country participation in International Labour Organization (ILO) conventions[94] relevant to child labour and forced labour

International protocols relevant to child labor and forced labor	Central/South America					Africa							Asia					
	Argentina	Bolivia	Brazil	Guatemala	Peru	Ethiopia	Malawi	Mozambique	Nigeria	Sudan	Tanzania	Uganda	India	Indonesia	Malaysia	Pakistan	Ukraine	USA
Forced Labor 1930 (ILO Convention 29)	♒	♒☠[1]		♒☠[1]	♒☠[1]	♒☠[1]	♒☠[1]	♒☠[1]	♒	♒☠[1]	♒☠[1]	♒☠[1]	♒	♒	♒	♒	♒☠[1]	♒☠[2]
Freedom of Association and Right to Organize 1948 (ILO Convention 87)	♒	♒☠[1]		♒☠[1]	♒☠[1]	♒☠[1]	♒☠[1]	♒☠[1]	♒		♒☠[1]	♒☠[1]		♒	♒	♒	♒☠[1]	♒☠[2]
Right to Organize & Collective Bargaining 1949 (ILO Convention 98)	♒	♒☠[1]	♒	♒☠[1]	♒☠[1]	♒☠[1]	♒☠[1]	♒☠[1]	♒	♒☠[1]	♒☠[1]	♒☠[1]		♒	♒	♒	♒☠[1]	♒☠[2]
Equal Remuneration 1951 (ILO Convention 100)	♒	♒☠[1]	♒	♒☠[1]	♒☠[1]	♒☠[1]	♒☠[1]	♒☠[1]	♒	♒☠[1]	♒☠[1]	♒☠[1]	♒	♒		♒	♒☠[1]	♒☠[2]
Abolition of Forced Labor 1957 (ILO Convention 105)	♒	♒☠[1]	♒	♒☠[1]	♒☠[1]	♒☠[1]	♒☠[1]	♒☠[1]	♒	♒☠[1]	♒☠[1]	♒☠[1]	♒	♒		♒	♒☠[1]	♒☠[1]
Discrimination in respect of Employment and Occupation 1958 (ILO Convention 111)	♒		♒☠[1]	♒☠[1]	♒☠[1]	♒☠[1]	♒☠[1]	♒☠[1]	♒	♒☠[1]	♒☠[1]	♒☠[1]	♒	♒		♒	♒☠[1]	
Minimum Age 1973 (ILO Convention 138)	♒	♒☠[1]	♒	♒☠[1]	♒	♒☠[1]	♒☠[1]	♒☠[1]	♒	♒☠[1]	♒☠[1]	♒☠[1]		♒	♒	♒	♒☠[1]	♒☠[2]
Worst Forms of Child Labor 1999 (ILO Convention 182)	♒	♒☠[1]	♒	♒☠[1]	♒	♒☠[1]	♒☠[1]	♒☠[1]	♒	♒☠[1]	♒☠[1]	♒☠[1]		♒	♒	♒	♒☠[1]	♒☠[1]

♒ = black box signifies signed and ratified; a blank cell signifies no information; unclear if signed or ratified

[1] Ratified and no information on whether signed [2] listed as not signed and not ratified

Of the countries surveyed for this report, four are identified as producing sugar cane (Bolivia, Brazil, Guatemala, Pakistan, and Uganda) and two as producing palm oil (Malaysia and Indonesia) using child labour and/or forced labour. In addition, under a US Executive Order in 2010, sugar cane was specifically identified in Bolivia as a product that was determined to be produced with forced or child labour. It is not clear whether this sugar cane is used for biofuels, and more research needs to be done and data collected to determine which regions produce sugar cane that is converted or exported to the EU for biofuels [USDOL TVPRA List, 2010].

Regional findings in Latin America: Most ILO Conventions are signed and ratified for each country surveyed (Argentina, Bolivia, Brazil, Guatemala and Peru). The consultant's data indicates enforcement is weak throughout the case-study countries with the exception of Brazil that has policies and education programs to eradicate child labour – especially in the informal market [ILO (OIT), Brazil]. In all cases, verification data was not available at the country level for small holder farms. Child labour and forced labour is prevalent for landless groups in Brazil, Guatemala, and Bolivia, harvesting sugar for ethanol.

[94] We requested information on whether the convention had been signed and ratified however there was little indication that the conventions were signed then later ratified. We however note the results though with little meaning, the most important element is if it is being implemented.

Brazil - Most of the child labour issues on biofuels production have focused on sugar cane ethanol. Data from 2002 indicate there are 3 million children (down from 5.4 million in 1994) with 1.65 million in agriculture with 35% paid, [ILO (OIT), 2004] Concern over child labour prompted a program in 2007 to certify biofuels with good social standards. For 10 years Brazil has contract laws to protect migrants with benefits and health care and minimum salaries for workers. Periodic inspections from the MOL enforce these social practices. As a country with a track record of implementing policies that influence good labour practices with biofuels, Brazil should be studied and the sustainability of these practices monitored. Worker contracts have always been in place and are now being adhered to as a result of increasing inspections. While there may be incidences of child labour related to biofuel feedstock/biofuel production, Bonsucro (previously BSI) and other private standards are in place in Brazil (Greenergy and Sekab) which monitor for labour. The Basil convention, FLO and ISEAL[95] are other mechanisms embraced by the Brazilian government to prevent child labour in biofuels [ISEAL Alliance, 2010].

Argentina – ILO Conventions are signed and ratified in Argentina and in 2000, the government created the National Commission for the Eradication of Child Labour (CONAETI), a body that coordinates, evaluates and monitors efforts to prevent and eradicate child labour [ILO/OTI]. The government recognizes registered unions and awards rights to members of those unions whose union has yet to be registered. While the legal working age is 18 years, the Ministry of Labour (MOL) cites 20% of overall child labour instances affecting those 14-17 years of age, with 14-17 year olds representing 14% of child labour in agriculture.[96] Soybean seeds, of which only 18% yields oil, are Argentina's only listed feedstock/biofuel production. Per comments from the consultant, as GDP depends greatly on agricultural production – especially seasonal labour from migrants and children - information cited on the MOL website is not considered 100% reliable and information on child labour outside of the government public website is obscure. With respect to monitoring child labour laws, the MOL provides a public website[97] where violations of child labour can be reported.[98]

Fair trade labeling and CSR certification is ensured via the NGO National Registry of Rural Workers and Employers (RENATRE), which registers employers and rural workers and has branches extending to all provinces. CONAETI which monitors child labour via record keeping serves to prevent the development of rural forced labour and offers a business membership option for those who want to join the campaign to eradicate child labour. Companies' compliance with contracts and levels of OSH, such as pesticide exposure and provision of safety materials, is only determinable via a specified audit.

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[95] http://www.isealalliance.org/news/update-launch-of-the-iseal-impacts-code-this-month
[96] http://www.oit.org.ar/documentos/ti_en_argentina.pdf, http://www.dol.gov/ilab/regs/eo13126/main.htm
[97] http://www.trabajo.gob.ar/left/estadisticas/bel/belDisplay.asp?idSeccion=1&idSubseccion=2
[98] http://www.trabajo.gov.ar/left/estadisticas/otia/index.asp?pregunta=2

Bolivia – Per the ILO website, and NATLEX, the database of national labour, social security and related human rights legislation, ILO Conventions are ratified. The consultant's data states signing of the conventions is not applicable. Workers were once able to form unions but government later limited organizing rights in response to limited government oversight mechanisms (no courts/regulations) [ILO website, NATLEX, Bolivia Ratification status of up-to-date conventions]. As government bureaucracy tends to be a hindrance to resolving issues between workers and employers, parties settle disputes over pay outside of traditional systems. The ILO lists sugarcane, a main ingredient in the production of ethanol, as a commodity produced by forced labour and child labour although it is difficult to link it to the sole production of ethanol for biofuels. The MOL recognizes and is committed to a more robust response to decreasing the occurrences of debt bondage of rural migrants, predominately children, who harvest sugarcane, however the National Plan of Eradication of child labour contains no language pertaining to mining, sugarcane and urban work. While the legal working age is 14, (with an option to apprentice at age 12) whereby children aged 14-18 need government or parent permission with the employer awarding time off during school hours, the law is poorly enforced, [DOS 2009 Human Rights Report: Bolivia]. With respect to child labour, the Organization of American States (OAS) and USDOL recorded the following statistics: In 2009, 313,529 children were estimated to be engaged in child labour, 315,630 estimated child labour in agriculture in 2002; and 21,000 individuals engaged in forced labour in 2003.Data indicates incidences of poor safety standards and general poor conditions in sugar mills, soy and sunflower production. The consultant lists five large privately owned Bolivian sugarcane mill as companies which comprise the sector. With respect to contract and safety conditions, conditions are still poor for labourers; contract agreements are verbal, often through an intermediary leading to debt bondage, [Pastoral Land Commission & Network for Social Justice and Human Rights, Agroenergy]. Moreover, migrant labourers live in cramped, poorly constructed camps, receive little to no medical treatment and there is no protection for children who are usually the ones to apply pesticides. Despite the dependence upon migrant harvesters for labour, data from the consultant indicates that government transparency and coordination with the private and public sector to limit child labour appears to be increasing. In 2010, government and sugarcane companies agreed to end child labour, and the Bolivian Foreign Trade Institute (IBCE) created the Triple Stamp initiative which conducts audits for businesses, ensuring they are free of child labour [Forest Stewardship Council, members list]. Triple Stamp provided its first certification in 2010. Individual sectors have undertaken CSR initiatives, most notably the mining companies and the forestry concessions.

Guatemala - Per the ILO website, ILO Conventions are ratified, but the consultant's data states signing of the conventions is non-applicable. The legal working age is 14 with 63% of child labourers working in agriculture, 1 million of which are between the ages 7-14, [MOL, Guatemala 2006]. While there is no data on the status of forced labour, sugarcane, from which ethanol is produced, is on the ILO's list of goods produced by child labour, [USDOL, 2009[99]] The consultant indicated that no data existed for palm oil or other crops with respect to risk associated with ILO standards as a biofuel feedstock/in biofuel production.

Peru - All ILO Conventions except Convention 111are ratified with only two (Convention 138 and 182) of the nine indicated as being signed per the ILO website (Peru) and Peruvian Law Information System. No data is listed on the consultant's survey for levels of risk associated with ILO with sugar cane for ethanol, palm oil or other biofuels. No data was given for the legal working age and the government does not consistently conduct labour inspections of organizations or monitor previous offenders, tending only to enforce the law when alerted of violations [ILO]. That said the Peruvian MOL is striving for greater transparency through creation of the National Prevention Committee and Eradication of Child Labour (CPETI). CPETI aims to reveal its list of Worst Forms of Child Labour (WFCL) on its website, creating guidelines of what constitutes a good working environment and working with other agents to evaluate and monitor the actions and efforts for prevention and progressive elimination of child labour.[100] No specific names of large multi-nationals involved in biofuel production were mentioned, however the companies are said to benefit local companies with a supply of hardware and grocery stores and overall agricultural health. Per the research team and an agronomy professor/specialist in energy crops at the National Agrarian University, employers provide contracts and benefits, with the private sector offering medical, sanitary and health facilities. As it pertains to biofuel certification, no child labour is used in biofuel production or feedstock crops as a result of the "together" program," a lending program designed to help rural women find opportunities for personal development in Peru.

Others

USA – Per the ILO website, all Conventions are ratified and the consultant indicates that none have been signed. Weak child labour inspection/monitoring at the farm level and cumbersome policies make it difficult to track labour practices, especially at the port level, [Human Rights Center, University of California, Berkeley] Of the biofuel crops listed (sugar cane for ethanol, palm oil and soybean oil), sugar cane for ethanol was categorized with a low risk for forced/child labour, [ILO-IPEC/USDOL] Worker contracts and OSH standards were in place, however there was no data on any certifications for biofuel production in the US.

Ukraine - While most of ILO Conventions have been ratified, there is no data indicating as to whether they have been signed. The ILO-IPEC/USDOL indicates information pertaining to the level of risks associated with ILO standards of crops as a biofuel feedstock/ biofuel production as non-applicable. Ukraine adheres to the EU legislations on working conditions and other social aspects however, there was no data listed for any other categories.

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[99] http://www.dol.gov/ilab/programs/ocft/PDF/2009TVPRA.pdf
[100] http://www.mintra.gov.pe/mostrarContenido.php?id=335&tip=333

Regional findings Asia: According to the ILO and International Trade Union Confederation (ITUC) websites, most ILO Conventions are signed and ratified for India, Indonesia, Pakistan and Malaysia. Most labour laws are recorded but not enforced, especially contract labour laws and child labour prevention in agriculture [ILO (Pakistan) 1995, National Human Rights Commission Annual Report (India) 2001-02]. Specific data on levels of forced and child labour in the countries in biofuel crops or feedstocks could not be found by the consultants. However, information did exist on the approximate amount of estimated child labour and more specifically child labour in agriculture in general. For countries where there was data (India and Indonesia), more than half of the child labour population (68% and 57%, respectively) were engaged in work in agriculture.

Indonesia – All but ILO Convention 111 (Discrimination in Respect of Employment and Occupation 1958) have been ratified. Private sector workers are the only worker-type allowed to unionize and must register with the government to be recognized. Language on equal pay for males and females is not in the current law and there is no data on monitoring or inspecting forced or child labour law. That said, while 15 is the minimum working age, employers can employ children aged 13-17 who work for 3 hours a day as long as they can ensure that this work does not occur during school hours.[101] Jatropha is the only biofuel crop, with no data for its level of risk associated with ILO issues, or those pertaining to palm oil or sugar cane as biofuel crops or for biofuel production. Workers receive contracts, have access to sanitation facilities, and medical access, [Labour Law No. 25; Indonesia, 2007].

Malaysia – While all but three ILO conventions (Freedom of Association and Right to Organize, Equal Remuneration 1948, Abolition of Forced Labour 1957, and Discrimination with respect to employment, 1958) are ratified in Malaysia. There was no information from the consultant on whether any have been signed. The government has also yet to comply with commitments made between 1996-2001 to relinquish restrictions on trade unions and address prevalence of forced/child labour and discrimination. There was a low risk of forced/child labour related to palm oil cultivation and processing and no reported data for other potential biofuel crops such as sugar cane.[102] Fourteen is the legal working age and no data exists on whether there is forced labour in any sector. There is a fairly advanced level of democracy and public participation in Malaysia. Data indicates that private sector organizations are "mostly" compliant with labour laws and that "most local companies" purchase biofuels or benefit from international companies purchasing feedstock crops. Information gathered from the consultant states that plantation unions negotiate contracts with companies on behalf of seasonal harvesters and while plantations provide medical services, workers are usually exposed to pesticides with inconsistent access to safety precautions/materials. The survey tool indicated that stakeholders of Roundtable on Sustainable Palm Oil (RSPO) are engaged in certifying that palm oil is made without forced/child labour.

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[101] Since this data was sourced, the USDOL TVPRA 2010 has cited Indonesia as a country that practices child labor in oil (palm). Further monitoring of this situation is recommended.

[102] Since this data was sourced, the USDOL TVPRA 2010 has cited Malaysia as a country that practices Forced labor in oil (palm). Further monitoring of this situation is recommended.

India – Of the eight ILO conventions in this study, none are signed and only three are ratified; Forced Labour 1930, Equal Remuneration 1951 and Abolition of Forced Labour 1957. While India practices a high level of democracy, the country has only just passed legislation on compulsory education for all. Government oversight is absent and monitoring of individuals who have been freed from bondage does not exist [National Human Rights Commission Annual Report, 2001-02]. In addition, lack of reported statistics makes it difficult to assess the pertinence of laws in place. The baseline data indicates that there is little enforcement of the minimum age law due to lack of resources and the complexity that different age laws for different sectors presents. Moreover, the highly bureaucratic processes make it difficult to systemize and there is no consensus of what qualifies as slave-like or horrible work conditions. The legal working age is 14 and data on the level of child labour in India indicates 8.9 million children and 6 million, or 68.14%, work in agriculture. As jatropha is only grown by small scale farmers who tend to be hired informally, there is no record of working conditions for this crop. Fair trade labeling occurs on a small scale in India for cotton and rice. According to data collected from the consultant, ECOCERT-India, the country's only fair trade crop certifier has 170 clients, ranging from processors, exporters', farmer groups and individual farmers, and has certified more than 300,000 ha across all crops. The consultant states "this [the practice] could be extended to jatropha, etc. but [there are] no reports of jatropha plantations…as the market is nascent and mostly domestically driven."

Pakistan –All ILO conventions have been ratified, the laws have limited impact on the extent of forced labour throughout Pakistan. Sugar cane and cotton are mentioned on the US Department of Labour (DOL) list of goods produced by child labour, with mention of sugar cane for ethanol being produced by debt bondage, a form of forced labour, where labourers are burdened with an initial debt upon employment that far exceeds their repayment abilities [ILO 1995]. Wheat as a biofuel crop has a low/medium level of risk associated with ILO issues, but the government conducts limited labour inspections in companies producing sugar cane, has tight control over small companies' unionizing rights, and minimally enforces the minimum wage law – especially for contract labourers, who earn less than unskilled labourers and whose rights are not accounted for by the labour law. Additionally, data indicates that all workers are subject to poor safety conditions and limited access to health insurance. There is limited recorded data on the demographics/characteristics of the Pakistani agriculture workforce to suggest why employment and child labour exists for the production of ethanol and not palm oil.

Regional findings in Africa: Most ILO Conventions have been signed and ratified for each country surveyed (Ethiopia, Malawi, Mozambique, Nigeria, Sudan, Tanzania and Uganda). Data indicates that only three of the eight study countries have mechanisms in place to gauge the amount of child labour in agriculture [ILO (Mozambique), ILO, Nigeria Daily-Tribune (Nigeria) and ILO-IPEC/USDOL (Tanzania)]. Other than in Tanzania and Mozambique [ILO-IPEC/USDOL] data on the level of risk associated with ILO issues by biofuel were not available at the country level since most occurrences were noted to occur at the community and small holder level [103].

Ethiopia – All ILO Conventions in Ethiopia have been ratified but there is no data on any being signed, or on laws in place to prevent child labour in biofuel production. Fourteen is the legal working age and while companies do use contracts to hire labourers there have been incidents of employers not paying contract farmers the agreed upon pay.[104] Information did exist on the approximate amount of estimated child labour and more specifically child labour in agriculture. 2006 records from the Central Statistical Agency of Ethiopia indicate 4,836,335 (children aged 10 to 14 years) were engaged in child labour in 2005 with 4,412,254 rural children estimated to be working in agriculture. Workers are exposed to pesticides and receive protective gear but the country study indicates that there are no certifications ensuring work is free of forced labour/child labour. No information was reported on wages or number of hours that men and women work. There was also no mention from the consultant's data on whether there are any risks associated with ILO issues in sugar cane for ethanol, palm oil or any other biofuels.

Malawi - All Conventions have been ratified in Malawi, but there is no data on any being signed. Labour inspections do enforce the minimum age law of 14. No indication of forced labour or child labour monitoring existed at the farm level inspections. The consultant's data indicated no levels of risk associated with ILO issues for sugar cane for ethanol and not applicable for palm oil. Forced labour migrant practices while acknowledged, are indicated as not specific to biofuels or biofuel production. No information reported on wages or number of hours worked men and women worked.

Mozambique - All ILO Conventions have been ratified but there is no data on any being signed. The labour law has structures in place for monitoring forced labour and child labour but it is noted as being unclear. Private sector compliance to labour laws is monitored only for an organization's first two years of existence. While as member of the South African Development Community (SADC), Mozambique agrees to "create an enabling environment consistent with the ILO Convention on the Minimum Age of Entry into Employment (No 138) or any other relevant international instrument,"[105] the most recent document from the ILO in 2000 indicates that Mozambique was in the process of ratifying Convention 138. Says Marc Schut of the Center for Promotion of Agriculture (CEPAGRI), if after two years CEPAGRI finds the project to violate the law, the company's investment rights are revoked. The law stipulates workers have contracts however there is no data on whether this is adhered to. Nor is their data on whether or not workers receive safety gear when exposed to pesticides. Some employers however offer latrines and medical facilities [Ines Chalufo, Ministry of Energy, biofuels officer]. Mozambique has a National Policy

[103] The data received indicated that ILO Convention labor issues were not disaggregated at the national evel, not separated out between feedstock for fuel and feedstock for food. There was more information at the local level in terms of available data.
[104] www.allafrica.com
[105] SADC, Article 7; http://www.sadc.int/index/browse/page/171

and Strategy for Biofuels with structures in place that provide for fair trade and Corporate Social Responsibility (CSR) and companies engaging in biofuel production or feedstock trade (export or import) are aware of the EU legislation and sustainability requirements. Private companies are also required by the state to have funds budgeted to enhance Mozambican education infrastructure, health and electrification. There were no reports on the level of risk associated with ILO issues of sugar cane for ethanol, palm oil or other fuels.

Nigeria – Despite all ILO Conventions being signed and ratified in Nigeria, the survey cites violations of the law allowing workers to organize and form unions [ILO website; WebMills]. Sugar cane and cassava for ethanol and palm oil all measure low with respect to risks associated with ILO issues as biofuel crops with minimal incidence of forced labour in sugar cane for ethanol production. The legal working age is18 with15 million children estimated to be engaged in child labour [Cleen Foundation Nigeria; ILO study/UNICEF Report on Nigeria]. There was no information listed for the number of children employed in agriculture. While no data existed of certification for farms complying with fair trade labeling and CSR, most private companies engage in some form of CSR, and agents monitor for compliance with forced labour and child labour in all sectors. The National Agency for the Prohibition of Trafficking in Persons (NAPTIP) ensures no forced or child labour is in place with the government probing into poor labour inspections and monitoring. Instances of democratic processes are increasing at the federal, state and local levels. With respect to existence of contracts and levels of occupational safety and hazard (OSH), neither is consistent in terms of delivery. The data from the consultant suggests the government is inconsistent in reporting the realistic amount of forced/child labour.

Sudan - All ILO Conventions have been ratified [WebMils; ILO website] but there is no data on any being signed. Moreover, data from the consultant indicates there is no information on enforcement or compliance or what if any biofuel production exists for sugar cane, palm oil or other feedstock. Benzene, charcoal and fuel were listed as main fuel sources. No data was provided regarding wage, hours worked, working conditions or fair trade certification or companies' compliance with fair trade/humane biofuel production.

Tanzania – With some exceptions, mainland Tanzania employers and most workers have the right to organize. Government programs exist with specific aims to economically empower women and girls in terms of developing skills and providing training but no robust measures have been put in place [International Labour Office – Dar es Salaam and Geneva: ILO, 2010]. Most labour laws exist although trafficking of child labour (from refugee camps) still occurs. Due to limited resources, the minimum age law of 15 years is poorly enforced – especially as it relates to domestic labour. The overall estimated figures for child labour in Tanzania are 36%, with 21% of children engaged in agriculture. A 2002 ILO report estimated that 1) 3.4 million out of 12.1 million children in the country are under the age of eighteen 2) work on a regular basis and 3) one out of every 3 children in rural areas is economically active compared with 1 in 10 in urban areas. In a 2002 report, only 26 % of children aged 5 to 9 and 56 % of children aged 10 to 14 were attending school. It is estimated that children in this sector work between 12 and 18 hours per day. Data from the consultant indicates that government is targeting sectors (e.g. mining and agriculture) and sexual exploitation of children through education and training. Information from the ILO [Dar es Salaam and Geneva: 2010] indicates that beyond household activities (which fall outside of their jurisdiction) labour officials ensure companies adhere to labour laws. It is also implementing anti-forced/child labour policies and programs through its participation in the ILO/IPEC Time-Bound Programme (TBP). The media is involved in exposing labour violations – especially as it relates to conditions in other commodities such as coffee, tea, cocoa and tobacco. In 2009, the Tanzanian government was planning to create legislation whereby all hazardous would be registered and made public. While there is a high risk associated with ILO issues for sugar cane for ethanol and palm oil, no risks included in the data from the consultant are listed for other staple crops (tea, tobacco, sugarcane, or jatropha) [ILO-IPEC/USDOL]. There are no certifications to ensure forced/child labour is not used in the production of biofuels and no audits are conducted to discern if forced labour exists in companies. The consultant's data indicates that working conditions are decent with employers offering contracts, latrines, medical facilities, and water and safety gear. While the study indicates private sector CSR activity, none was listed and no local companies were reported to benefit from any large company production.

Uganda – While all ILO Conventions have been ratified, compliance and enforcement records are limited in Uganda because case records do not exist [ILO website; WebMils]. The consultant's report indicated no available data for the level of risk associated with ILO issues for bioenergy crops. Though we have information that indicates that jatropha is used in Uganda, no information was reported on the use of it as a fuel crop for biofuel production. In 1995, a new constitution established the country as a republic; however, the country's institutions of democratic governance remain weak and are not participatory, transparent, nor accountable to an informed public. According to the consultant's data, the government has poor social service delivery, severe social sector issues and there is a decaying faith in democratic systems.[106] In 2006, Uganda held its first multiparty general elections and has since built a framework for decentralization that will encourage both political participation and institutional accountability.

ILO Conventions Data Limitations

The information presented on ILO conventions in target countries applies generally to the feedstocks in the target countries, which may or may not be used for biofuels in the EU. In some of the target countries biofuel production is minimal so it is difficult to attribute. This also applies for feedstocks where biofuel production is a byproduct as in the case of soy production in Argentina. Lack of information was a pervasive limitation characterizing all countries surveyed. In the case of Malawi for example, information on Gross Domestic Product (GDP), status of major economic

[106] www.rti.org/brochures/Uganda_linkages.pdf

industries, and sectors of the economy where forced labour occurs might have shed light on what agriculture practices are employed and/or why some are at risk of using child labour. More information is needed in India to determine what percent of forced/child labour in agriculture is attributable to feedstocks used for biofuel production. A separate baseline survey would need to be conducted to assess the situations in the sugar cane, palm oil and Jatropha fields to ascertain information on the ages of labourers and quality of contracts. Basic ground- truthing on such things as overall populations for the purpose of discerning the percentages of children engaged in child/forced labour in agriculture and reasons for lack of adherence by workers to safety regulation (e.g., workers do not use safety goggles provided to them by employers, especially considering the data indicates Brazil having the highest use of pesticides) would provide a strong contextual foundation.

ILO Conventions Recommendations

Since it may be unlikely that the countries studied will "sign" the ratified conventions, it may be more useful and meaningful to identify other indicators that demonstrate a country's commitment to improved labour laws and enforcement of legal ages and non-hazardous working conditions for employees. ILO-IPEC should be commissioned by the EU or other European bodies and donors to conduct sample studies on forced labour or child labour in crops that are being sold and exported for biofuels. Regional organizations and industries might partner to fund these studies.

Creating an effective inspection agency and empowering its workers would highlight increased government transparency and consequently lead to the reduction of child labour and forced labour incidences. Increased government transparency can lead to greater citizen engagement, where communities and industry and government will be more likely to sustain child labour monitoring awareness and practices after a company's or a project intervention ends.

Finally, the sometimes weak enforcement and monitoring of labour practices in the US collected from the consultant, suggests that a developed nation does not necessarily indicate developed systems or enforcing measures are in place. Developing countries have developed community awareness and certification schemes that the developed countries could benefit from and use. Particularly with respect to migrant labour and adult forced labour.

M 7 Conclusion and Recommendations

There is evidence that use of biofuels for household cooking and energy use may improve local incomes and economies, but the link to EU biofuels consumption is not clear. The Global Bioenergy Partnership (GBEP) focuses on local biofuel use and benefits and GBEP indicators currently under development may improve insights in the relation between EU consumed biofuels and local socio-economic impacts.

A trend to monitor would be the transition of traditional food crops to all biofuel crops whether being used for biofuels or in place of another crop, (sugar/starch and oil, inclusive of jatropha and castor) and what, if any, improvements in health and increased income levels can be attributed to increased biofuel production/use. While by themselves, the yields of most biofuel are not competitive as a crude oil replacement, the combined yields of all biofuels could represent a more sustainable energy alternative than continued dependence on a limited natural resource with inherent negative externalities. In Indonesia for example, additional data on what percentage feedstock crops and biofuel production comprise of the overall economy could suggest which endeavor is more lucrative. Perhaps with more transparent laws and better enforced/monitored labour practices (especially as it relates to child labour and forced labour) coupled with incentives to the private domestic sector; biofuel production would gain a stronghold in the case-study countries. Similarly in Uganda, in an effort to diversify the economy and engage in the global market, government could devote a portion of its allocated food crop land to biofuels production. Revenue from biofuel production could reduce the burden of burgeoning food prices.

Government driven incentives of biofuel industry can have a socio-economic impact if the aim is increase bio-fuels production. The data from the studies indicate that farmers will likely be more willing to engage if the enabling environment (via tax incentives, land titles, subsidies, and land right policies) is profitable, equitable and there are built in measures to diversify.

Strengthening and increasing transparency of government policies on forced/child labour is an essential ingredient in ensuring a sustainable biofuel industry. Providing incentives (e.g. seeds and tax breaks) and expanding existing infrastructure (e.g. irrigation to reach the 85% of farmers whose crops are rain-fed dependent) in Mozambique could create opportunities for agents along the value chain. Already in Ethiopia, there is an interest and engagement by both the commercial and small holder farmers to engage in/expand their involvement in biofuel production. Biofuel production in Malawi has the potential to replace environmentally disruptive extractive industries like oil drilling (for petrol creation) as an approach which leaves less of an environmental footprint.

Extending incentives to small holders and increasing female engagement (especially to women who are already involved in production, manage household finances and stay in school as long as or longer than males), via micro lending opportunities has the potential to strengthen the country’s biofuel market and reduce risks to farmers and food security. Follow up studies may track characteristics such as equalized gender land rights, wage earnings, and practices that ensure safe and legal working conditions as socio-economic measures that would result in a sustainable impact.

M 8 References

Agroenergy, http://www.social.org.br/cartilha%20agroenergia%20ingles.pdf , retrieved 2010-08

Asociacion De Azucareros De Guatemala (AZAGUA) - Cane Sugar Refining and located in Guatemala City; http://www.asazguasins.org.gt/.

Bakovich, Osvaldo. 2010. Conversation. Director of the Biofuels Program at the Secretary of Energy, Argentina.

"Biodesel Production from Soybean in Argentiana," Carbio. http://www.carbio.com.ar/es/pdf/biblioteca/4_Biodiesel_Production_from_soybean_in_Argentina.pdf -

Bolivia - http://www.ilo.org/ilolex/cgi-lex/ratifgroupe.pl?class=g03&country=Bolivia, accessed 2010-07-27.

Brazil - http://www.oitbrasil.org.br/;
http://www.dol.gov/ilab/programs/ocft/pdf/2009tvpra.pdf

Cesano, Dr. Daniele, PhD; field researcher in rural Brazil. Interview.

Cleen Foundation Nigeria; ILO study/UNICEF Report on Nigeria

Cooperativa dos Produtores de Cana Porto Xavier Ltda (COOPERCANA); http://www.coopercana.com.br/index.php

Diaz-Chavez R, Mutimba S, Watson H, Rodriguez-Sanchez S and Nguer M. 2010. Mapping Food and Bioenergy in Africa. A report prepared on behalf of FARA. Forum for Agricultural Research in Africa. Ghana.

Ecocert India; http://www.ecocert.in/news/

Food and Agriculture Organization.
http://www.fao.org/bioenergy/20546-020edc30df3480d6cb12c5d56901127ff.pdf - Brazil, Sakab.
http://www.fao.org/uploads/media/0908_Jatropha_Alliance_-Swiss_Aid_Study_on_Jatropha_in_Mozambique.pdf - pg. 17

Forest Stewardship Council; http://www.fsc.org/latin-america_bolivia.html, accessed 2010-08-27.

Government of Pakistan, 1998 Census Report, Population Census Organization 2001.

Guest, Robert. Africa: The Shackled Continent. 2004. Pan Books Macmillan Publishers. London.

Goldman Sachs http://www.gceholdings.com/pdf/GoldmanReportFoodFeedFuel.pdf
Hilbert, Jorge. 2010. Director of the National Bioenergy Program or PNB at INTA, +54 11 4665 0495 Conversations with the baseline consultant.

Horn of Africa Regional Environment Center and Network; Integrated Approach to Meet Rural Household Energy Needs of Ethiopia, Horn of Africa Regional

Environment Center and Network (HOAREC/N), 2010; (Project Application for the EU Energy Facility 2010).

Human Rights Center, University of California at Berkeley; usa - http://www.law.berkeley.edu/HRCweb/index.html

ILO website; Argentina; www.oit.org.ar (in Spanish)

ILO-IPEC http://www.ilo.org/ipec/lang--en/index.htm

International Labour Rights Fund (ILRF)
http://www.asiantribune.com/news/2010/07/12/united-states-violates-ilo-convention-182-allowing-child-labour-%E2%80%93-investigative-report
International Labour Organization. World Report 2010. Accelerating Action Against Child Labour. Geneva

ISEAL Alliance, http://www.isealalliance.org/news/update-launch-of-the-iseal-impacts-code-this-month - pg. 11

Kwara State Government (Nigeria). http://www.kwarastate.gov.ng/

La Gremial de Palmicultores de Guatemala (GREPALMA); http://www.grepalma.org/

Labour Law No. 25 (Indonesia); http://www.bpkp.go.id/unit/hukum/uu/1997/25-97.pdf

Lerner, Anna .GTZ ProBEC, contact: +258823031782 Conversation. 2010

Mandal, Dr. R.; Jatropha. “Plantation and Oil Extraction through Panchayati Raj”; jetropha.up.nic.in/presentations/RMANDALNEW.ppt

Ministry of Agriculture; Biofuel Development Team in Ministry of Agriculture (Indonesia). http://mekanisasi.litbang.deptan.go.id/eng/

Ministry of Energy and Mines, Brazil. http://www.mme.gov.br/mme (in Portuguese only)

Ministry of the Environment (MMA), (Brazil) www.mma.gov.br

Ministry of Labour:
http://www.mintrabajo.gob.gt/org/funciones/prevision/proteccion-a-la-adolescencia-trabajadora/entendiendo-el-trabajo-infantil-en-guatemala
http://www.mintra.gov.pe/mostrarContenido.php?id=335&tip=333

Mozambique;www.**ilo**.org/public/english/region/afpro/mdtharare/.../**convention**182.do

Mundi Index
http://www.indexmundi.com/agriculture/?country=us&commodity=palm-oil&graph=production

Ndege, G. O., 2007, Culture and Customs of Mozambique, Westport: Greenwood Press

Nigeria: National Agency for the Prohibition of Trafficking in Persons (NAPTIP)

Peru - http://webfusion.ilo.org/public/db/standards/normes/appl/appl byCtry.cfm?CTYCHOICE=0490&lang=ES

Peters, F. 2009, Socio-Economic Impact Study of biofuel plantation on farm households in Mozambique, Wageningen University, Master Thesis.

Promoción de Inversiones en Biocombustibles PROBIOCOM,
http://www.hechoenperu.org.pe/cober2008/Foro3/a%20Ricardo%20Diaz.pdf.24 October 2008.

Rekha Mehra and Mary Rojas, Women, Food Security and Agriculture, in a Global Market, 2010)

SADC, Article 7; http://www.sadc.int/index/browse/page/171

Sangonet; http://www.sangonet.org.za/category/countries/malawi

Sen, Mitali. "The Cost of Cooking: The Impact of Bio-fuel Use on Women's Lives in Rural India" Paper presented at the annual meeting of the American Sociological Association, Atlanta Hilton Hotel, Atlanta, GA, Aug 16, 2003 <Not Available>. 2009-05-26 <http://www.allacademic.com/meta/p107182_index.html>

Schut, Marc; Interview. Center for Promotion of Agriculture (CEPAGRI)].

Sheil, D. Casson, A., Meijaard, E., van Nordwijk, M. Gaskell, J., Sunderland-Groves, J.,Wertz, K. and Kanninen, M. 2009. The impacts and opportunities of oil palm in Southeast Asia: What do we know and what do we need to know? Occasional paper no. 51. CIFOR, Bogor, Indonesia.

SNV. http://www.snvla.org/mm/file/Publicaciones%20pdf%20Peru/Impacto%20socioeconomicos%20de%20la%20produccion%20de%20biocombustibles%20en%20la%20amazonia%20peruana.PDF

Srivastava R, 2005, Bonded labour in India: Its Incidence and Pattern. http://www.ilo.org/sapfl/Informationresources/ILOPublications/lang--en/docName--WCMS_081967/index.htm. Govt. view at http://labour.nic.in/dglw/Bonded_labr.html

Uganda: From Periphery to Centre. A Strategic Country Gender Assessment. World Bank, 2005.

The 20th Century Transformation of U.S. Agriculture and Farm Policy. USDA; http://www.ers.usda.gov/publications/eib3/eib3.htm

ILO Jakarta. 2011 Training on OSH Improvement for Community Owned Plantation in Serdang Bedagai, North Sumatera http://www.ilo.org/jakarta/whatwedo/eventsandmeetings/lang--en/WCMS_153337/index.htm

Twelve Studies on Brazilian Sugar Cane Agribusiness and Its Sustainability. http://www.inmetro.gov.br/painelsetorial/biocombustiveis/; 69. Macedo I.C., 2005. Sugar Cane's Energy: Twelve Studies on Brazilian Sugar Cane Agribusiness and Its Sustainability. São Paulo: UNICA (São Paulo Sugarcane Agroindustry Union); http://www.mte.gov.br/trab_escravo/lista_suja.pdf; http://www.reporterbrasil.org.br/listasuja/resultado.php

USAID, "Transforming Participatory Governance in Uganda"; http://www.rti.org/brochures/Uganda_linkages.pdf

U.S. Department of Labour's List of Goods Produced by Child Labour or Forced Labour. 2010, Washington, DC; http://www.dol.gov/ilab/programs/ocft/PDF/2009TVPRA.pdf

US Department of Labour. http://www.dol.gov/

US Department of State; http://www.state.gov/g/drl/rls/hrrpt/2009/wha/136102.htm accessed 2010-08-15.

Ethiopia - http://www.state.gov/r/pa/ei/bgn/2859.htm#econ
Mozambique - http://www.state.gov/r/pa/ei/bgn/7035.htm

Nigeria - http://www.state.gov/r/pa/ei/bgn/2836.htm
Sudan - http://www.state.gov/r/pa/ei/bgn/5424.htm
Ukraine - http://www.state.gov/r/pa/ei/bgn/3211.htm

WebMills Nigeria, Sudan, Tanzania, Uganda, etc. www.dol.gov/ilab/webmils

Winrock International. Liberia Smallholder Revitalization Strengthening: The Oil Palm Value Chain in Bong, Lofa, and Nimba Counties 2007. Submitted to the Sustainable Tree Crops Program.

Winrock International. Best Practices in the Reduction of Child Labour through Education. 2008. CIRCLE Project. Little Rock, Arkansas.