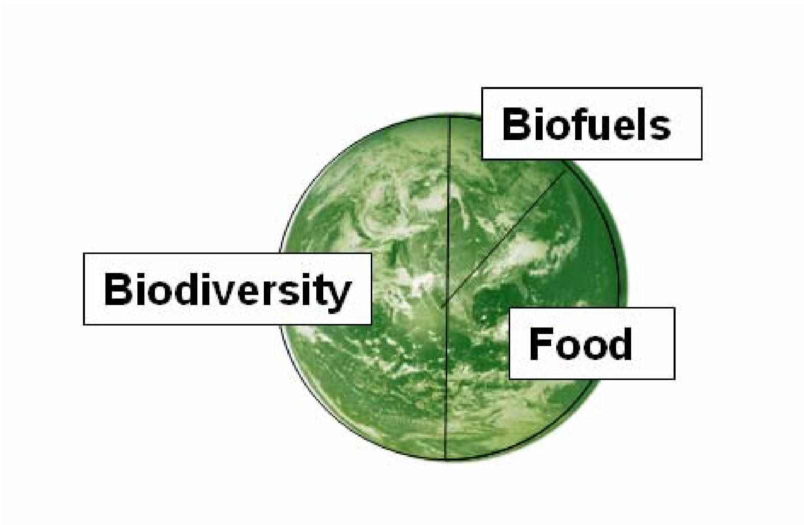
Tracking biofuels policy development in selected overseas economies

Phase I

Data sources, global trends and overview of biodiversity impacts



Joint Nature Conservation Committee
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Contents

1. Summary

Under its Global Impacts Programme JNCC is undertaking a review of the potential impacts on biodiversity of the use of biomass for energy. This work is concentrating initially on the impacts of liquid biofuels (bioethanol and biodiesel) demand and supply with a focus on biomass supply originating from non-OECD countries.

Within this geographical area of interest JNCC has reviewed available evidence on biofuels demand and supply to identify the key regions that currently or will in the future be important global sources of biomass for energy. Existing reviews identify three key regions where supply of biomass for energy will exceed regional demand and where significant developments are likely to occur in the coming decade. These are Sub-Saharan Africa, the Caribbean & Latin America and the CIS/Baltic. Some regions of Asia may be important sources of biofuel but land availability is much more limited in this region.

JNCC has used existing data sources to identify key potential biomass source countries within these regions with the intention of using this screening process to monitor country specific biofuel policy and programme developments. Key future biomass providers have been identified on the basis of current and future potential capacity which principally reflects land availability. Political intentions are also an important determining factor in respect of domestic bioenergy use and aspirations to supply the global market.

The list of countries identified at this stage as of primary interest as actual or potential *biofuel supply economies* is shown below, but this will evolve as new entrants to the supply market appear and develop policies designed to promote the use of biomass for energy at home or for export.

Sub-Saharan Africa	Republic of South Africa Mozambique Ghana Democratic Republic of the Congo
Caribbean & Latin America	Argentina Brazil Colombia
CIS and Baltic	Kazakhstan Russian Federation Ukraine
Asia	Malaysia Indonesia Papua New Guinea

JNCC is currently developing an intelligence gathering procedure to monitor major bioenergy policy and programme developments in these countries, and selected biofuels demand countries, and this information will be made available for a trial period on the project website. In parallel with this work, JNCC is developing a strategic biofuels evaluation tool that can be used to screen biomass for energy policies and programmes at a national level using a set of sustainability criteria. The procedure in development will allow major sustainability impacts of individual policies and programmes to be identified and related to potential ecosystem and biodiversity impacts within the countries concerned.

2. Background and JNCC objectives

As part of its Global Impacts Programme, the Joint Nature Conservation Committee is developing techniques to track commodities coming into the UK and investments flowing out with the objective of linking these flows of resources (material and monetary) to potential ecosystem impacts around the world. The work is focussing on set of key natural resource and agricultural commodities supplied to the UK and EU by a set of key countries outside the OECD[1], and the counter flows of investment from the UK into these global economies.

The work on commodity flows and tracking overseas UK investment – termed Foreign Direct Investment – is reported on through the Global Impacts Programme website (www.ukglobalinfluence.org) which allows access to selected investment and commodity datasets in a UK, EU and global context.

The Global Impacts Programme is not 'report focussed' but is designed to identify diverse information sources (on trade, investment, national biodiversity information etc.), collate this information and provide structured access through the project and JNCC websites. 'Structuring' allows information on specific commodities, including biofuels, to be accessed in the context of specific countries and, ultimately, specific ecosystems.

The increasing use of biomass for bioenergy is of sufficient importance to merit a separate line of work within the JNCC programme which is reported on in this document. Under the Global Impacts Programme biofuels work is focussing on the following specific work areas:

- Identify key biofuel producing countries and develop and maintain a biofuels intelligence gathering programme, monitoring policy and other major developments in these supply countries and selected biofuel demand countries[2]. This will be delivered through the project website (http://www.ukglobalinfluence.org/) from June 2008 and maintained for a trial period to end 2010;

- Develop a biofuels impact screening approach applicable at a strategic national level to establish risks/opportunities associated with biofuels programmes involving specific crops. Case studies will be developed for some/all of the priority biofuel countries. Work is in progress on this approach and will continue through 2008.

1 With the exception of OECD member Mexico.
2 Initially: Argentina, Brazil, Democratic Republic of Congo, China, Colombia, Ghana, Indonesia, India, Kazakhstan, Malaysia, Mexico, Mozambique, Papua New Guinea, Russian Federation, Ukraine, Republic of South Africa.

This report concentrates on three areas:

- identifying data sources for monitoring biofuel policy developments around the world;
- identifying key regions and countries where biofuel demand and supply are likely to be of particular importance; and,
- summarising initial JNCC work on screening biodiversity and other impacts likely to arise from the use of biomass for fuel.

3. Data sources for monitoring international biofuels policy developments

Biofuels reviews and reports are proliferating against the background of a rapidly developing global industry. National policy decisions are emerging almost daily. Some of the studies referred to in this report are based on assessments of agricultural and other data that are 'time robust' and will not change rapidly. The JNCC review to establish which regions are likely to be most significant in the future for biofuel production, and where impacts are likely to fall, is based on this type of review.

The most useful reviews for assessing current, and predicting future likely, environmental impacts, particularly for ecosystems and biodiversity, are those that focus explicitly on land availability under different constraints and scenarios. The following are three key reports that provide quantitative assessments and have been used in the JNCC review[3]:

- The 'Oak Ridge study' – is a study of potential biofuel/biomass sources available to the US economy under a range of future scenarios. The study does not cover all potential suppliers – notably omitting Malayasia and Indonesia – but the numerical analysis is extremely useful in helping to identify the most significant regional and global biofuel sources in terms of crops and countries.

- The 'SADC study' of Sub-Saharan African biofuel potential;

- The Smeets *et al* (2006) comprehensive global review of land availability for bioenergy and actual production potential. This study presents a detailed and quantitative global analysis with a range of scenarios explored.

By contrast, the political environment affecting bioenergy policy and programmes can change quickly as targets for biofuel substitution are set and then revised or varied according to changes in public, NGO or other pressures. Tracking changes in bioenergy policy within countries already identified as significant in respect of global biofuels production, identifying policies in newly emerging biofuels producers and predicting where and how impacts may be felt requires use of a range of intelligence sources. The four principal sources in use by JNCC at present are itemised below.

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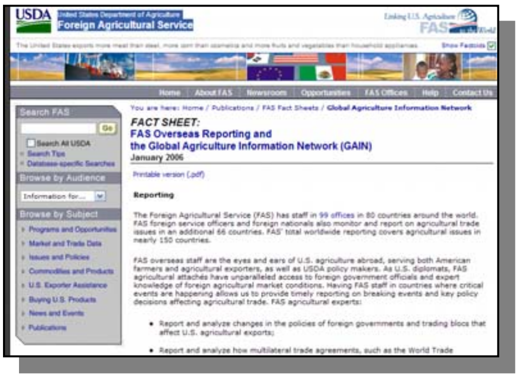
3 This not an exhaustive list of literature available nor all sources used by JNCC, but a list of key reports referred to in this document. See reference page for full details.

- **United States Department of Agriculture Foreign Agricultural Service**



The FAS global electronic reporting system provides information on a wide range of subjects pertaining to international agricultural trade, production, and policies. FAS posts report on current developments affecting agricultural trade on a continual basis, but also submit scheduled periodic reports.
www.fas.usda.gov/scriptsw/attacherep/default.asp

- **F.O. Licht's World Ethanol & Biofuels Report**

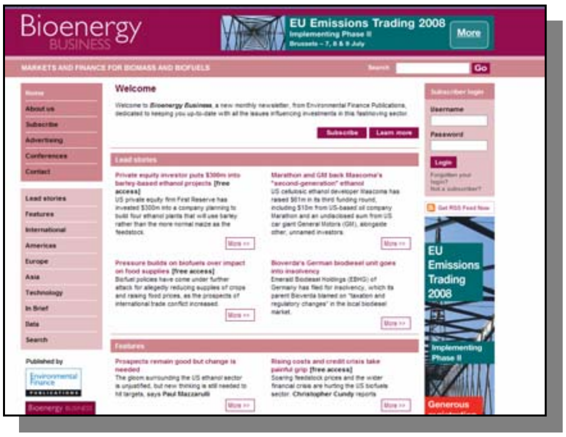
F.O. Licht's World Ethanol & Biofuels Report gives news, comment, analysis and statistics on fuel ethanol, biodiesel, industrial and beverage alcohol markets worldwide. It includes world and regional prices and trade statistics, regular ethanol and biodiesel production estimates and ethanol trade analysis.
www.agra-net.com/portal/puboptions.jsp?Option=menu&pubId=ag072

- **Biofuels International**

Biofuels International magazine a global publication covering biodiesel, bioethanol, and biomass production.

www.biofuels-news.com/index.html

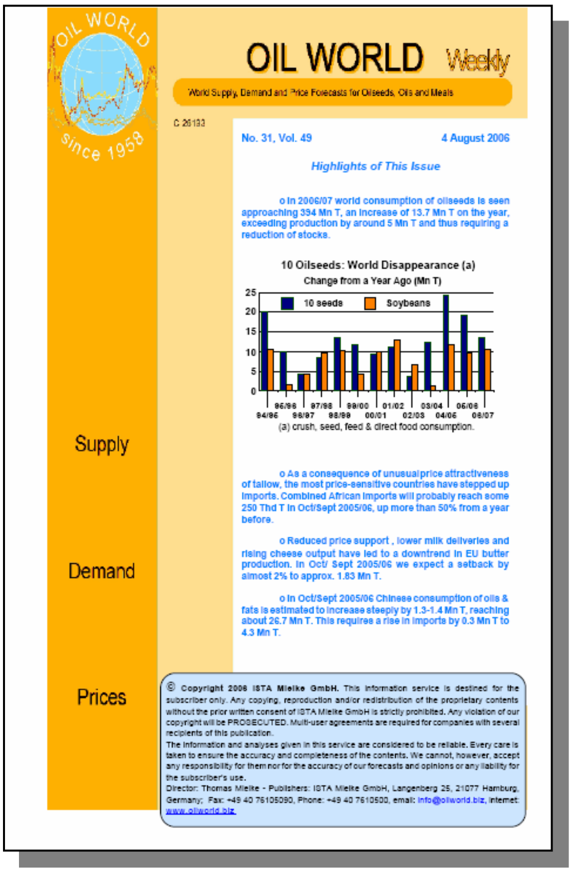
- **Bioenergy Business**



Bioenergy Business is a monthly newsletter and e-mail information service providing news and analysis of developments in biofuels and biomass.

www.bioenergy-business.com/

- **Oil World Weekly**



Oil World Weekly provides information and forecasts of the current and prospective world supply, demand and prices for oilseeds, oils, fats and oilmeals.

www.oilworld.biz/

4. Global patterns of biofuels demand

4.1 Policy drivers for demand and supply

Global demand for liquid biofuels – bioethanol and biodiesel – has three drivers:

- a requirement to reduce greenhouse gas emissions from the transport sector by substituting biofuels for fossil fuels on the assumption that this will reduce C02 emissions;
- greater fuel security, minimising fossil fuel import requirements;
- a desire to supplement farm incomes.

Biofuel policies are based upon partial substitution of biofuel for fossil liquid fuels. Although high levels of substitution are possible for specialist fuels – up to complete replacement by 100% biodiesel or ethanol – biofuels targets typically range up to 10% substitution of the national fuel supply. Such targets are being set globally and based on incremental increases in substitution levels as biofuel programmes develop, as a global trade in biofuels/feedstocks increases and as vehicles capable of using mixed fuels become available.

The major fossil fuel consuming economies of the USA, EU and China are, by setting biofuel substitution targets, becoming the major biofuel consumers creating a significant demand which will be met in part by domestic production and partly by imports. The political motives for pursuing biofuel substitution policies are based on one or more of the three drivers. For the USA fuel security and farm incomes are the key drivers. For the EU reducing transport sector C02 is the prime driver. Chinese economic growth is creating a rapid increase in fuel requirements and biofuels provide one means of improving security of supply.

In addition to the three major economies mentioned above, other countries are setting targets for biofuel use to meet both domestic demand and potential export markets. Collectively these economies, in addition to the three major global consumers, are creating a new global industry for production and consumption of bioethanol and biodiesel to satisfy both domestic demand and export. In spite of recent concerns over competition with food supplies, and environmental protest, global biofuel demand is expected to reach 100 million tonnes by 2010 , half of this from North America and 20% from the EU, assuming its target of 5.75% substitution by 2010 is met .

In general terms it is possible to view the key biofuels economies as either importers (demand economies) where domestic demand now, or in the future, will outstrip supply or exporters where domestic production will exceed national requirements allowing surpluses for export (supply economies). Figure 1 highlights countries reviewed by one study (Oak Ridge), characterising them in terms of policy, biofuels crop options and targets. This list includes the three main demand economies (USA, EU, China) and some of the established and emerging supply economies.

The key factors determining whether economies will be on the demand or supply side are:

- transport fuel demand (diesel and gasoline) – determined by size of economy;
- expected biofuel substitution levels – determined by policy;
- overall domestic agricultural production potential - determined by land availability and agricultural yields;
- the existence of food supply surplus or deficits - influencing land available for bioenergy;

• the existence of environmental and other policies limiting land use/production capacity;
• suitability of climate and other factors for growing specific bioenergy crops.

Country	Primary Feedstock		2007 Forecast (million gallons)		Blending targets for ethanol and biodiesel
	Ethanol	Biodiesel	Ethanol	Biodiesel	
Argentina	molasses, sugarcane, corn	soybeans	66	53	5% blends in all gasoline and diesel, 2010
Brazil	sugarcane	soybeans, palm oil, castor oil	4,967	64	25% blend in gasoline in 2007 (adjustable); 2% in diesel by 2008 and 5% by 2013.
Canada	corn, wheat, straw	animal fat, vegetable oils	264	25	5% in motor vehicle fuel by 2010; 2% in diesel by 2012.
China	corn, wheat, cassava	vegetable oils, *Jatropha*[lxiii]	423	30	Five provinces use 10% blend with gasoline; five more provinces targeted for future
Colombia	sugarcane, cassava, sugar beet	palm oil	100	13	10% in gasoline and 5% in diesel by 2008.
EU	grains, sugar beet	rapeseed, sunflower, soybeans	608	1,732	5.75% biofuel share of all transportation fuel by 2010; 10% by 2020.
India	molasses, sugarcane	*Jatropha* imported palm oil	106	12	10% in gasoline by 2008; 5% in diesel by 2012 (soft targets).
Indonesia	sugarcane, cassava	palm oil, *Jatropha*	--	108	10% biofuel by 2010.
Malaysia		palm oil	--	87	5% in diesel (target date under discussion)
Mexico	molasses, sugarcane	animal fat, recycled oils	25	1	Proposed legislation (pending signature) did not include firm targets.
Thailand	sugarcane, molasses	palm oil	79	69	10% in gasoline (soft target) and 10% in diesel by 2012.
United States	corn	soybeans, other oilseeds, wastes	6,499	445	15 billion gallons of biofuel by 2012; 24 b. gal. by 2017; 36 b. gal. by 2022.

Figure 1: Overview of biofuel production targets in selected countries.
Source: Oak Ridge study

4.2 The EU as a model for quantifying biofuels demand

Estimating supply versus demand in respect of transport biofuels requires modelling of a number of economic, agricultural and technological parameters. Recent modelling undertaken by the European Commission provides an insight into how potential demand for biofuels can be estimated, and the extent to which this may be met by domestic as opposed to overseas production.

The Commission biofuels scenarios for 2020 are based on the following:

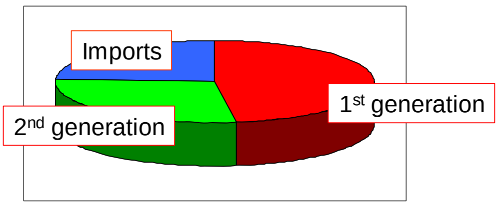
i. Establishing potential future sustainable levels of EU biomass production for biofuels based on both 1st and 2nd generation technologies;
ii. Forecasting future use of gasoline (petrol) and diesel in the EU;
iii. Estimating the quantity, nature and potential source of imported biofuels and biofuel feedstocks needed to support the EU biofuels market.

The EU Commission 2020 scenarios for biofuels use in the EU are based on 7% and 14% substitution which straddle the Commission's proposed 10% mandatory substitution. Critical to limiting excessive imports of biofuels/feedstock is the development of 2nd generation technology that uses wood and straw rather than plant oils and starch/sugar. The Commission models assume between 20% and 37% of biofuels will be produced by 2nd generation technology in 2020. If this technology develops more slowly than assumed in the model the EU demand for biofuels will significantly outstrip EU capacity and imports of biofuels or feedstocks will be substantially increased.

2020 EU Biofuels scenarios

Percentage substitution	7%	10%	14%
Bioethanol (mt)	15	22	30
Biodiesel (mt)	14	20	28
Total liquids (million tonnes)	30	42	58
2nd generation percentage	0.2	0.28	0.37

2020 EU biofuel scenario for 10% substitution



Source: EU Commission

Figure 2: EU biofuels scenarios for 2020

Figure 3 shows a general biofuels trajectory for the future supply based on the expected change in balance between 1st and 2nd generation fuels, as food crop sources are replaced by more advanced energy crops and new technologies for production of ethanol and biodiesel from lignocellulose material.

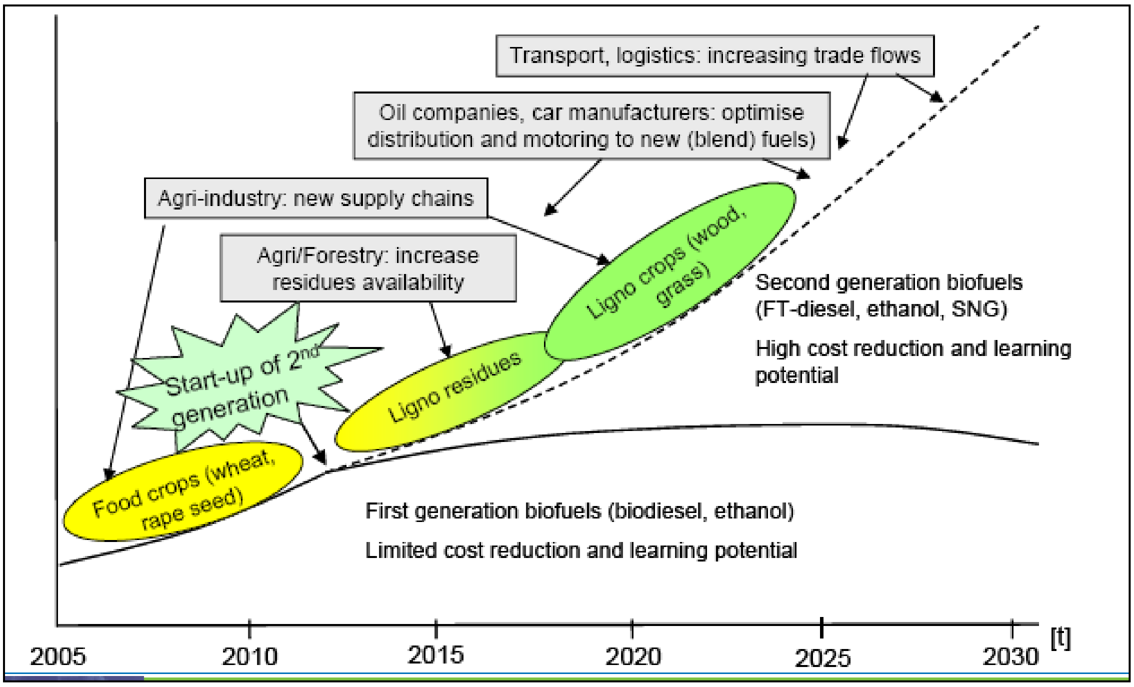


Figure 3: Biofuels trajectory showing 1st and 2nd generation supply
Source: http://www.refuel.eu/

5. Global pattern of biofuels supply

5.1 Overview of biomass for bioenergy -organic material flows for bioenergy/biofuels

Biofuels are usually classified as 1st or 2nd generation based upon processing techniques involved.

- **First Generation** fuels are produced by fermentation of starch or sugar to produce ethanol, or transesterification of plant oils to produce biodiesel (methyl esters);
- **Second Generation** fuels are produced from cellulose/lignocellulose by advanced fermentation techniques to produce ethanol or, by gasification and Fischer Tropsch processes, to create biodiesel.

There is a common assumption that 2nd generation biofuels will be less environmentally harmful than 1st generation fuels, but impact assessment of biofuels policies and programmes must be case specific, and this assumption must be questioned. To promote a more effective assessment of biofuel policy and programme impacts it is possible to take an alternative approach and look at the biomass streams themselves that lead into these processes. Four such streams are recognised here.

This classification scheme focuses on *production techniques* (their energy, GHG and other impacts) rather than *end processing.* The four biomass streams can be summarised as follows:

Route 1: Conventional farming practices – conventional food crops

- Can supply food or fuel industry – price dependent switching to most appropriate market
- No change in agricultural practices or type of crops
- Feeds into first generation processing plants for bioethanol or biodiesel

Route 2: Energy farming practice – modified (for energy) food crops or non-food crops

- Supplying only energy industry
- Change in farming practice (rotations, etc.) to maximise biomass yield
- Use of modified food crops (rapeseed with oils optimised for biodiesel, cereals with enzyme content suitable for fermentation etc.) or non-foods such as *Jatropha*
- Feeds into first generation processing plants for bioethanol or biodiesel

Route 3: Energy farming practice – energy (lignocellulose) crops

- Supplying only energy industry
- Change in farming practice to maximise biomass yield
- Use of non-food crops to produce lignocellulose – short rotation coppice, *Miscanthus* etc.
- Feeds into second generation processing plants for bioethanol or biodiesel

Route 4: Use of agricultural and forestry waste

- Supplying only energy industry
- Feeds into second generation processing plants for bioethanol or biodiesel

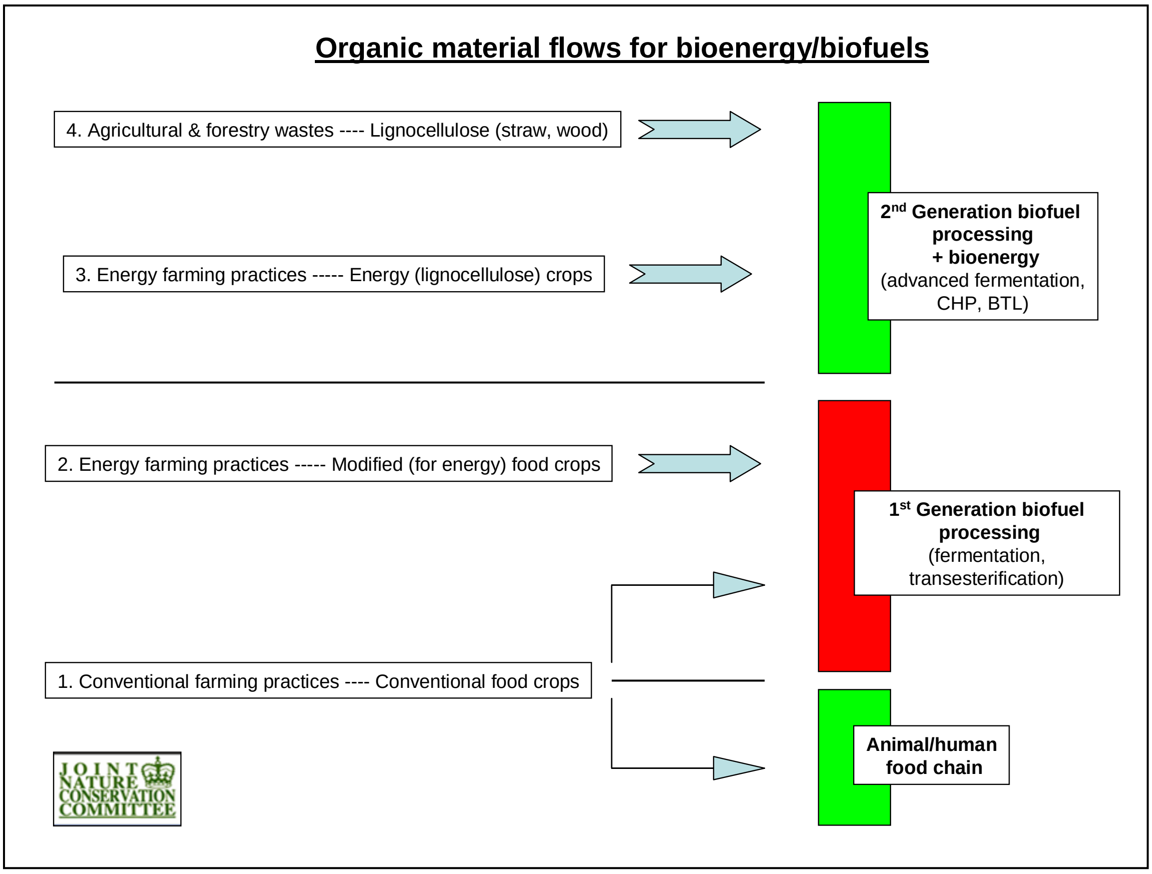


Figure 4: Biomass streams for biofuel processing

The objective of focussing on the upstream end of the biomass to energy chain is to ensure that potential impacts of biofuel production can be assessed on the basis of three key factors, namely:

- *Programme location* – to account for the nature of the landscape from which biomass is being sourced;
- *Crops used* – to account for the specific (soil, water, GHG etc) demand and impact attributes of the energy crops;
- *Land management techniques* –to account for practices used in specific programmes (practices that can maximise/minimise energy, water, fertiliser use etc).

5.3 Biofuel and bioenergy crops

Many types of biomass can be used in the material flows feeding the biofuels industry but in practice there is a limited array of crops that are of significance.

Crops from conventional farming practices are principally:

- Sugar cane, corn (maize) and wheat for bioethanol;
- Palm oil, rapeseed and soya for biodiesel.

The Oak Ridge study, examining potential biofuel supplies available to the USA from foreign sources, highlights a narrow range of crops for which significant volumes will be available through to 2027. Noticeably significant proportions of total production of sugar cane (Brazil) and soya (Brazil and Argentina) are expected to be available for bioenergy. Corn and wheat represent less significant sources of raw material.

Feedstock/Year	Baseline	
	Total supply mmt	% available
Feedstock Crop Supply		
Sugarcane		
2012	1,225	47%
2017	1,457	48%
2027	1,932	51%
Corn		
2012	280	7%
2017	325	7%
2027	427	7%
Soybeans		
2012	155	65%
2017	202	66%
2027	314	67%
Wheat		
2012	153	18%
2017	160	19%
2027	176	19%
Palm Oil		
2012	2	41%
2017	3	41%
2027	7	40%

Figure 5: supply statistics for 5 key biofuels crops available to 2027
Source: Oak Ridge study

Additional biomass will become available from non-food crop sources (or from food crop waste such as bagasse) including perennials and forest products. Although the Oak Ridge study does not cover all potentially significant suppliers of biomass (not including the CIS, Indonesia and Malaysia) the total biomass feedstocks scenarios published by Oak Ridge (Figures 5 & 6) give an indication of the relative importance of different biomass sources, in particular highlighting the role of sugar cane for ethanol and soya for biodiesel.

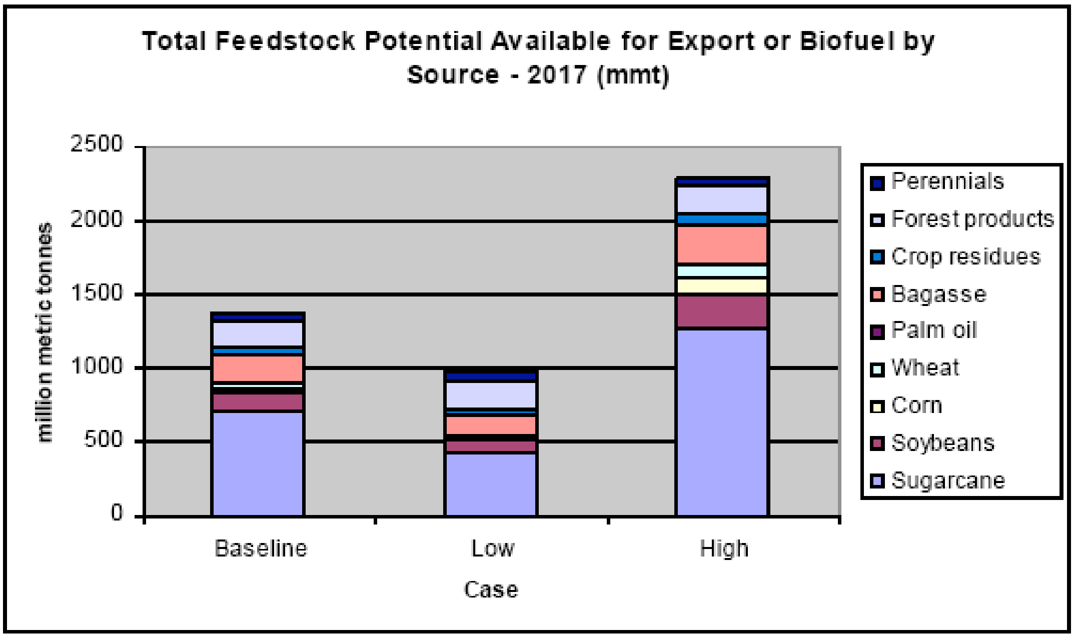


Figure 6: 2017 scenarios for biofuel feedstock (excluding Malaysia and Indonesia)
Source: Oak Ridge study

5.4 Global biofuels supply – recent trends

The two liquid biofuels – bioethanol and biodiesel – are the current focus of global debate in respect of biomass for energy programmes.

Bioethanol

Global production of fuel ethanol is expected to be around 80 billion litres in 2008 approximately 8 times that of biodiesel. Around 80% of ethanol is produced in North and South America (Brazil and USA) from maize and sugar cane. Although these two countries dominate production, a new set off ethanol producers are emerging including China, India and Thailand in Asia, Colombia in South America and the EU (Figure 8). African production is not yet significant but could become important.

Biodiesel

The global leader for biodiesel production is the EU, using mainly rapeseed, but the USA, Brazil and Argentina are rapidly developing capacity based on soya. The third major plant oil used for this fuel is palm oil, originating mainly in Indonesia and Malaysia although this remains overwhelmingly a food crop. Within South America Colombian palm oil production is expanding rapidly with the possibility of this country becoming an important regional supplier. Alternative plant oil sources, such as *Jatropha*, are being developed in some countries but biodiesel production will remain dependent on the 'big three' for the foreseeable future.

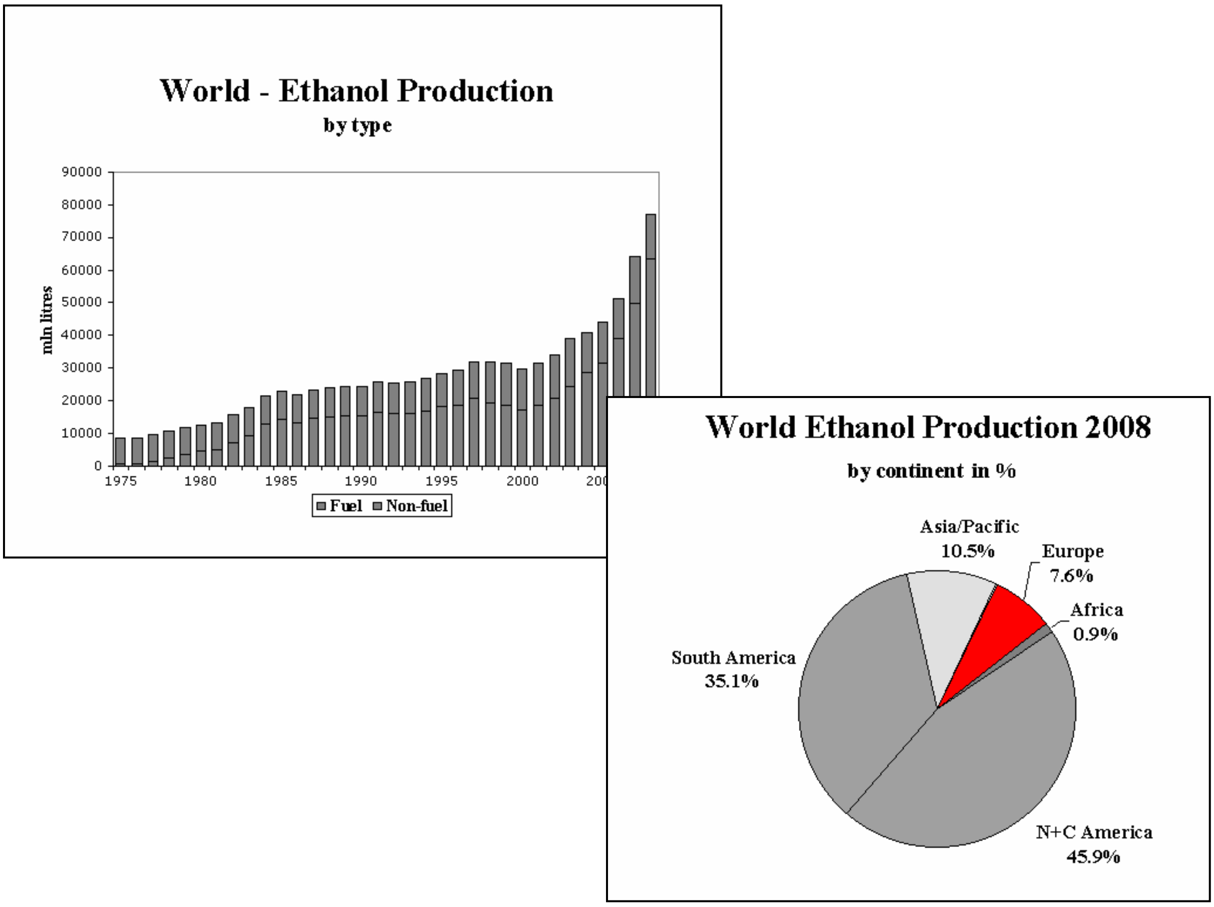


Figure 7: Global growth in fuel bioethanol production through time and regional distribution in 2008. Source F O Lichts

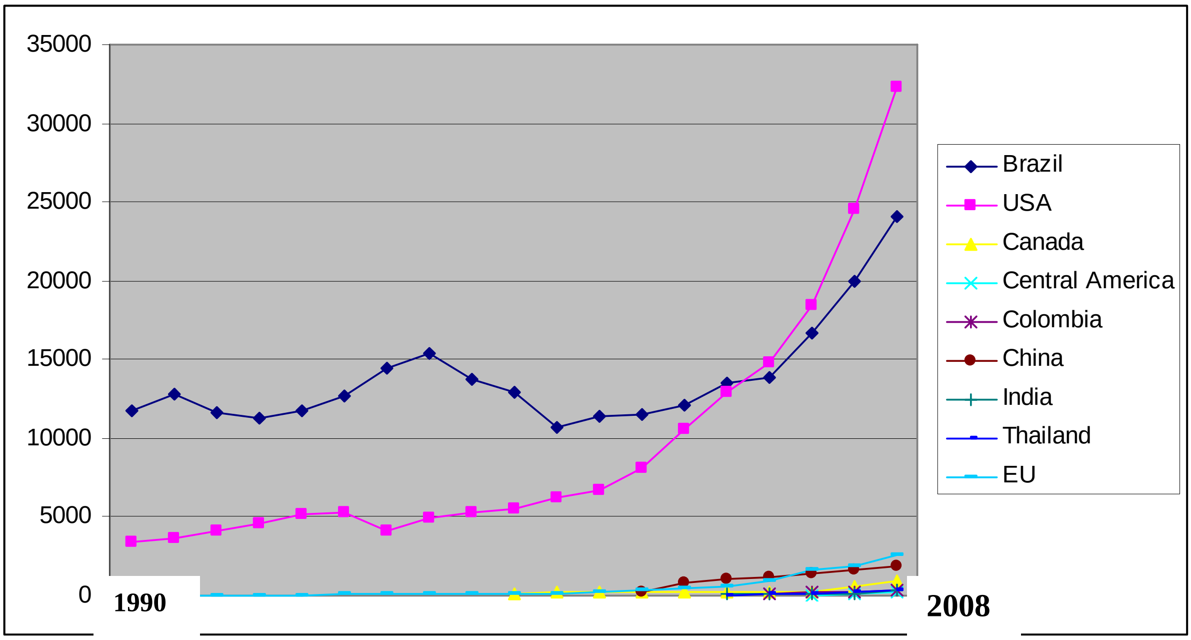


Figure 8: Global growth in fuel bioethanol production
Source: F O Lichts

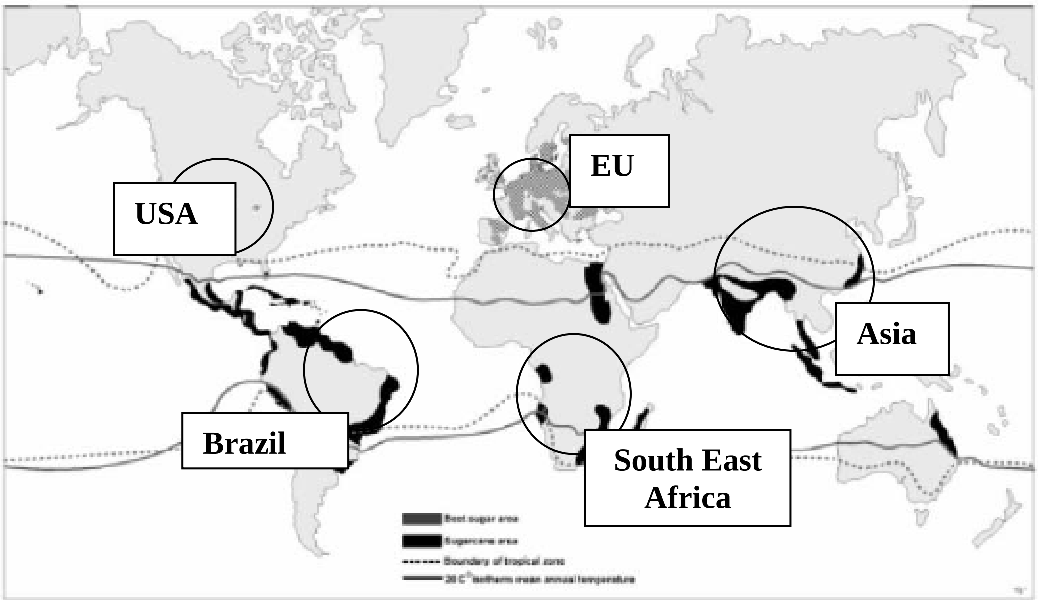


Figure 9: Global distribution of sugar cane and principal likely global sources for bioethanol from this and other crops

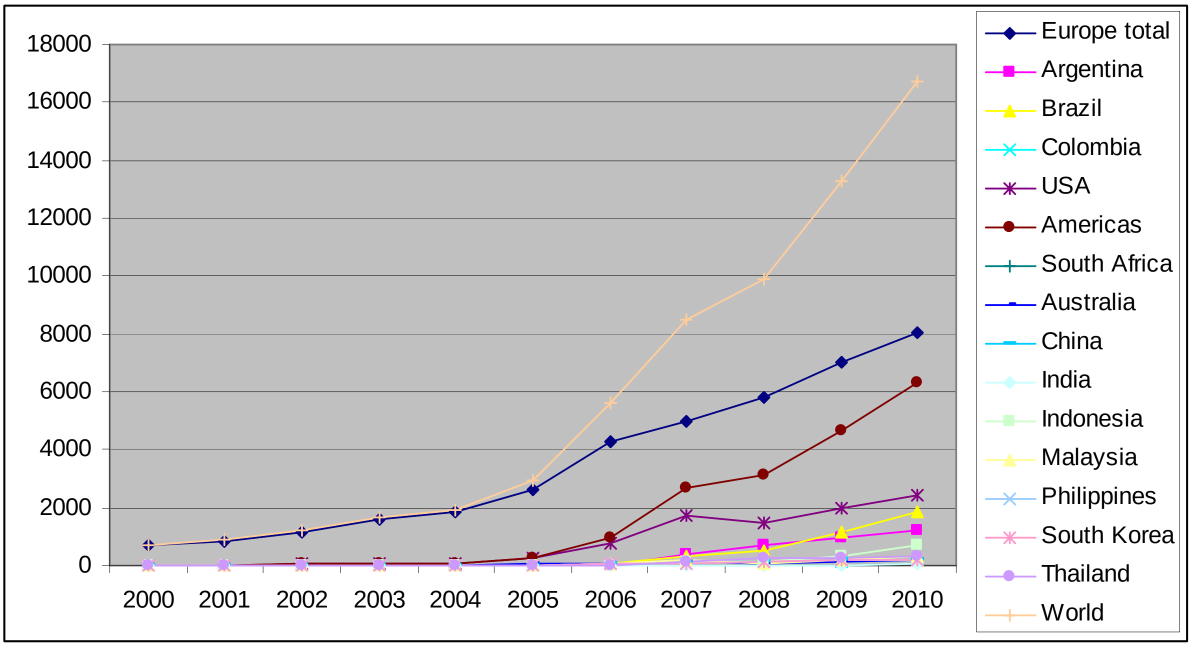


Figure 10: Global growth in biodiesel production
Source: F O Lichts

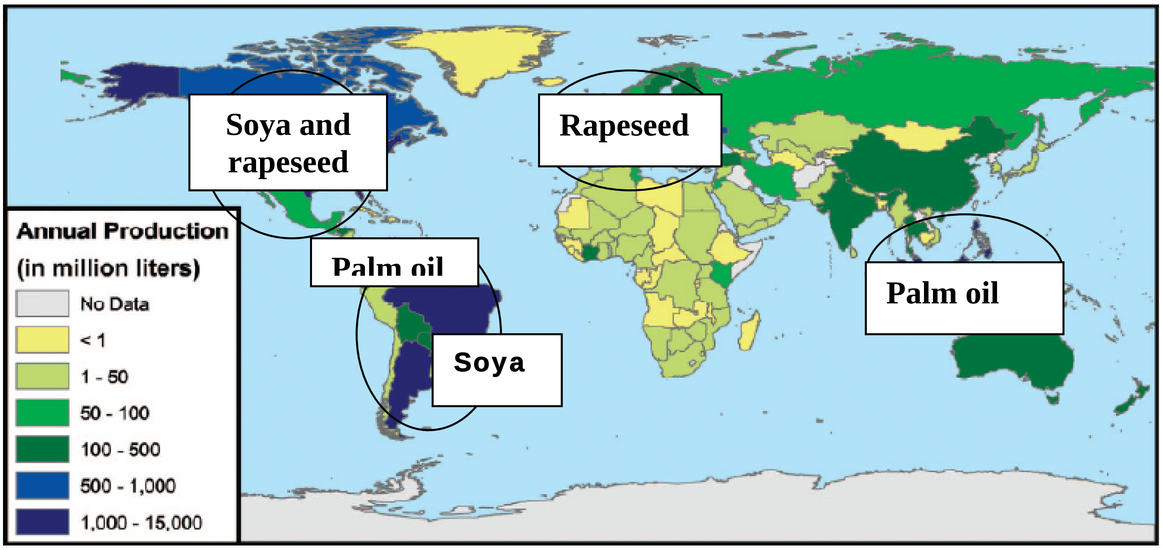


Figure 11: Global distribution of biodiesel production
Source: SAGE www.sage.wisc.edu/energy/index.html

5.5 Global supply – future potential

The extent to which biomass can be used in the future to produce energy, based on current technologies of using energy crops or forest residues, is limited primarily by available land. With rising food prices there is land competition between food and fuel use, and also between the major grain and plant oil crops.

Global assessments of bioenergy potential are currently being based on various assumptions as to land availability and crop and energy yields.

Land availability

According to the FAO[4], the potential to increase the global area of cropland is still significant but this potential land area is not distributed evenly around the globe and over half of the available rainfed land is within South America and Africa. Comparison of the total area of actual global cropland (arable land & permanent crops) with the areas suitable for crop production indicate that sub-Saharan Africa and Latin America have the potential for a four to six fold increase in the area of cropland.

The concept of 'available land' is potentially dangerous because much of it can have existing natural or social functions but in all scenarios presented by Smeets[5], the largest surplus land potential comes from three regions:

- Sub-Saharan Africa;
- the Caribbean & Latin America;
- the CIS and Baltic.

Land for bioenergy crops may become available in these areas through expanding agricultural frontiers or increasing yields for food crops thereby releasing land for energy crops The potential in Sub-Saharan Africa and the Caribbean & Latin America regions

[4] As reported by Smeets et al (2007). A bottom-up assessment and review of global bio-energy potentials to 2050. Progress in Energy and Combustion Science 33, 56–106.
5 Smeets et al. (2007)

results from the current inefficient production systems and inefficient land use patterns and low cropping intensity. In the CIS/Baltic the collapse of communism and the subsequent economic restructuring resulted in a decrease of yields and production offering scope for new potential.

Energy potential

Assessments of bioenergy potential go beyond land availability assumptions and can be based on a range of factors:

- Crop yield per area;
- Conversion efficiency (biomass to energy);
- Production systems – energy crops only or energy crops plus wide range of organic wastes;
- Application of technology – including GMOs;
- Water supply regime – rainfed only or supplemented by irrigation.

FAO modelling of potential bioenergy yields for different global regions using these variables, in addition to land area, emphasises the importance of South America, Saharan Africa and the CIS as potential biomass producers (Figure 12).

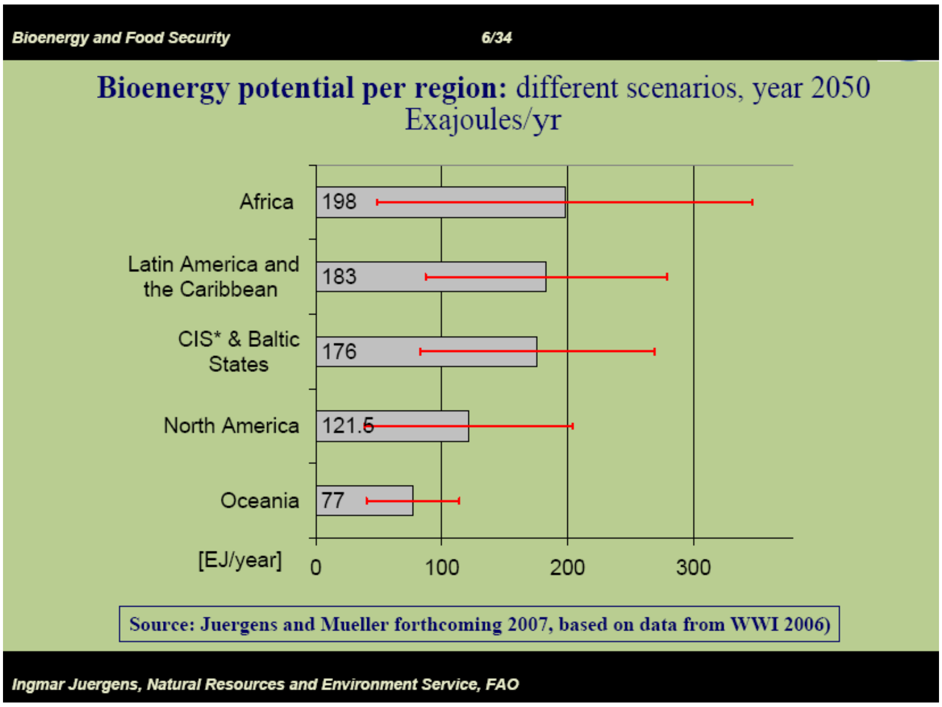


Figure 12: Regional bioenergy potential in Exajoules(10 to the power 18 Joules)
Source: FAO

The energy potential analysis undertaken by Smeets *et al* emphasises the importance of the same three regions, Latin America, Sub-Saharan Africa and the CIS, under a range of scenarios based on the above mentioned factors.

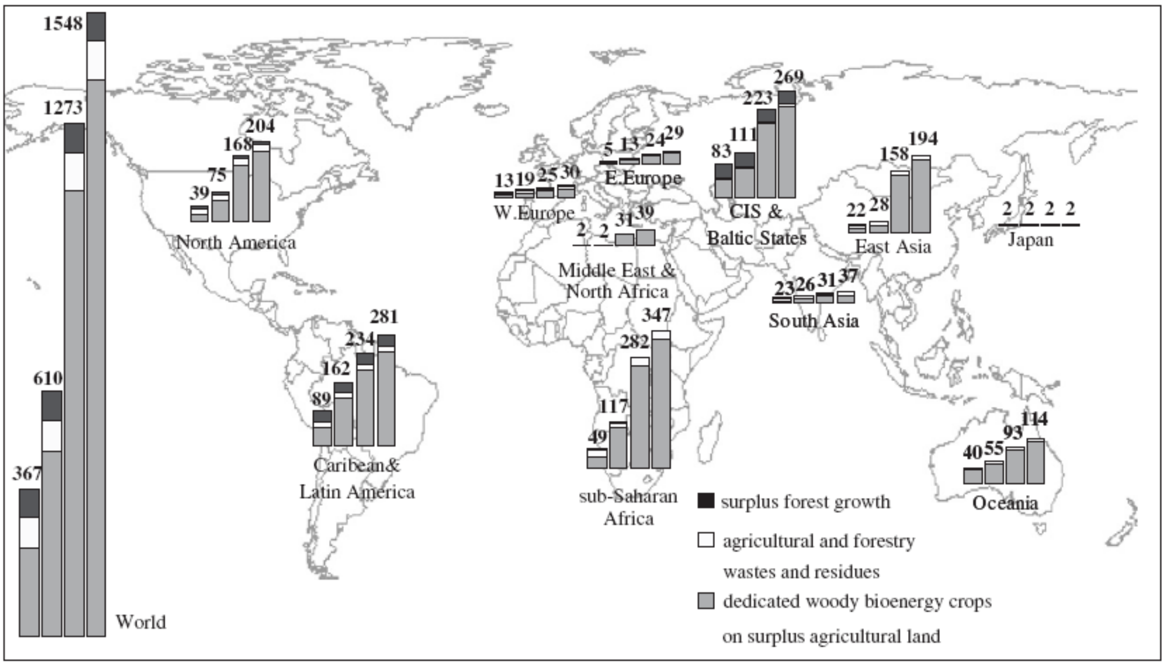


Figure 13: Regional bioenergy potential for 2050 under four scenarios.
Source: Smeets et al 2007. Numbers in Exajoules/year

6. Provisional regional analysis.

Global assessments of biomass for bioenergy potential all emphasise the importance of South America, Sub-Saharan Africa and the CIS as potential suppliers of biomass. In the context of the JNCC review work these are seen as the three key regions for further analysis along with East Asia (Fig. 14). The objective of the ongoing analysis, and policy monitoring is to identify key producing countries in these regions in terms of existing policies and programmes or in anticipation of development of significant programmes.

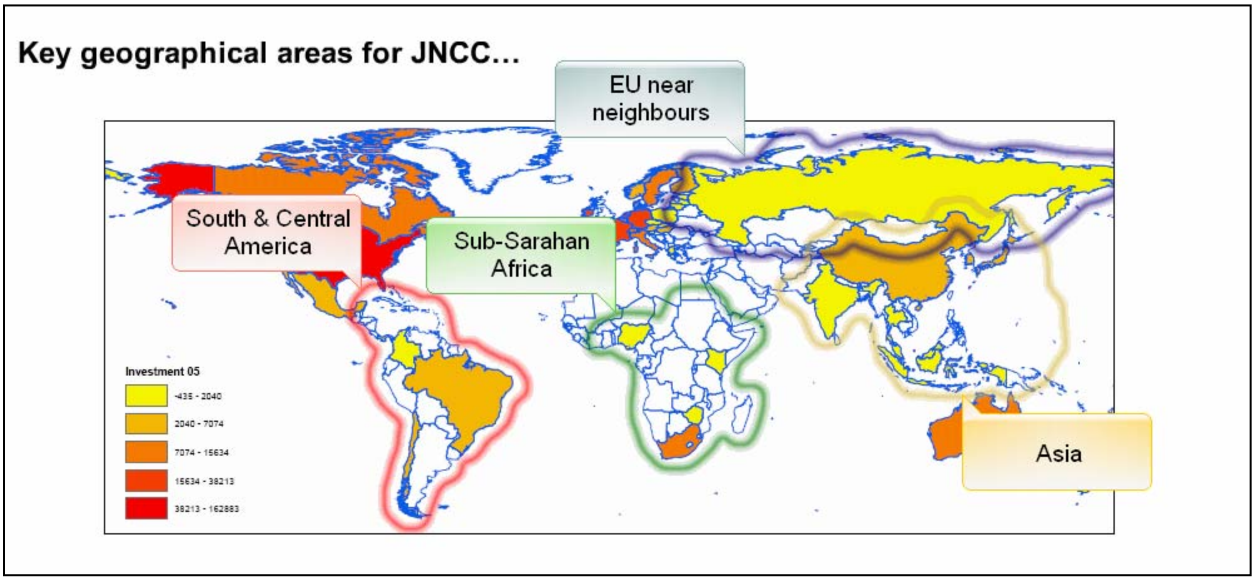


Figure 14: Four key regions for JNCC in analysing biomass for bioenergy supply and potential impacts

6.1 Sub-Saharan Africa

Land availability – less than 6% of African land area is cultivated and overall productivity is low[6]. Tabulations below, sourced from SADC[7] and Ethanol Africa, both indicate low agricultural usage of land in many countries of the region but present significantly different estimates of what is available. Land 'availability' figures need to be moderated by looking at a range of social, economic and environmental issues.

In addition to highlighting those countries that have most potential, taken together these figures indicate two key facts in relation to the productive potential for Sub-Saharan Africa:

- The region has massive 'absolute' land potential in terms of unused land and scope for increased yields;
- Allowing for land needed for domestic food and bioenergy energy supply, there is significant potential for surplus bioenergy production to meet global demand.

6 Biomass, Livelihoods and International Trade: Challenges and Opportunities for the EU and Southern Africa. SEI 2007
7 Feasibility study for the production and use of BIOFUEL in the SADC region

Country	Land Area (mil ha)	Suitable Cropland (~ 20 %) (mil ha)	Area Under Crops Today (mil ha)	Area Required For Domestic Energy Supply (mil ha)
DRC	227	45	8	0.2
Angola	125	25	4	0.6
Tanzania	88	18	5	0.3
Zambia	74	15	5	0.2
Mozambique	78	16	3	0.2

Figure 15: Land availability in selected African countries
Source: SADC

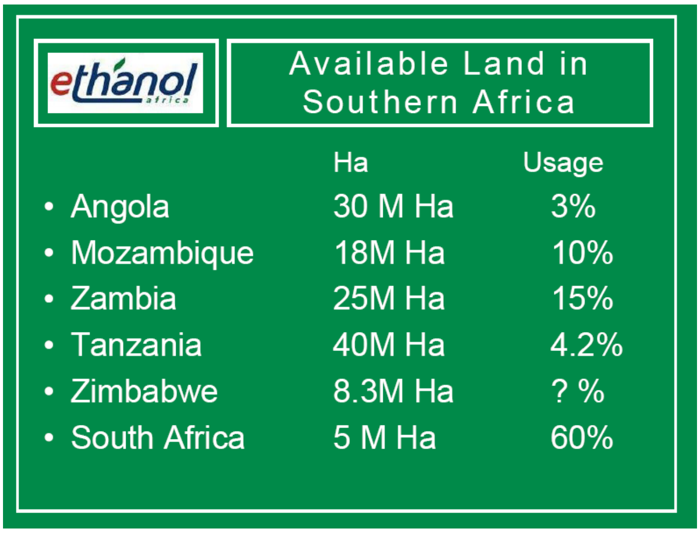


Figure 16: Land availability in selected African countries
Source: Ethanol Africa

Crop types – eight crop types are recognised of potential significance for biomass-bioenergy conversion in southern Africa. Figure 17 lists seven of these, indicating distribution and yield across the region. One additional, still experimental, crop is *Jatropha* which produces an inedible oil suitable for biodiesel. With the exception of palm oil, all the crops can be grown across the whole SADC region. Sugar cane (for ethanol) and soya beans and palm oil (biodiesel) are the primary energy crops which are widely grown or have high yields. Maize is potentially very significant in the Republic of South Africa for ethanol use but is likely to be restricted as an energy crop to ensure security of food supply.

Country	CROP						
	Palm oil	Sunflower	Soyabean	Maize	Sorghum	Sugar cane	Cassava
Angola	280	11		510		360	5 ,600
Botswana		7		10	32		
DRC	1,150		14.6	1,155	54	1,787	14,951
Lesotho				150	46		
Madagascar	21		0.05	349.7	1	2,460	2,191
Malawi		3.7		1,733	45	2,100	2,559
Mauritius				0.19		5,200	0.13
Mozambique		6.3		1,248	314	400	6,150
Namibia		0.05		33	6		
South Africa		675.5	220	9,737	449	19,095	
Swaziland				70	0.6	4,500	
Tanzania	65	28	2.1	2,800	650	1,800	6,890
Zambia		10	15	1,161	19	1,800	950
Zimbabwe		8	84	1,000	80	4,100	190
TOTAL	**1,516**	**749.6**	**335.8**	**19,957**	**1,697**	**43,602**	**39,441**

Figure 17: Crop tabulation for seven principle African biofuels crop types. Source: SADC based on FAO data. Yields in 1000 metric tonnes.

6.2 Central / South America

The recent Oak Ridge study[8] on biofuel feedstock potential, highlights three South American countries as potential major sources of biofuels in the future, Argentina, Brazil and Colombia, based on land availability and their production of key biofuels crops such as sugar cane, palm oil and soya.

Land Units in millions of hectares Country	Total land available "equivalent suitable for cultivation"	Actually Cultivated or in Permanent Crops	Available Equivalent Arable Land
Argentina	71	29	42
Brazil	394	67	327
Canada	76	52	24
China	138	127	11
Colombia	48	4	44
India	169	170	0
Mexico	36	27	9

Figure 18: land availability for selection of countries, including principle South American potential sources.

Crop Types – bioenergy production in the region is currently dominated by sugar ethanol from Brazil. Although other crops are becoming important, including palm oil and soya for biodiesel, ethanol is likely to remain the main bioenergy output from South America

8 Keith L. Kline Gbadebo A. Oladosu Amy K. Wolfe Robert D. Perlack Virginia H. Dale Matthew Mcmahon. 2008. Biofuel feedstock assessment for selected countries. Oak Ridge National Laboratory. To Support the DOE study of Worldwide Potential to Produce Biofuels with a focus on U.S. Imports.

in the future. The World Bank[9] view of the future biofuel development in the region is based on three time scales:

- Short term (to 10 years) – sugar cane based ethanol production the best economic and environmental option;
- Medium term (to 20 years) – cane based ethanol supplemented by other energy crops, in particular soya;
- Long term (20 years plus) – much broader based ethanol industry using cellulosic feedstocks supplemented by other energy crops.

The series of figures on the following pages (all from the Oak Ridge study) illustrates the biofuel crops and likely source countries in and beyond the region anticipated to be important for future biofuels supplies. Argentina and Brazil are expected to be pre-eminent within this region but Colombia is developing both an ethanol and biodiesel capacity.

	Feedstock supply potential: 2012, 2017, 2027				
Selected Countries	Sugarcane	Palm Oil	Soybeans	Corn	Wheat
Argentina	X		X	X	X
Brazil	X		X	X	
Canada				X	X
China	X		X	X	X
Colombia	X	X			
India	X				
Mexico	X			X	
Caribbean Basin (CBI)	X	X			

Figure 19: principal feedstocks identified for countries studied by Oak Ridge including five South/Central American countries. CBI = Caribbean Basin.

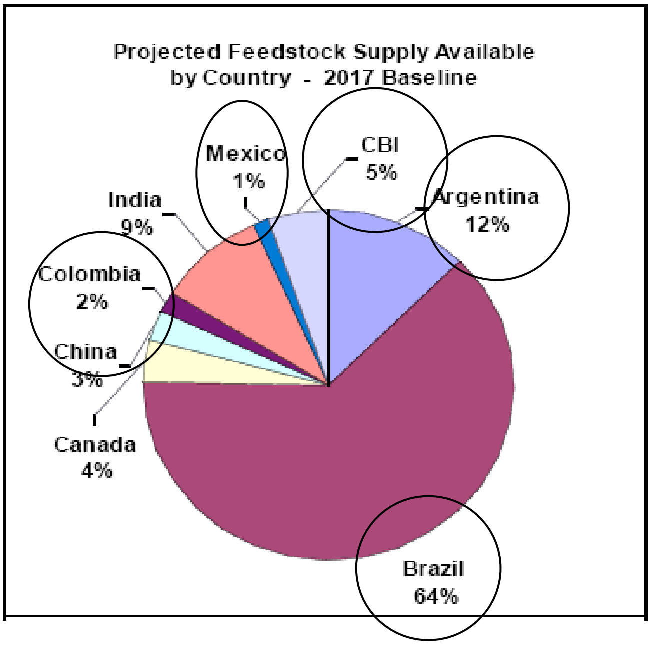


Figure 20: relative feedstock supply identified by Oak Ridge including five key South/Central American supply countries. CBI = Caribbean Basin.
(Note: analysis did not include CIS or SE Asia)

9 Banco Interamericano de Desarrollo Departamento de desarrollo sostenible borrador Biocombustibles ¿La formula mágica para las economías rurales de ALC? Peter Pfaumann (SDS / RUR) Noviembre 2006 Unidad de desarrollo rural sds/rur

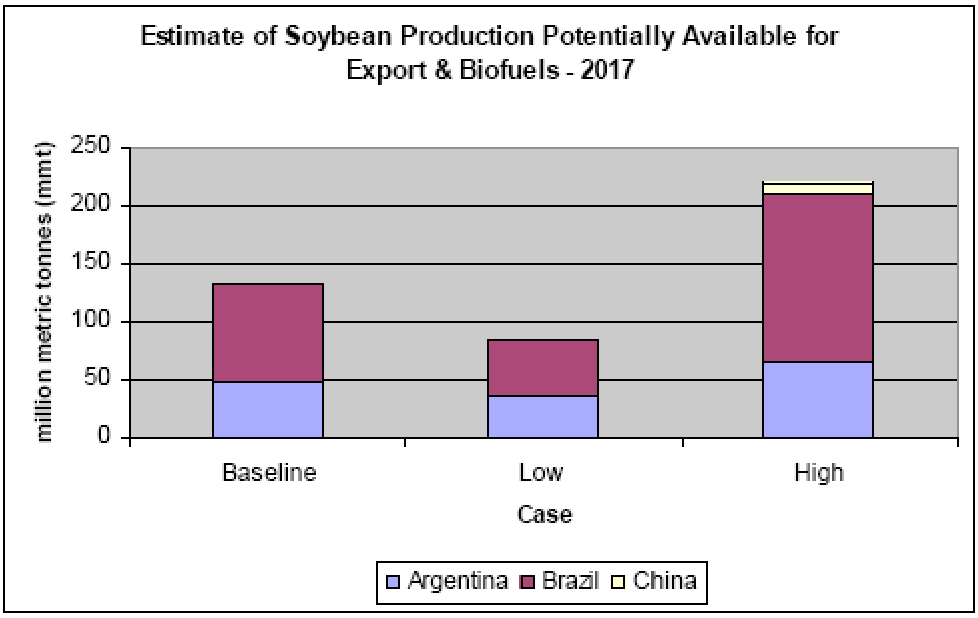


Figure 21: Relative global importance of Brazil and Argentina as suppliers of soya

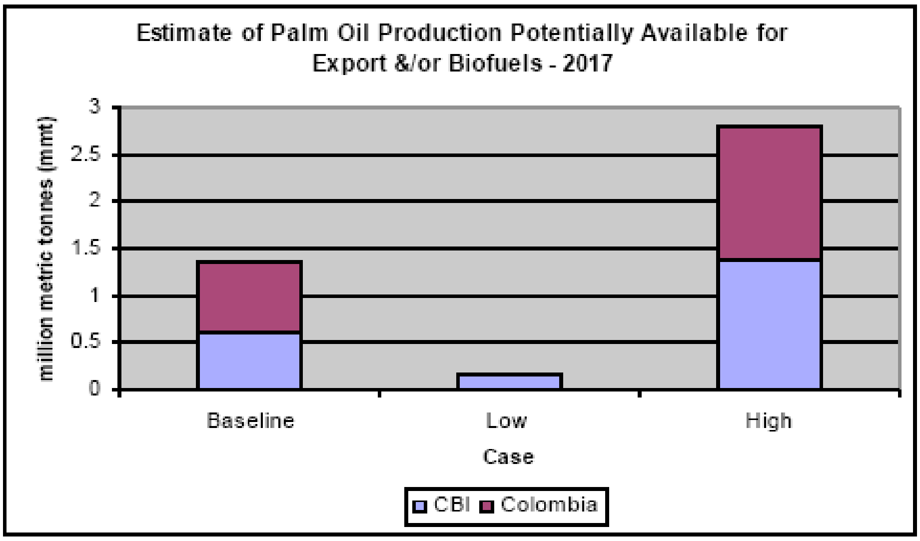


Figure 22: Relative regional importance of the Caribbean and Colombia as suppliers of palm oil

6.3 Asia

Biofuel potential within the Far East principally involves palm oil as a feedstock for biodiesel in the short term but with other crops developing with time. Between 1990 and 2003 , oil palm plantations have primarily expanded in the top two palm oil producing countries of Malaysia and Indonesia[10] but other countries (Papua New Guinea and Thailand in particular) are potential growth countries for the future in response to rising global demand from the bioenergy and food industries.

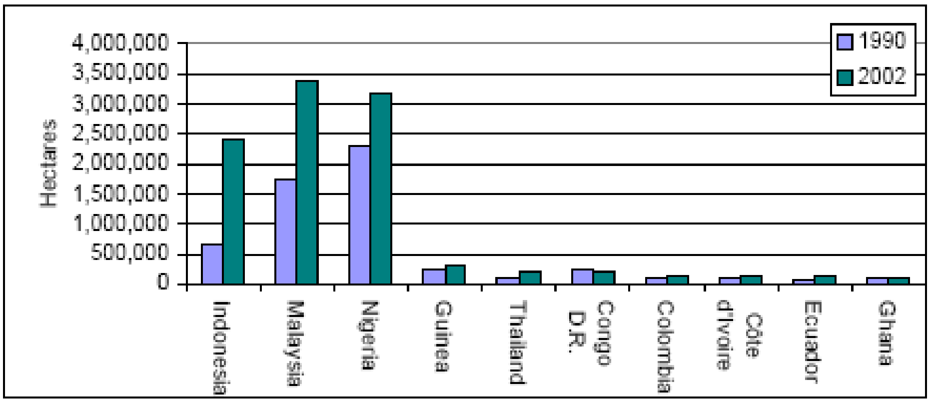


Figure 23: Oil palm distribution by country. Source WWF and FAO.

Other crops of future use for biofuels include sugar cane and cereals but the major economies in the area – India and China – are cautious about the use of food crops for energy and are promoting non-food crops such as *Jatropha* or use of waste materials. Future biofuel potential in the region will therefore involve diversification away from use of palm oil.

	Feedstock supply potential: 2012, 2017, 2027				
Selected Countries	Sugarcane	Palm Oil	Soybeans	Corn	Wheat
Argentina	X		X	X	X
Brazil	X		X	X	
Canada				X	X
China	X		X	X	X
Colombia	X	X			
India	X				
Mexico	X			X	
Caribbean Basin (CBI)	X	X			

Figure 24: Principal biofuel feedstocks in India and China. Source: Oak Ridge

10 OIL PALM, SOYBEANS & CRITICAL HABITAT LOSS. A Review Prepared for the WWF Forest Conversion Initiative. 2003

6.4 The CIS and Baltic states – the EUs near neighbours

The FAO identifies these areas as potentially significant producers of bioenergy from both forest biomass and also from energy crops, such as rapeseed and sunflower.

Potential from the C.I.S. & Baltic States is due to a combination of limited increase in population growth, limited increase in consumption and large underused areas agricultural land. Land area is therefore relatively large compared to the projected demand for food. Figures from the UK's Home Grown Cereals Association indicate that the amount of 'available' land in Russia and the Ukraine is far less than in potential tropical suppliers – and lack the competitive advantage of the tropical zone - but the proximity of this potential bioenergy source to the EU market makes these areas potentially important as a supplier to the EU

(Million Hectares)	Total Land	Suitable Arable Land	Land in use*	Land Available
UNITED STATES	947	220	180	41
BRAZIL	854	169	64	105
UKRAINE	60	40	34	6
RUSSIA, FED.REP	1,674	147	130	17

Figure 25: Land availability statistics for selected countries, including Russia and the Ukraine. Source: UK HGCA

7. Biomass for energy – overview of links to environmental and biodiversity impacts

7.1 General impacts of different organic material flows for bioenergy/biofuels

In Section 5.1 four biomass streams were defined as important for biofuels production through either 1st or 2nd generation processes. This approach emphasises case specific impact assessment in terms of what is happening in particular locations using specific crops and management techniques.

An overview of the possible implications of each of these four streams is presented below.

Route 1: Conventional farming practices – conventional food crops	
Process	**Implications**
• Can supply food or fuel industry – price dependent switching to most appropriate market • No change in agricultural practices or type of crops • Feeds into first generation processing plants for bioethanol or biodiesel	• Minimal/no GHG reduction – no attempt to reduce emissions through change in farm practices; crops used not optimal for GHG reduction • Direct competition with food supply through switching from one market to another • Low energy efficiency – no attempt to reduce energy input to production • Uncertain biodiversity effects – neutral or negative. No positive benefit.

Route 2: Energy farming practice – modified (for energy) food crops	
Process	*Implications*
• Supplying only energy industry • Change in farming practice (rotations, etc.) to maximise biomass yield • Use of modified food crops (rapeseed with oils optimised for biodiesel, cereals with enzyme content suitable for fermentation etc.) • Feeds into first generation processing plants for bioethanol or biodiesel	• Best practice can significantly reduce GHG emissions if appropriate farming practices adopted (minimum fossil fuels use, minimal agrichemical use, avoid land use changes that release CO2, etc.) • Reduced competition with food supply – still some competition through land use changes • Best practice can ensure energy efficiency • Best practice can have positive biodiversity effects through increasing crop diversity, avoidance of monocultures etc or at least be neutral. • If optimised only for GHG reduction then some negative implications for water use, soil function and biodiversity. GHG

	reduction needs to be balanced against other environmental needs.

Route 3: Energy farming practice – energy (lignocellulose) crops	
Process	*Implications*
• Supplying only energy industry • Change in farming practice to maximise biomass yield • Use of non-food crops to produce lignocellulose – short rotation coppice, miscanthus etc. • Feeds into second generation processing plants for bioethanol or biodiesel	• Best practice can significantly reduce GHG emissions if appropriate farming practices adopted (minimum fossil fuels use, minimal agrichemical use, avoid land use changes that release CO2, etc.) • Reduced competition with food supply – still some competition through land use changes • Best practice can ensure energy efficiency • Best practice can have positive biodiversity effects through increasing crop diversity, avoidance of monocultures etc or at least be neutral. • If optimised only for GHG reduction then some negative implications for water use, soil function and biodiversity. GHG reduction needs to be balanced against other environmental needs

Route 4: Use of agricultural and forestry waste	
Process	*Implications*
• Supplying only energy industry • Feeds into second generation processing plants for bioethanol or biodiesel	• Significant reduction of GHG emissions possible • No competition with food supply • Energy efficient • Uncertain biodiversity effects – neutral or negative. If based only on GHG reduction then some negative implications for soil function and biodiversity through excessive removal of biomass from woodland and soils. GHG reduction needs to be balanced against other environmental needs.

7.2 Biodiversity impacts in a sustainability assessment context

The use of biomass for bioenergy programmes can have a range of positive or negative social, economic or environmental impacts. The principal interest for JNCC work in respect of global biofuels work is to identify the potential for biodiversity impacts of biomass-bioenergy programmes in a set of priority biodiverse countries which are currently, or are emerging as, biomass/biofuel suppliers. Analysis of these impacts may de undertaken 'directly', looking immediately at the casual links between biofuels development and potential biodiversity impacts. The approach taken in this programme, and the analytical tools being developed, is less direct and based on a more general 'sustainability' assessment of the potential impact of bioenergy programmes and linking this to biodiversity as appropriate.

This sustainability approach is based upon the following principles:

- Biomass for energy programmes have significant potential social, economic and environmental impacts;
- Whilst it is possible to look for direct causal links between bioenergy programmes and biodiversity this approach can fail to recognise the indirect biodiversity loss/gain drivers arising from wider social, economic or environmental impacts;
- The JNCC biofuels/bioenergy work in the context of this work programme is to examine potential biofuels impacts in terms of six environmental 'sustainability' indicators namely:

    i. Land use;
    ii. Soil function;
    iii. Water use;
    iv. Pollution;
    v. GMOs/invasive species;
    vi. Greenhouse gas emissions.

Each of these environmental indicators have implications for biodiversity (see following section) but also have wider environmental (and social and economic) implications. Undertaking impact analysis against this range of environmental indicators is designed to make such analysis relevant to a wider audience of policy makers, allow screening of biofuels programmes against a broad set of indicators and permit subsequent work to be focussed on those areas where significant impacts are likely to arise.

7.3 Relationship between biofuels sustainability indicators and biodiversity impacts

Different biomass production techniques will result in different biodiversity impacts varying from negative through neutral to positive (Section 7.1). Biodiversity drivers – unfortunately usually drivers for loss – have been categorised by the Millennium Ecosystem Assessment with five key drivers:

i. Habitat change
ii. Overexploitation
iii. Pollution
iv. Invasive species.
v. Climate change

In the case of biomass for energy use an additional potential driver, the use of GM technology, has been added for the JNCC assessment work. The JNCC defined sustainability indicators can be linked to the MA drivers in a simple analytical process.

The first step in the use of these six environmental 'sustainability' indicators (Section 7.2) is to undertake an initial sustainability screening of biomass for biofuel (or, more generally bioenergy) programmes. Such screening will allow key potential environmental impacts of individual programmes to be identified and the nature of the on the ground impacts to be specified (in terms of land use, water use etc.). This screening can define impacts in broad terms, rather than being biodiversity specific, giving a wider social and economic relevance to the analysis.

Impacts of greatest likely magnitude can be highlighted by this process and then related to specific biodiversity impacts using, if necessary, the MA terminology (Fig. 26). In some cases there may be significant sustainability impacts identified but in the context of the region where they are occurring, there may be little or no scope for biodiversity impacts. Alternatively, a high sustainability impact, for example in water use or soil function impact, may pose a high risk for local/regional biodiversity. Work is in progress to develop this approach and apply it at a strategic level to key global suppliers of biomass for bioenergy.

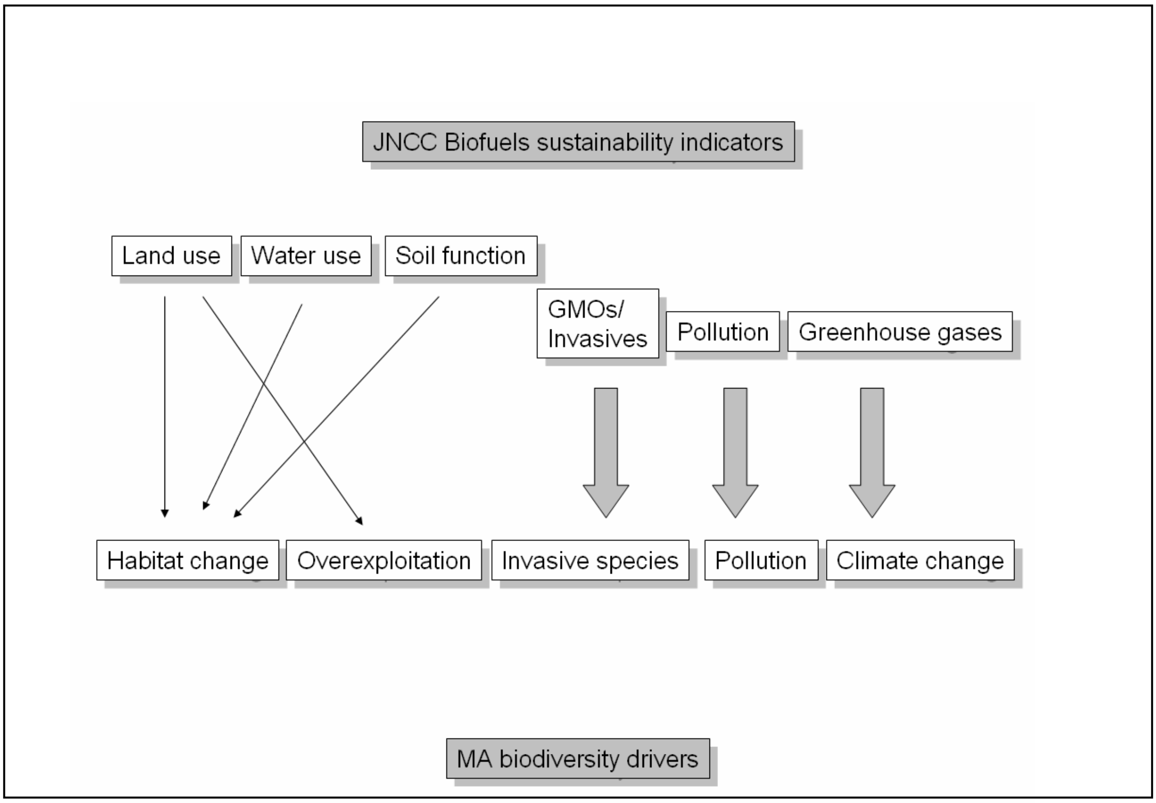


Figure 26: Relationship between biofuel environmental indicators used by JNCC and the MA biodiversity drivers

8. Biodiversity impact of biofuels developments – tools and approaches

8.1 Overview

The JNCC biofuels work under the Global Impacts Programme falls under two areas.

- Identify key biofuel producing countries and develop and maintain a *biofuels intelligence gathering programme*, monitoring policy and other major developments in these countries[11]. This will be delivered through the project website (http://www.ukglobalinfluence.org/) from June 2008 and maintained for a trial period to end 2010.

- develop a *biofuels impact screening approach* applicable at a strategic national level to establish risks/opportunities associated with biofuels programmes involving specific crops. Case studies will be developed for some/all of the priority biofuel countries. Work is in progress on this approach and will continue through 2008.

8.2 Policy tracking – background and work in progress

Biofuels policies around the world are developing rapidly. Countries are setting targets for biofuels substitution based on environmental and economic considerations, and developing strategies to meet these targets based on domestic agricultural production, waste recovery programmes and import or export strategies.

Given the pace of change within the industry an intelligence gathering exercise, aimed at monitoring developments in key biofuels producing countries is being developed by JNCC on a trial basis. This intelligence gathering uses sources reviewed in section 3 of this report and aims to track (in 'real time') three aspects of national developments in the 15 key countries currently identified as biofuels priorities for the JNCC programme:

- National biofuels substitution targets;
- National policy and current national trends in respect of biofuels crop development;
- Significant developments within the biofuels industry with emphasis on links to the UK and EU i.e. through significant investment programmes.

Within the context of the JNCC programme this work is designed to provide contextual information on key countries to identify geographical areas, and specific ecosystems, where biofuels production may affect biodiversity. A key aspect of the intelligence gathering exercise is to identify emerging trends.

11 Initially: Argentina, Brazil, Democratic Republic of Congo, China, Colombia, Ghana, Indonesia, India, Kazakhstan, Mexico, Mozambique, Papua New Guinea, Russian Federation, Ukraine, Republic of South Africa

8.3 Biofuels impact screening approach – sustainability indicators

The biofuels 'sustainability assessment approach' being developed by JNCC was summarised in section 7.2. and is based on six specific indicators:

i. Land use;
ii. Soil function;
iii. Water use;
iv. Pollution;
v. GMOs/invasive species;
vi. Greenhouse gas emissions.

JNCC commissioned work from consultancy Scott Wilson in 2007 to begin development of a screening procedure based on these indicators. A first step has been to refine the criteria to determine critical areas for evaluation within each topic, in particular by identifying sub-criteria. Figure 27 tabulates the initial results of this refining process listing the main criteria and sub-criteria.

Topic: Land use	
General	Environmental Sustainability Land use Indicator World Ranking
Agriculture	Land: Area of Arable and permanent cropland and % change Units: Thousand hectares
	Crop Diversity
Biodiversity and threats to biodiversity	Ecosystem areas
	Forest Extent (000 Ha)
	Red Data List Species - critically endangered and showing a downward trend, where agriculture is identified as a threat
	G200 Ecosystems and Identified Threats
	Forest Extent: Frontier forest, percent threatened
	Protected Areas: IUCN categories I-V, percent of total land area
	Environmental Sustainability Ecosystem Stress Indicator World Ranking
	Environmental Sustainability Biodiversity Indicator World Ranking
Topic: Soil Function	
Quality and degradation	Land degradation: severity of human-induced degradation (% of total area)
Major soil constraints (Sodicity, Shallowness, Erosion Risk)	% of total land suffering from salinity, sodicity, shallowness or erosion risk
Topic: Water Use	
Irrigation and Cultivation systems	Land: Irrigated land (thousand hectares)
Rainfall and Rainfall distribution	Volume and location
Agricultural use of water resources	Water withdrawals for agricultural use as % of total water withdrawal
Environmental Sustainability Water Quantity Indicator World Ranking	
Wetlands of international value	number of RAMSAR sites
Environmental Sustainability Water Quality Indicator World Ranking	

Figure 27a: Provisional sustainability criteria for biofuels strategic assessment. Source JNCC and Scott Wilson

Topic: GHG emissions	
Sectoral Emissions	Carbon Dioxide emissions from Agriculture (thousands metric tons of carbon dioxide) and as a percent of Total Carbon Dioxide (CO2) Emissions by Sector: Other Commercial, Public, and Agricultural Sectors
Degree of mechanisation	Number of Tractors & Percent Change or Total road network
Total Carbon Stock	Carbon stock in forest and other wooded land Carbon (million metric tonnes)
Environmental Sustainability Greenhouse Gas Emissions Indicator World Ranking	
Topic: Pollution	
Fertilisers and Pesticides	Agricultural Inputs: Fertilizer consumptionConsumption (tonnes) | Nitrogen (N total nutrients) +
	Agricultural Inputs: Fertilizer use intensity (Kg Fertiliser per hectare of cropland)[3]
	Agricultural Inputs: Pesticide use intensity (Kg Pesticide per hectare of cropland)
Topic: GMOs and Invasive Species	
Genetic Degradation	Domesticated crop varieties and livestock breeds
	The number of national crop varieties/livestock breeds that are endangered.
	Wild species abundance, richness and non-native species
Invasive species	Proportion of alien or invasive species
	Wild crop relatives found

Figure 27b: Provisional sustainability criteria for biofuels strategic assessment. Source JNCC and Scott Wilson

8.4 Biofuels impact screening approach – biofuels crop impact screening in a national context.

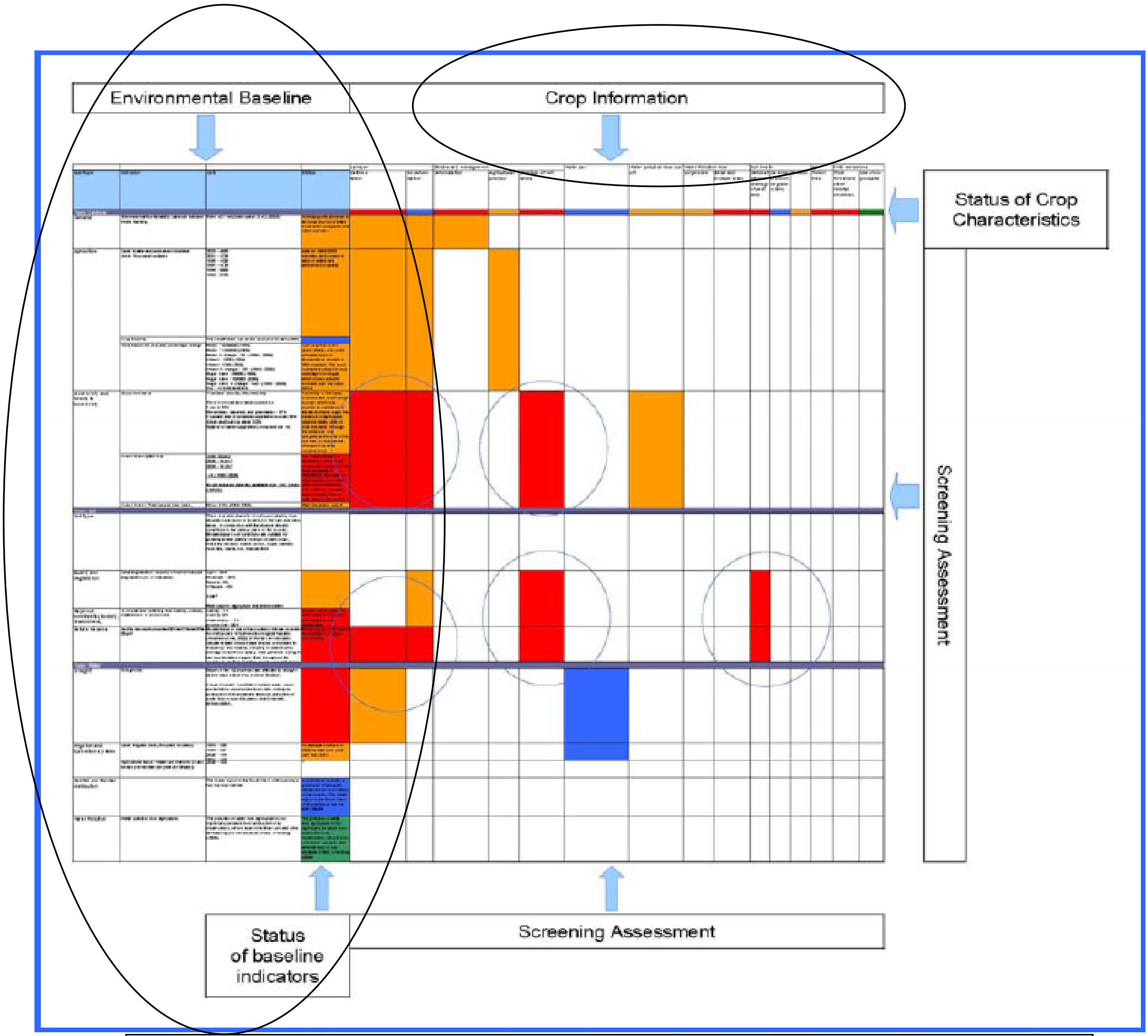
Defra has commissioned research[12] into the nature of biodiversity impacts that may result from use of specific biofuel crops. Results have not been published to date but one output from this work is a matrix based analysis of impacts of individual crops in terms of a set of key indicators such as water use, land use and soil impacts. Impacts are coded to identify those that are most significant (Figure 28).

This approach provides a starting point for work within the JNCC programme looking at country specific biofuels impacts assessments. Work in progress is seeking to link the crop specific assessments developed by Defra to country specific baseline data. This involves cross referencing crop impacts (for crops relevant to specific countries) to country baseline data that defines environmental sensitivity within subject countries. Such cross referencing through a matrix approach (illustrated in Figure 29) seeks to highlight conflict areas for further investigation. Two case studies – for Colombia and Mozambique are in progress to test the use of this approach.

Key Indicator and score	Impact code	Key factor	Impact
Land use change		Replaces arable cultivation	The area for maize production in the USA increased by 12 million acres between 2006 and 2007 and further growth is expected. A large source of this land is from adjusting crop rotations between maize and soy. Where this occurs there is likely to be a greater need for nitrogen fertilization and therefore an increase in GHG emissions.
		Replaces land currently set aside for conservation reasons.	Other sources of land include reduced fallow, cropland used as pasture, shift from other crops such as cotton and, in the USA, land that was part of the Conservation Reserve Program (CRP), (Westcott, 2007). This is often very vulnerable land and where this occurs the impacts will be negative and likely to include release of soil carbon, an increase in agrochemical inputs and soil erosion.
Biodiversity management		Cultivation in vulnerable ecosystems	As part of the CRP, the US Government pays farmers not to cultivate the most vulnerable areas. CRP land that is subsequently converted to maize production will have negative biodiversity impacts. For instance a report found that nesting rates on CRP lands to be ten times higher than on land in crop production, (Farrand and Ryan, 2005).
		Cultivation in non vulnerable ecosystems	Land that is converted from other crops such as soy will not have such large impacts on biodiversity.
Water use		Drier climates	Maize has a relatively high water demand, especially during the flowering stage[3]. Often this requires irrigation and in the USA maize is the second largest consumer of irrigated water. Moreover in places where groundwater is used for irrigation, such as Nebraska, where water is drawn from the Ogallala Aquifer[4], water may be extracted faster than it is being replaced, which is unsustainable.
		Wetter climates	Rain fed cultivation. However maize can be sensitive to drought, especially during the flowering stage. In many places it is a staple food crop and droughts have often led to crop failure and famines, especially in Africa[1]
Water Pollution			In the USA, where maize is the feedstock for 98% of ethanol production, it receives more nitrogen fertilizer than any other major crop. This can lead to pollution of water courses and drinking water (EWG 2007). Most of the maize is grown in the Midwestern

Figure 28: Example of AEA analysis of biofuel crop (maize) impacts assessment.

12 Review of work on the environmental sustainability of international biofuels production and use. Report to CEOSA, DEFRA. In preparation. AEA report.

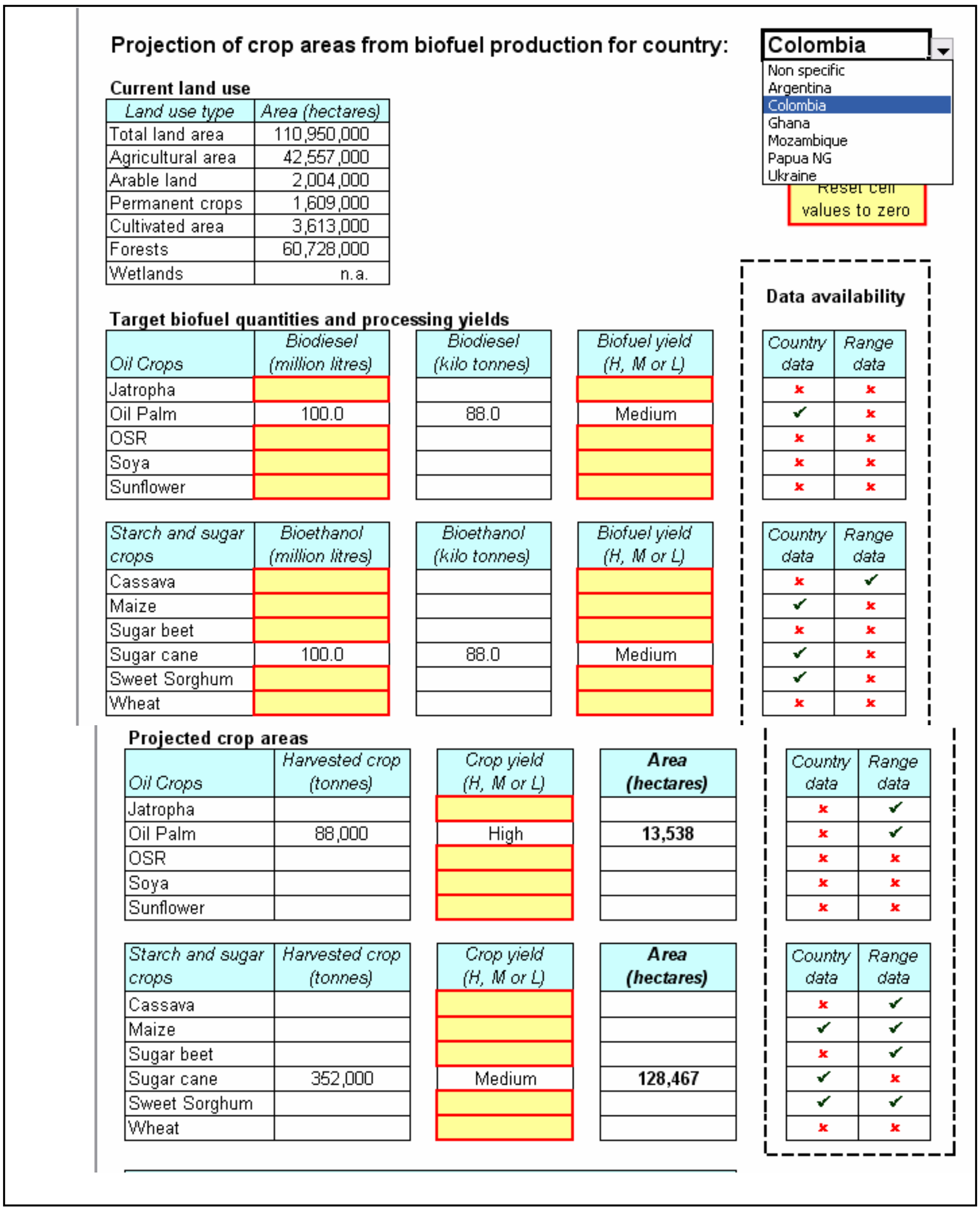


Colour	Potential for conflict / opportunity
	HIGH potential for conflict
	MEDIUM potential for conflict
	LOW potential for conflict
	Unclear from evidence available
	Potential opportunity

Figure 29: Top; Initial results from trial cross referencing of biofuel crop information (impact assessment) to environmental baseline information for Colombia. Bottom: Colour coding for highlighting potential high impact areas.

8.5 Biofuels impact screening approach – matching policy, land use and biofuel outputs through quantification.

An important element in assessing the social, economic or environmental impact of biomass for bioenergy programmes, and determining best options, is quantification of land use requirements and potential yields. Biomass production is limited, ultimately, by land availability but crop and energy yields are important factors. JNCC is developing, in collaboration with Land Use Consultants, a spreadsheet based biofuels calculator that allows *either* the land use requirements of specific biofuels targets to be calculated *or* permits biofuel yields to be calculated. These calculations are based on crop and country[13] specific parameters. The following screen shots illustrate the test version which will be available on the project website in June 2008. The calculator will be further developed during 2008 to cover the full suite of biofuel priority countries.


Projection of crop areas from biofuel production for country: Colombia

Non specific
Argentina
Colombia
Ghana
Mozambique
Papua NG
Ukraine

Reset cell values to zero

Current land use

Land use type	Area (hectares)
Total land area	110,950,000
Agricultural area	42,557,000
Arable land	2,004,000
Permanent crops	1,609,000
Cultivated area	3,613,000
Forests	60,728,000
Wetlands	n.a.

Target biofuel quantities and processing yields

Oil Crops	Biodiesel (million litres)	Biodiesel (kilo tonnes)	Biofuel yield (H, M or L)	Country data	Range data
Jatropha				✗	✗
Oil Palm	100.0	88.0	Medium	✓	✗
OSR				✗	✗
Soya				✗	✗
Sunflower				✗	✗

Starch and sugar crops	Bioethanol (million litres)	Bioethanol (kilo tonnes)	Biofuel yield (H, M or L)	Country data	Range data
Cassava				✗	✓
Maize				✓	✗
Sugar beet				✗	✗
Sugar cane	100.0	88.0	Medium	✓	✗
Sweet Sorghum				✓	✗
Wheat				✗	✗

Data availability

Projected crop areas

Oil Crops	Harvested crop (tonnes)	Crop yield (H, M or L)	**Area (hectares)**	Country data	Range data
Jatropha				✗	✓
Oil Palm	88,000	High	**13,538**	✗	✓
OSR				✗	✗
Soya				✗	✗
Sunflower				✗	✗

Starch and sugar crops	Harvested crop (tonnes)	Crop yield (H, M or L)	**Area (hectares)**	Country data	Range data
Cassava				✗	✓
Maize				✓	✓
Sugar beet				✗	✓
Sugar cane	352,000	Medium	**128,467**	✓	✗
Sweet Sorghum				✓	✓
Wheat				✗	✗

Figure 30a: Screenshot from JNCC biofuels calculation spreadsheet

[13] Currently applicable to six countries: Argentina, Colombia, Ghana, Mozambique, Papua New Guinea, Ukraine

Projection of biofuel production from crop areas for country: Colombia

Current land use

Land use type	*Area (hectares)*
Total land area	110,950,000
Agricultural area	42,557,000
Arable land	2,004,000
Permanent crops	1,609,000
Cultivated area	3,613,000
Forests	60,728,000
Wetlands	n.a.

Reset cell values to zero

Target crop areas and yields

Data availability

Oil Crops	*Area (hectares)*	*Crop yield (H, M or L)*	*Harvested crop (tonnes)*	*Country data*	*Range data*
Jatropha				✗	✓
Oil Palm	1,000,000	Medium	5,000,000	✗	✓
OSR				✗	✗
Soya				✗	✗
Sunflower				✗	✗

Starch and sugar crops	*Area (hectares)*	*Crop yield (H, M or L)*	*Harvested crop (tonnes)*	*Country data*	*Range data*
Cassava				✗	✓
Maize				✓	✓
Sugar beet				✗	✓
Sugar cane	1,000,000	Medium	2,740,000	✓	✗
Sweet Sorghum				✓	✓
Wheat				✗	✗

Projected biofuel quantities

Oil Crops	*Biofuel yield (H, M or L)*	*Biodiesel (kilo tonnes)*	*Biodiesel (million litres)*	*Country data*	*Range data*
Jatropha				✗	✗
Oil Palm	Medium	5,000.0	5,681.8	✓	✗
OSR				✗	✗
Soya				✗	✗
Sunflower				✗	✗

Starch and sugar crops	*Biofuel yield (H, M or L)*	*Bioethanol (kilo tonnes)*	*Bioethanol (million litres)*	*Country data*	*Range data*
Cassava				✗	✓
Maize				✓	✗
Sugar beet				✗	✗
Sugar cane	Medium	685.0	778.4	✓	✗
Sweet Sorghum				✓	✗
Wheat				✗	✗

Choose a processing rate from the drop down list

Biodiesel

5,000.0	**Kilo tonnes**	**or**	**5,681.8**	**M litres**
189,205	**terrajoules**	**or**	**52,557**	**GWh**

Bioethanol

685.0	**Kilo tonnes**	**or**	**778.4**	**M litres**
20,784	**terrajoules**	**or**	**5,773**	**GWh**

Figure 30b: Screenshot from JNCC biofuels calculation spreadsheet

8.6 Timeline for JNCC Global Impacts programme biofuels work to end 2008

June 2008

- *Launch intelligence gathering exercise* through project website - http://www.ukglobalinfluence.org/bioenergy/index.cfm - aimed at monitoring developments in key biofuels producing countries in terms of national biofuels substitution targets, national policy and current national trends in respect of biofuels crop development and significant developments within the biofuels industry;

- Provide web access to test version of *national biofuels calculator* based on six test countries.

November 2008

- Further develop *biofuels impact screening* approach using two countries as case studies (Colombia and Mozambique) refining both the biofuel crop impact assessments technique and national baseline assessment. Provide access to screening tool and cases study reports via project website;
- Refine *national biofuels calculator*, verify and develop underlying crop and bioenergy database to allow extension to all priority biofuel supply countries.

9. Key references

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