Biofuels production, trade and sustainable development: emerging issues

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Environmental Economics Programme/Sustainable Markets Group

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1 Introduction

Biofuels are products that can be processed into liquid fuels for either transport or heating purposes.[1] Bioethanol is produced from agricultural products including starchy and cereal crops such as sugarcane, corn, beets, wheat, and sorghum. Biodiesel is made from oil- or tree-seeds such as rapeseed, sunflower, soya, palm, coconut or jatropha.

Although efforts to produce biofuels date back to the early days of the automobile (particularly the successful experience of the PROALCOOL Programme launched by Brazil in 1975), biofuels have only started to be seen as a serious alternative to oil worldwide over the last five years or so. Their reduced carbon emissions compared to conventional fuels and their positive impacts on rural development, together with the current high oil prices, are key elements behind their market development.

The perceived benefits of biofuels are reflected in the increasing number of countries introducing or planning to introduce policies to increase the proportion of biofuels within their energy portfolio. If this is to be achieved, significant increases in production are required rapidly to satisfy greater global demand. For instance, the EU's goal of 5.75 per cent biofuel content in the fuel transport blend by 2010 will require a fivefold increase in EU production. With the coming into force of the Kyoto Protocol and the implementation of the different domestic measures for biofuels, global biofuel production is expected to quadruple in the next twenty years, accounting for about 10 per cent of world motor petroleum.[2]

Currently very little biofuel enters international markets since the bulk of it is consumed domestically. However, trade in biofuels is expected to expand rapidly, as many countries will not have the domestic capacity to supply their internal markets. Governments will need to create the conditions both at global and national levels for increased production and trade.

Despite enthusiastic views on the potential of biofuels for sustainable development, there is currently very little research on the links between biofuel production, trade and sustainable development. Existing research focuses on the economic and technological aspects of biofuel production. Research on environmental aspects tends to concentrate on their energy balance and potential for reduced GHG emissions. Almost no research has been done on the trade aspects or the wider implications for sustainable development of trade in biofuels.

At present there is no comprehensive trade regime specifically applicable to biofuels. Biofuels are categorised as "other fuels", or as alcohol (in the case of ethanol) and are subject to general international trade rules under the World Trade Organization (WTO). Energy crops are covered by the WTO Agreement on Agriculture. Biofuels may also be included in a list of "environmental goods" for accelerated trade liberalisation under the current Doha Round. In addition, there are several barriers – including tariffs but especially non-tariff barriers - affecting biofuel production and trade that could jeopardise developing countries' potential to benefit from a wider global biofuel uptake. Developed countries' domestic policies and support for

[1] Other types include biomethanol, biodimethylether and biogas
[2] IEA 2004

production of energy crops (e.g. subsidies and tax credits) and biofuels processing are key in this sector. Another cause for concern is the proliferation of different technical and environmental standards with no mutual recognition between them.

An increase in trade in biofuels would imply crop expansion in several countries. This would have implications for sustainable development that would need to be investigated. On the one hand, biofuels could lead to greater economic gains, rural development (i.e. poverty reduction), and reduced GHG emissions compared to oil fuels. On the other hand, production of energy crops could cause expansion of the agricultural frontier, deforestation, monocropping, water pollution, the spread of GMOs, food security problems and poor labour conditions, amongst other concerns. The positive impacts and trade-offs involved vary depending on the energy crop in question, conversion technology and the country under consideration. These need to become clearer.

This paper seeks to provide a preliminary identification of the main sustainable development issues involved in the debate around production and trade in biofuels. The paper is organised as follows. Chapter 2 provides a brief description of the different types of biofuels. Chapter 3 identifies the major international biofuel producers and suppliers and the main international buyers. Chapter 4 provides an overview of key policies behind biofuel market development. Chapter 5 analyses relevant aspects of trade in biofuels, including the main trade barriers and relevant trade rules. Chapter 6 analyses the main links between biofuels and sustainable development. Finally, Chapter 7 concludes by identifying some gaps and ideas for further work.

2 Definition and types of biofuels

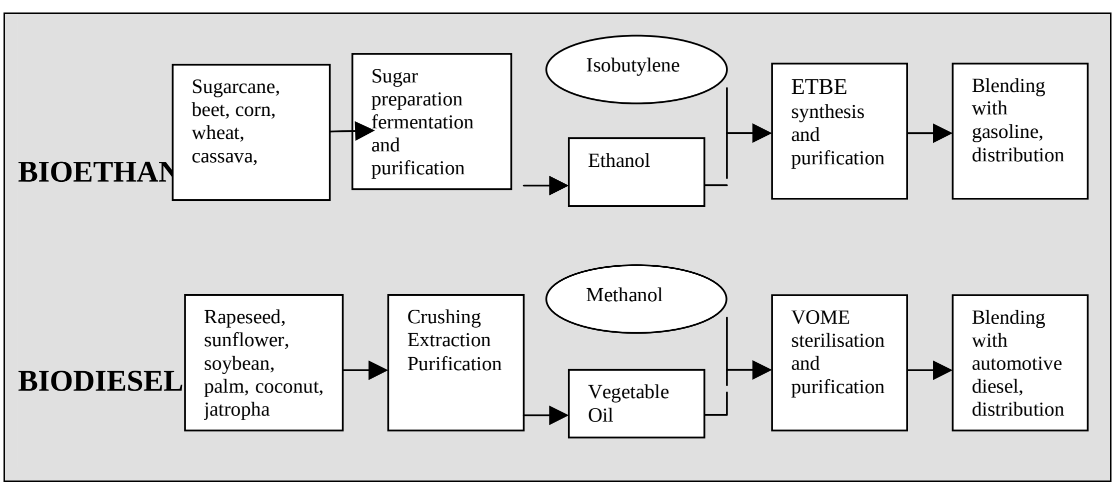
Biofuels can be defined as liquid fuels produced from biomass for either transport or burning purposes. They can be produced from agricultural and forest products, and the biodegradable portion of industrial and municipal waste.

This paper concentrates on two types of transport biofuel: bioethanol and biodiesel,[3] which account for more than 90 per cent of global biofuel usage.[4]

Bioethanol is a distilled liquid produced by fermenting sugars from sugar plants and cereal crops (sugarcane, corn, beet, cassava, wheat, sorghum) and whose manufacturing process is presented in Figure 1. A second generation of bioethanol – lignocellulosic - also includes a range of forestry products such as short rotation coppices and energy grasses. Bioethanol can be used in pure form in specially adapted vehicles or blended with gasoline. Bioethanol can be blended with gasoline in any proportion up to 10 per cent without the need for engine modification. Blends of 5 per cent or 10 per cent of bioethanol in gasoline are denominated B5 and B10, respectively.

Biodiesel or vegetable oil methyl ester (VOME) is produced from the reaction of vegetable oil with ethanol or bioethanol in the presence of a catalyst to yield mono-alkyl esters and glycerine, which is then removed (see Figure 1). Oil is produced from oily crops or trees such as rapeseed, sunflower, soya, palm, coconut or jatropha, but it can also be produced from animal fats, tallow and waste cooking oil. A second generation of biodiesel technologies - the Fischer-Tropsch process - synthesises diesel fuels from wood and straw to a gasification stage. Similar to bioethanol, biodiesel can be used in pure form in specially adapted vehicles or blended with automotive diesel. A blend of 5 per cent of biodiesel is denominated as B5.

Figure 1: Biofuel manufacturing processes



Source: adapted from "The Paths to Sustainable Development", available at: http://www.total.com/static/en/medias/topic103/Total_2003_fs03_Biofuels.pdf

[3] Other types include biomethanol, biodimethylether and biogas
[4] Biofuels Taskforce 2005

3 Biofuel markets, production and trade

3.1 Trends in global biofuels production

Initial efforts to produce biofuels date back to the early days of the automobile. However, they were quickly replaced as the fuel of choice by cheap petrol, which continued relatively unchallenged until the oil crisis of the 1970s, inducing governments to explore alternatives sources of fuel. In 1975 the Brazilian Government launched the PROALCOOL Programme to replace imported gasoline with bioethanol produced from locally grown sugarcane. It was then that biofuels started to be seen as a serious alternative to petrol. However, once the oil crisis ended in the late 1970s to early 1980s, interest in biofuels diminished.

Renewed interest in biofuels has been reflected in the rapid expansion of global biofuel markets in the last five years or so. Commonly cited driving forces behind the current market development of biofuels include: current high oil prices, opportunities for greater energy security, and currency savings through a reduced oil bill. But what is new about this renewed interest and what makes biofuels a serious option for partially replacing oil as a transport fuel are their alleged reduced greenhouse as (GHG) emissions. This would help countries to combat the global warming problem and would enable them to comply with the commitments under the Kyoto Protocol. In addition, the Brazilian experience shows that biofuels can deliver export opportunities and rural development.

Biofuels are a serious option to compete with oil in the transport system compared to other technologies such as hydrogen, because biofuel technologies are already well developed and available in many countries. Bioethanol and biodiesel can be mixed with the petroleum products (gasoline and diesel) they are substituting for and can be burned in traditional combustion engines with blends containing up to 10 per cent biofuels without the need for engine modifications. Flexi-fuel vehicle (FFV) technology[5] is now sufficiently well developed to allow the gradual introduction of biofuels in any country.[6] FFV cars can run with any type of fuel blend from pure gasoline to up to 85% biofuel blend.[7] In addition, the distribution of liquid biofuels can easily be accommodated by the existing infrastructure for petroleum fuel distribution and retailing.[8] Furthermore, the current level of oil prices makes production from the most efficient producing countries competitive.

The above factors indicate that biofuels are an important challenge to the oil industry, and explain the rapid increase in global production and use in recent years. Global biofuel production is estimated to be over 35 billion litres.[9] This figure is however

[5] The main technical difference between regular vehicles and FFV is a small system placed in the vehicle that enables the engine to adapt to any type of fuel blend. The main advantage of FFV is that the motors can operate with regular gasoline – when biofuels are not available or are not economically competitive (Coelho, 2005).

[6] Coelho, 2005

[7] Brazilian FFVs are built to operate with any percentage of ethanol-gasoline blend and even with pure (hydrated) ethanol.

[8] Doering, 2004

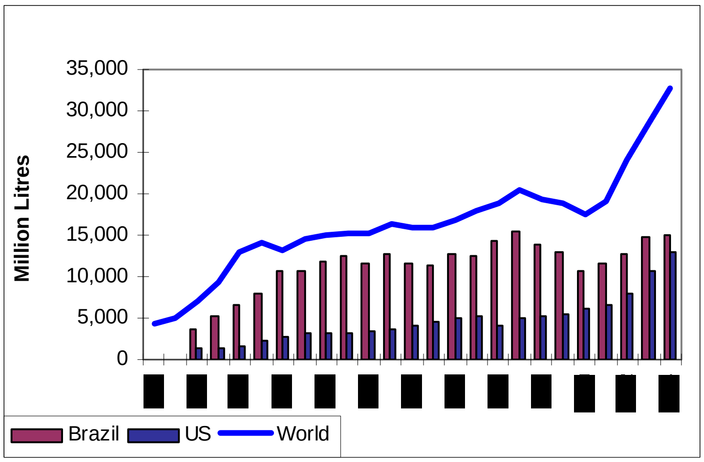
[9] EC 2006

very small compared to the 1,200 billion litres of gasoline produced annually worldwide.[10]

Bioethanol and biodiesel are both produced around the world, but more bioethanol is produced than biodiesel. The former is mainly produced and consumed in the Americas while the main market for the latter is the EU.

3.1.1 Bioethanol production

Figure 2: Global bioethanol production



Source: F.O. Licht, cited in Murray 2005.

Bioethanol is by far the most widely used biofuel for transportation worldwide. Global production reached 33 million litres in 2004, with an average annual growth of 12 per cent over the last five years (See Figure 2). About 60 per cent of global bioethanol production comes from sugarcane and 40 per cent from other crops.[11]

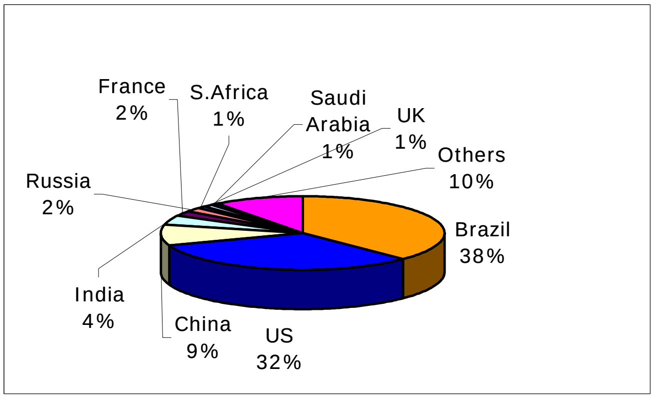
Figure 3 shows the top ten global bioethanol producers in 2004. Brazil leads world production with 15 billion litres distilled from sugarcane, equivalent to 38 per cent of worldwide production. Prompted by the increase in oil prices, Brazil began to produce bioethanol from sugarcane in the 1970s and is considered the most successful example of a commercial application of biomass for energy production and use. Extensive experience in bioethanol production, suitable natural conditions for sugarcane production and low labour costs have made Brazil the most efficient bioethanol-producing country.[12] Production is mainly destined for the internal market, where bioethanol accounts for 41 per cent of Brazilian gasoline consumption. Over recent years exports have started to expand, but still account for less than 10 per cent of domestic production.

The US is the second largest producer and consumer, accounting for 32 per cent of world bioethanol production in 2004. Bioethanol started to be produced from corn in the early 1970s, but only recently began to be more widely used. Bioethanol production capacity increased from 4 billion litres in 1996 to 14 billion litres in 2004[13]

[10] BIOFRAC 2006
[11] Trindade S 2005a
[12] Bioethanol production costs in Brazil are around 20 euro-cents per litre as compared with 30 cents in the United States and 50 cents in the European Union.
[13] BIOFRAC 2006

and currently accounts for over 2 per cent of national gasoline consumption.[14] Despite the rapid increase in production, ethanol consumption has been outpacing production in the last few years, leading to increased ethanol imports.[15]

Figure 3: Top 10 bioethanol producers, 2004



Source: F.O. Licht, cited in Murray 2005.

Several other countries are trying to replicate Brazil's success in producing bioethanol and are introducing measures to stimulate production, including the following.

- The EU produced 10 per cent of the world's bioethanol in 2004.[16] France is currently the front-runner in the EU's attempt to boost bioethanol use, accounting for 2 per cent of global production, mainly from sugar beet and wheat. However, France is rapidly being overtaken by Spain as the EU's largest bioethanol producer.
- China accounts for about 9 per cent of global bioethanol production, 80 per cent of which is grain-based – mainly derived from corn, cassava and rice.
- India accounts for 4 per cent of global bioethanol production. This is made from sugarcane. [17]
- Thailand, the world's second largest sugar exporter, is planning to introduce B10 by 2007, with production goals of 1 to 1.5 billion litres a year.
- Canada produces around 231 million litres of bioethanol per year, mainly from wheat and straw, and is planning to increase production to 1.4 billion litres by 2010.
- In South America, sugar producing countries like Colombia and Peru are taking measures to stimulate production and consumption of sugarcane-based bioethanol. In 2001 Colombia introduced a law that stipulated that the country's gasoline must contain 10 per cent ethanol by 2009, with gradual increases to 25 per cent in 15 to 20 years.[18] The country is already producing 1,050 million litres a day and is exploring the potential of other sources such as cassava and beets.[19]
- Australia is assessing a wider role for bioethanol within the transport system

[14] Severinghaus J., 2005
[15] Elobeid A and Tokgoz S. 2006
[16] EC 2006
[17] Bhojvaid P 2006
[18] IPS 2006
[19] RDS 2006

- Sugar-producing African countries such as South Africa, Kenya, Malawi, Zimbabwe and Ghana are also exploring possibilities for large-scale bioethanol production.

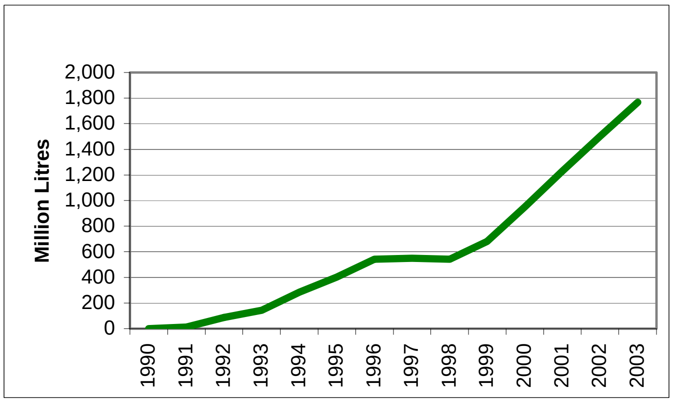
Overall, it is estimated that the world produces enough bioethanol to replace roughly 2 per cent of total gasoline consumption. Table 1 summarises the main bioethanol producing countries.

A new generation of bioethanol technologies – called lignocellulosic bioethanol -, is being developed. Lignocellulosic bioethanol uses enzymes to synthesise bioethanol and is being developed in North America, particularly in Canada. The main barrier to widespread adoption of lignocellulosic alternatives is technological: the enzymes needed to convert cellulose are prohibitively expensive and inefficient; but new enzymes that will make this technology viable are said to be forthcoming. [20] Experts envisage the technology might be ready for commercial use by 2015.

3.1.2 Biodiesel production

Biodiesel started to be widely produced in the early 1990s and since then production has been increasing steadily. Global biodiesel production reached a record of 1.8 billion litres in 2003 (see Figure 4). Compared to bioethanol, however, total biodiesel production is fairly small.

Figure 4: Global biodiesel production



Source: F.O. Licht, cited in Murray 2005.

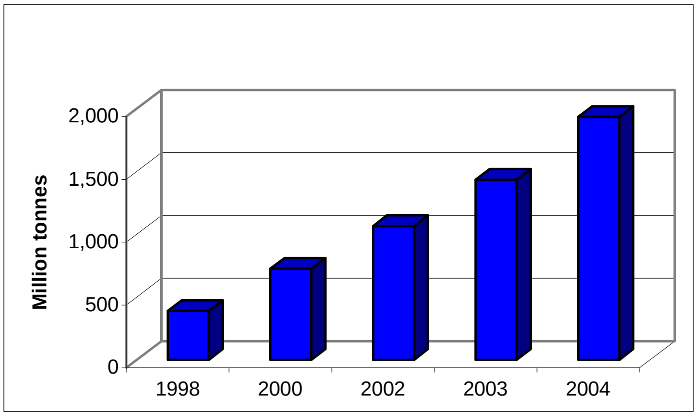
The EU is the main producer of biodiesel, accounting for about 95 per cent of global production. Biodiesel demonstration plants opened in Europe in the 1980s as a means to sustain rural areas while responding to increasing energy demand. Production then declined in the early 1990s due to falling oil prices, but subsequent rises in energy prices have led to renewed growth.[21] EU biodiesel production capacity has been increasing by an average of 81 per cent annually since 2002 (See Figure 5).[22]

Biofuels currently account for about 1.4 per cent of EU fuel consumption,[23] and biodiesel represents about 82 per cent of the EU biofuel market. Between 80 and 85

[20] Sexton E, Martin L. and Zilberman D 2006
[21] Biofuels Taskforce 2005
[22] IFP 2004
[23] GAIN 2005a

per cent of EU production comes from rapeseed oil,[24] which is equivalent to 20 per cent of the total EU rapeseed production.[25] However fierce competition within the food sector has dramatically increased the price of rapeseed oil, and it has begun to be replaced by soyabean oil and palm oil. Depending on the availability of vegetable matter for conversion, it is estimated that biodiesel could cover as much as 10 per cent of the road transport requirements in the EU by 2020.[26]

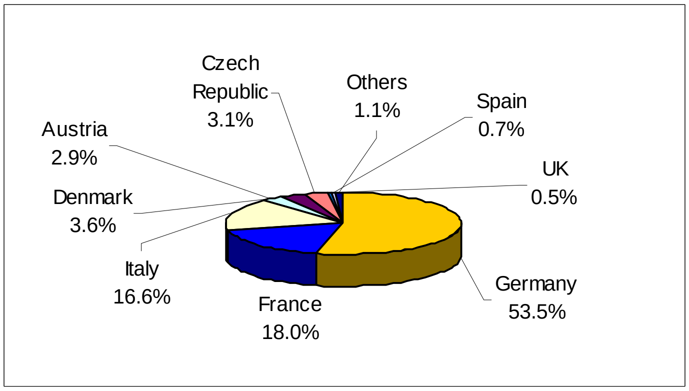
Figure 5: EU biodiesel production capacity*



Source: European Biodiesel Board 2004: EU25; *Production Capacity ≅ production

Figure 6 shows the main EU biodiesel producing countries in 2004. Production is heavily concentrated in just three countries: Germany (53 per cent), France (18 per cent) and Italy (17 per cent).

Figure 6: EU biodiesel producing countries 2004 *



Source: European Biodiesel Board; * Biodiesel Producing Capacity

Although at present the EU is the undisputed leader in biodiesel production, many countries in the Americas, Africa and Asia are showing interest in biodiesel production:

[24] See Dufey A.
[25] GAIN 2005a
[26] IFP, 2004

- In the US, for instance, approximately 76 million litres of biodiesel from soya were produced in 2004. Experts predict that, in the best case scenario, in the next 20 years biodiesel could take care of 25 per cent of the US diesel needs.[27]
- In 2002 Brazil launched a biodiesel initiative that set targets for use of biodiesel within the mix of transport fuel of 2 per cent, 5 per cent and 20 per cent by 2007, 2013 and 2020, respectively. Implementation of the initiative will require production of 800 ML/year, 2000 ML/year and 12,000 ML/year, respectively.[28]
- Colombia introduced a requirement of 5 per cent biodiesel within the transport fuel mix from September 2005. This has encouraged substantial investment in biodiesel production.[29] Colombia's interest in producing biofuels is not only focused on fulfilling the domestic demand but also on exploiting export opportunities.
- In April 2006, Argentina approved the 'Biofuels Act', which imposes a requirement of 5 per cent biodiesel in petroleum derivatives beginning in January 2010. This obligatory minimum would require an annual production of 600,00 tonnes of biodiesel for the domestic market. [30]
- India started an ambitious large-scale biodiesel programme based on jatropha, which, among other things, introduces a blend containing 5 per cent biodiesel with fixed prices
- Thailand is considered one of the most successful new entrants to the biofuels market, with the establishment of an ambitious programme, which includes targets for biodiesel within the transport fuel mix, investments in roadmaps and biofuel plants, and the implementation of the Special Purpose Vehicle (SPV) scheme to encourage local investment.[31]
- Several other palm oil and coconut producers including Malaysia, Indonesia and the Philippines are planning to scale up the biodiesel production in Asia.
- Importantly, several African countries including Burkina Faso, Cameroon, Ghana, Lesotho, Madagascar, Malawi and South Africa are exploring the potential of jatropha as a large-scale biofuel source.[32]

Finally, a new generation of biodiesel technology - the Fischer-Tropsch process - synthesises diesel fuels including wood and straw to the gasification stage. There are several large-scale projects underway in the EU, especially in France and Germany. Commercial development is planned to start by 2008.[33]

Table 1 summarises main global biofuel-producing countries according to the type of biofuel and feedstock used as input.

[27] Olsen S 2006
[28] Volpi G. 2005
[29] Hernández C 2006
[30] IPS 2006
[31] F.O.Licht 2005
[32] See D1 Oils plc 2005
[33] IEA, 2004

Table 1: Global biofuel production

Country	BIOETHANOL			BIODIESEL		
	Production (ML)	**Typical Use**	**Feedstock**	**Production (ML)**	**Typical use**	**Feedstock**
AMERICAS						
Brazil	15,098	E26	Sugarcane	Still minimal	B2, B5	Soya oil, castor oil, palm oil
US	12,907	E10; some E85, E10	Corn (95%), sorghum;	75 gallons (200) 200gallons by 2007	Blends <75%	Soya oil
Canada	231	E10	Wheat and straw	10		Straw
Colombia	900 lt/day	E10	Sugarcane		B5	Palm oil
Argentina	42	E5 by 2010			B5 by 2010	Soya oil
Ecuador						Palm Oil
Peru		E7.8 by 2010	Sugarcane			
EUROPERAN UNION						
Germany	269		Rye, wheat,	1,035	B100; B5	Rapeseed
France	829		Beet and wheat mainly	348		Rapeseed
Italy	151		Wheat	320		Rapeseed
Denmark				70		
Austria				57		
Spain	299		Wheat, barley, wine	13		
Sweden	98	Fuel, heating; (E5; E85)	Forestry; Wheat;	1.6		

UK	401		Beet	10		Rapeseed
Czech Rep.	47			60		Rapeseed
Poland	201					Rapeseed
ASIA						
China	3,649	E10 but most not for fuel	Corn, cassava, sugarcane, rice sweet potato,	68ML (capacity 2004)		Jatropha and others
India	1,749	E5	Sugarcane		B20 by 2011	Jatropha
Thailand	280	E10	Sugarcane, tapioca/cassava	90 ML (2005). 722ML by 2010		Palm, peanut, soya, coconut, Jatropha
Indonesia	167		Sugarcane			Palm oil
Pakistan	26		Sugarcane			
Philippines	83		Sugarcane			Coconut oil
AFRICA						
South Africa	416		Sugarcane		B1-B3 by 2006	Jatropha
Malawi	6	Encouraging use	Sugarcane			
Ghana	6	Encouraging use	Sugar, corn			
Zimbabwe	6		Sugarcane			
Kenya	3		Sugarcane			
OCEANIA						
Australia	33		Sugarcane		B5	Soyabeans

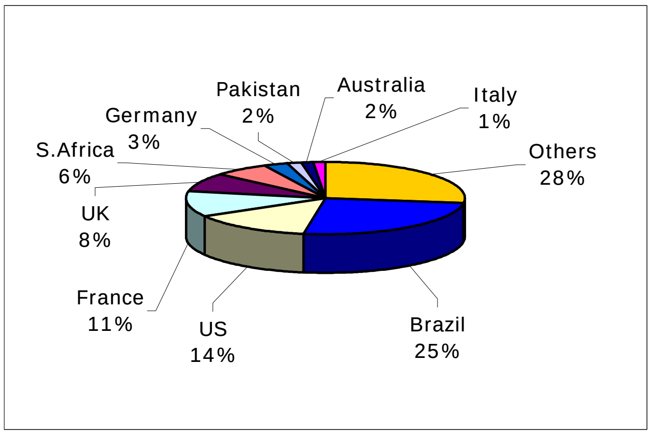
Source: IEA, 2004; RFA, 2005. European Biodiesel Board; Australian Task Force, 2005; IPS 2006.

3.2 Trends in global biofuel trade

At present only limited amounts of biofuels enter the international market as the bulk of production is consumed domestically. In the case of bioethanol, less than 10 per cent of global production enters the international market. However, international trade is expected to grow very rapidly in the coming years as the global increase in consumption and the scaling up of production will not coincide geographically.

Figure 7 shows the main ethanol exporters in 2002. It shows Brazil as the largest bioethanol exporter, providing about 25 per cent of global bioethanol exports in this year. More recent data, however, suggest that Brazil has increased its exports to 50 per cent of global bioethanol exports. The second largest exporter of bioethanol is the US (14 per cent), followed by France (11 per cent) and UK (8 per cent). Exports from these EU countries are destined to other European countries. Countries from the Caribbean Basin Initiative (CBI)[34] such as Guatemala, Costa Rica, El Salvador and Jamaica are also important exporters. Bioethanol is reprocessed in these countries and re-exported to the US. Peru exports to Japan and to the US under the Andean Pact.[35] Other important exporters are sugar producing countries like Pakistan – the second largest exporter to the EU after Brazil, South Africa, Swaziland and Zimbabwe, which enjoy preferential access to the EU market.

Figure 7: Ethanol - main exporting countries, 2002



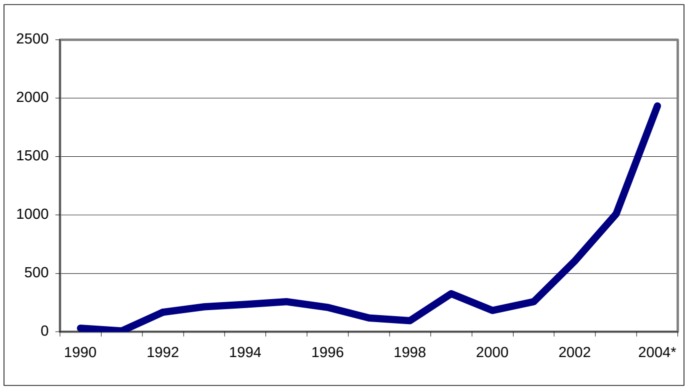
Source: FAOSTAT

Figure 8 shows the evolution of Brazil's ethanol exports since 1990 and indicates a marked increase in exports in the last five years or so. As suggested above, Brazil now supplies about 50 per cent of the international demand for bioethanol. The main destinations for Brazilian bioethanol exports in 2004 were India (20 per cent), the US (18 per cent), Korea (10 per cent) and Japan (9 per cent), as indicated by Figure 9.

[34] CBI countries include the Central American countries Belize, Costa Rica, El Salvador, Guatemala, Guyana, Honduras, Nicaragua and Panama, and the Caribbean countries Antigua, Aruba, the Bahamas, Barbados, British Virgin Islands, Dominica, Dominican Republic, Grenada, Haiti, Jamaica, Montserrat, Netherlands Antilles, St.Kitts and Nevis, St.Lucia, St.Vincent and the Grenadines, and Trinidad and Tobago.

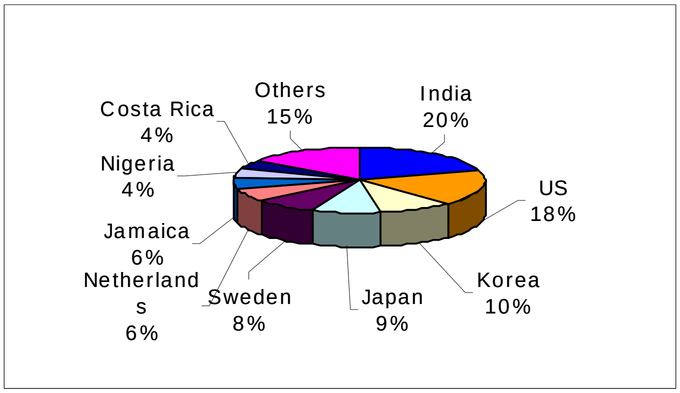
[35] Trindade S 2005a

Figure 8: Brazil's bioethanol exports



Source: FAOSTAT

Figure 9: Destinations of Brazilian bioethanol exports, 2004

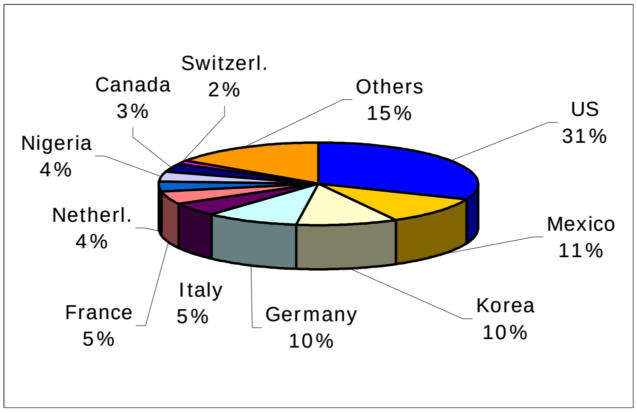


Source: RFA 2005

The US is the main importer of bioethanol, accounting for 31 per cent of global imports. US imports represent 5 per cent of domestic production and they mainly come from Brazil (54 per cent) and CBI countries. Other significant importers are Mexico, Korea and Germany with 11 per cent, 10 per cent and 10 per cent of global bioethanol imports, respectively. These are followed by Italy (5 per cent), France (5 per cent), Netherlands (4 per cent) and Nigeria (4 per cent) (See Figure 11). Venezuela also imports bioethanol from Brazil.[36] The EU imports a large proportion of the bioethanol it uses[37], mainly from Brazil and Pakistan. Other important EU suppliers are Guatemala, Ukraine and Peru.[38] The main EU importer is Sweden. As suggested before, there are also significant intra EU trade flows of bioethanol.

[36] Trindade S 2005a
[37] GAIN 2005a
[38] GAIN 2005b

Figure 10: Bioethanol - main importing countries, 2002



Source: FAOSTAT

Trade in biodiesel is at a less developed stage than trade in bioethanol, and data is therefore even patchier. However, it is expected that trade in biodiesel will develop in a similar way to that of bioethanol. There is already some evidence of increasing trade flows. The EU, for instance, currently imports about 3.5 million tonnes of refined and crude palm oil a year, mainly from Malaysia and Indonesia. This is set to rise by about 1 million tonnes in 2006 as two new Malaysian-owned palm oil refineries come into service in Rotterdam. [39] Palm oil and its by-products are expected to supply up to 20 per cent of the EU's biodiesel in the next five years. [40] Malaysia is also preparing to export to Colombia, India, South Africa and Turkey. In addition, the US recently started to import palm oil-based biodiesel from Ecuador. It intends to import 45 million gallons in 2006, and more than 100 million the following year, exceeding the 75 million gallons the entire US biodiesel industry produced in 2005.[41]

3.2.1 Future prospects for biofuels

While ten years ago there were only a handful of countries producing biofuels, by 2006 many countries around the world are using biofuels on a large scale. Forecasts for the future of this market are very optimistic as all types of countries, industrialised and developing, large and small, are implementing or planning to implement directives to promote greater use of biofuels. Accordingly, production capacity is expected to rise as suggested by the establishment of many new projects around the world.

According to IEA (2004), with the entering into force of the Kyoto Protocol in 2005 and the first target period under the EU Biofuels Initiative coming into effect in December 2005, world biofuel production is expected to quadruple to over 120,000 ML by 2020, accounting for about 6 per cent and 3 per cent of world motor petroleum

[39] Krishnan B and Mudeva A 2005
[40] Krishnan B and Mudeva A 2005
[41] Pioneer Press 2005

use and total road energy use, respectively.[42] A more recent estimate from IEA increased this figure to 10 per cent of world fuel use for transport by 2025.[43]

Biofuels are not expected to totally replace oil-based fuel in the transport system; rather they are an alternative or a complement to it.

Brazil is expected to continue as the leading bioethanol producer and exporter. Although the internal market will still account for the largest part of production, exports will rise sharply. According to the São Paulo Sugar and Bioethanol Institute, the value of Brazil's bioethanol exports are expected to jump from US$ 1 billion a year to US$ 8 billion by 2007.[44]

The US is expected to continue demanding large quantities of bioethanol. The stronger demand will be served both by internal production and imports, mainly from Brazil and CBI countries. Other sugar-producing countries such as Indonesia and Southern Africa are also predicted to become exporters.

Box 1: Brazil is set to continue as the main bioethanol exporter

The Brazilian Government is preparing for bioethanol's global role. According to Brazil's Trade Minister Luiz Furlan, "we are also expanding the cultivation of sugarcane to meet the increasing domestic and foreign demand for bioethanol. By 2013 Brazil is expecting to need to increase cultivation by 3 million hectares from the 5.7 million currently used for sugarcane. Brazil does have the potential for increasing sugarcane cultivation since there remain vast tracts, up to 90 million hectares, of unused agricultural lands." It is estimated that 70% of Brazil's increased bioethanol demand over the next five years will come from the domestic market.

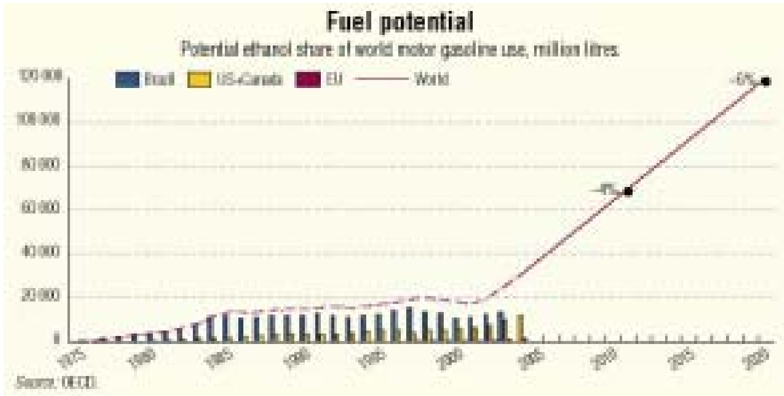
To support major production and trade, Petrobras, Brazilian Government authorities and private stakeholders are increasing their investments in production, pipelines, railways and port facilities to meet the rising demand and further reduce production and logistical costs. Current logistical infrastructure for the export of bioethanol supplies up to 2.5 billion litres a year. With the recent negotiation of additional export contracts, Petrobras will make additional investments to expand the logistical capacity to supply up to 9 billion litres and construct fuel pipelines to add another 3 billion-litre export capacity. By 2010 Brazil will have an export capacity of 12 billion litres a year."

Source: Costa I. 2006

The EU is expected to continue to be the main market and producer of biodiesel, followed by the US and Brazil. Table 2 shows some rough estimates for world production provided by Early et al (2005), which provide details of the estimated increases in production in the different countries. In terms of feedstocks, this production is likely to be composed of 58 per cent of rapeseed oil, 25 per cent soya oil, 16 per cent palm oil and 1 per cent other oils.[45]

[42] IEA 2004
[43] Cited in F.O Licht 2005a
[44] BNamericas.com. 2005
[45] Early J et al 2005

Figure 11: Potential bioethanol share of world motor gasoline use



Source: IEA 2004

Table 2: World biodiesel production, 2004 and 2010

Country	2004 (Thousand Mt)	2010 (Thousand Mt)	Var. 2004-2010 (%)	Participation by 2010 (%)
EU	1,400	6,000	329	77
US	125	750	500	10
Brazil	25	750	2900	10
Other	50	250	400	3
Total	**1,600**	**7,750**	**384**	**100**

Source: adapted from Early J., Early T. and Straub M. 2005

In order to implement the European Directive 2003/30/EC that sets a target of 5.75 per cent of biofuel within the mix of transport fuel by 2010, 18.6 million tonnes of oil equivalent of biofuels is needed.[46] This will require imports to sustain the programme.[47] Indeed, Malaysia and Indonesia are already expanding palm oil plantations to meet greater demand and are together expected to supply up to 20 per cent of this market. Brazil is also expected to be the main beneficiary of EU imports of soya for biodiesel.[48]

Other promising import markets are likely to be Asian countries like Japan, Korea and Taiwan, which have very little land available for increased production. Japan, for

[46] EC 2005

[47] According to GAIN 2005a, the EC commitment under the Blair House Agreement to limit production of oilseeds on set-aside land to one million metric tonne soybean meal equivalent means the biodiesel industry has reached the point where it must now use oilseeds from non-set-aside land, imports of oilseeds or of vegetable oil.

[48] Early et al 2005

instance, has been highlighted as potentially the world's largest bioethanol importer.[49] Currently Japan allows a 3 per cent bioethanol content in gasoline, which requires 1.8 billion litres of alcohol-based fuel each year. Discussions are taking place on increasing the blend cap to 10 per cent, which would result in a 6 billion litres market.[50] In order to secure this future supply, Japan and Brazil have recently formed a joint venture company that will produce bioethanol. Japan is also examining the options of palm and coconut oil from the Philippines to make B5 available from April 2006.[51] In China, although supply capacity is increasing fast, growth in demand might well exceed growth in production. Projections show that 22.7 metric tonnes of biofuels will be needed to blend 10 per cent biofuels into all Chinese cars by 2020. The present target is only 11 metric tonnes capacity expansion.[52]

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[49] Trindade S 2005a
[50] Green Car Congress 2005
[51] Australia Task Force 2005
[52] RNS Reuters News Service 2005

4 The role of domestic policies in biofuel market development

Domestic policies to support biofuel production respond to different policy goals associated with biofuel production. Earlier experiences such as those of the US and Brazil were mainly motivated by pressure to reduce the import bill and increase energy security, though rural support appeared as an important driver in a later stage of these experiences. Today a new policy interest is added, driven by the potential of biofuels to contribute to ameliorating the problem of global warming. All this implies that these policies cover a range of sectors, typically including energy, agriculture, industry and trade.

Given that, on the one hand, costs of biofuels production are higher than those of conventional fuels[53] and, on the other hand, there are positive externalities associated with biofuels[54], the use of some form of public policy is essential to make biofuel production competitive in the earliest stages of industry development. The use of policy tools such as the setting of national targets for the blending of biofuels with standards fuels, tax benefits, subsidies and loan guarantees to encourage greater production and consumption has been the rule rather than the exception behind the development of this market. Some of the main experiences are briefly described below.

In **Brazil**, for instance, the 1975 PROALCOOL programme (presented in detail in Box 1) was promoted as a reaction to the oil crisis and aimed to replace gasoline with blends of bioethanol produced from sugarcane. In order to do this several policy measures were introduced including: production quotas and a fixed purchasing price for bioethanol; control of domestic bioethanol sales and distribution by a monopolistic agent (Petrobras); subsidies to bioethanol blend gasoline producers; tax incentives to car owners using bioethanol blend gasoline; and soft loans to implement the necessary technical changes for vehicles.

Although the Government liberalised this market in the early 1990s (abolition of Petrobras's monopolistic distributional arrangement; liberalisation of bioethanol prices and reduction of subsidies on bioethanol blend gasoline producers), the Government still fixes minimum rates of blending with oil (currently at 20 to 25 per cent). In 2001 some additional measures were introduced as a means to revive the PROALCOOL programme, including a tax reduction on flexi-fuel cars (FFA), subsidies for FFA car purchasers and subsidies for sugar storage in order to secure future bioethanol supply. Even though the current level of Government support for bioethanol in Brazil is minimal compared to other countries, historically it was a key factor behind the development of the market and it still has a role to play.

Brazil would like to replicate the bioethanol programme for biodiesel, and in 2004 the Government launched the National Programme for the Production of Biodiesel (PROBIODIESEL Programme). In early 2005 the Government passed a bill, making the production of a 2 per cent biodiesel fuel blend made from castor oil and soya oil compulsory by 2007. This obligation will be increased to 5 per cent and 20 per cent by 2013 and 2020, respectively. In addition to the setting of targets for biodiesel-diesel percentage blends, the regulation also involves a framework that includes differential rates depending on the oilseeds used, where they are grown, and whether they are

[53] For information of costs see section 6.1.3 Higher Costs than Conventional Fuels

[54] See Chapter 6 on Biofuels and the Sustainable Development Debate

produced by large agribusiness concerns or family farmers. Biodiesel feedstocks and the fuel itself are exempted from Industrial Products Tax (IPI). The programme has also instituted a 'Social Fuel' seal which aims to promote social inclusion throughout the new fuel's production and value chain. It establishes the conditions for industrial producers of biodiesel to obtain benefits and credits. In order to receive the seal, an industrial producer must purchase feedstock from family farmers and enter into a legally binding agreement with them to establish specific income levels and guarantee technical assistance and training.[55]

Box 2: the Brazilian PROALCOOL programme

The PROALCOOL programme was launched by Brazil in 1975 and it still remains the world's largest commercial application of biomass for energy production and use. It involved co-operation between the Government, farmers, alcohol producers and car manufacturers.

Prompted by the increase in oil prices, Brazil began to produce bioethanol from sugarcane in the 1970s. Production increased from 0.6 billion litres in 1975 to a peak of 13.7 billion litres in 1997. The task for the programme's first five years was to replace gasoline with 20 to 25 per cent blends of bioethanol. After the second oil crisis (1978-79), steps were taken to use hydrated "neat" bioethanol (96 per cent bioethanol and 4 per cent water). The investment required was funded through Government soft loans. Tax reductions were also offered for bioethanol use. By December 1984, 17 per cent of Brazil's car fleet was using neat alcohol and this figure grew to more than 25 per cent by the late 1980s. A fall in oil prices and subsidy elimination led to market liberalisation in 1991. Supply shortages raised concerns about future availability and the share of neat bioethanol cars fell from almost 100 per cent of new cars sales in 1988 to less than 1 per cent by the mid-1990s.

In 2002 the Government began to revive the PROALCOOL Programme. This included a tax reduction on bioethanol powered car manufacturers and subsidies for purchasers of new bioethanol cars. Credits for the sugar industry were also introduced to cover storage costs to ensure future supply. At the heart of the programme is the ten-year deal with Germany. Germany is purchasing carbon credits as part of its Kyoto Protocol commitments and, in turn, helps Brazil subsidise taxi drivers and car hire companies by 1,000 *reais* (US$ 3,000) per vehicle on the first 100,000 vehicles sold.

Sufficient and secure bioethanol supplies are key factors for the successful revival of the PROALCOOL programme and to rebuild consumer confidence in bioethanol-powered cars. To this end the Government developed and funded a programme to build up bioethanol stocks, paying for this by selling bioethanol during draw-down periods. About 500 million *reais* have been allocated to this programme since 2001. In addition, the Government asked the industry to produce an additional 1.5 billion litres in 2003/04 to maintain the maximum alcohol price at 60 per cent of the gasoline price.

Brazil is also strengthening its market through exports. As the world's largest and most efficient bioethanol producer, it is already supplying bioethanol to several countries and is negotiating with several others interested in buying bioethanol.

In the **US**, interest in biofuels also began in response to the 1970s oil crisis, and legislation to promote the production and use of bioethanol as a transport fuel was passed.[56] However, it was only in the 1980s that the US began assisting production to address the crisis in the corn industry. Bioethanol then attracted further interest as an anti-knocking agent[57] when lead was phased out from petrol.[58] The 1990 Clean Air Act

[55] Ministry of Mines and Energy of Brazil (no date)
[56] IEA, 2004
[57] For octane enhancement
[58] Australia Task Force, 2005

Amendments set up the oxygenated fuel programme that required petrol sold in areas with high carbon monoxide levels to contain 2.7 per cent oxygen. Later, the Reformulated Gasoline Programme required petrol containing 2 per cent oxygen to be sold in areas with high levels of photochemical smog. However, it was only with the prohibition of MTBE as oxygenate in early 1990s, that bioethanol started to be widely used.

Several other initiatives have also stimulated uptake of bioethanol in the US. There is a US$ 0.51/gallon tax credit for bioethanol; federal agencies are required to use alternative fuels in their fleets; the Clean Cities Programme created a market for alternative-fuelled vehicles, various states offer incentives and assistance, and several have bioethanol mandates. The 2005 Energy bill incorporates the tax credit within a larger mandate, requiring gasoline refiners to nearly double their use of renewable energy additives (read bioethanol) in the coming years. In particular, it introduced a Renewable Fuel Standard that requires US fuel production to include a minimum amount of renewable fuel each year. It starts at 4 billion gallons in 2006, increasing gradually before reaching the goal of 7.5 billion gallons in 2012.[59] From 2013 onwards renewable fuel production must grow by at least the same rate as gasoline production.[60] In addition, US domestic producers are insulated from imports as the US adds on a US$ 0.54/gallon secondary duty to the normal tariff of 2.5 per cent to shield domestic producers from competitive imports.

Regarding biodiesel, in 2004 the US approved a tax credit of US$ 1 per gallon of vegetable oil or animal fat-based biodiesel blended with petrodiesel, which is framed in the context of the 2004 American Job Creation Act.[61] Moreover, the Renewable Fuel Standard introduced in the 2005 Energy Bill also applies to biodiesel production.

In the **EU**, biodiesel began to be promoted in the 1980s as a means to prevent the decline of rural areas while responding to increasing levels of energy demand. However, it only began to be widely developed in the second half of the 1990s. Key policies affecting the European market for biofuels include energy, agriculture and climate change policies.

In 2003, the EU approved two draft directives concerning energy supply diversification and the reduction of GHG emissions. Directive 2003/30/EC sets indicative targets for biofuel consumption in the transport sector: biofuels must constitute 2 per cent of all gasoline and diesel motor fuels by 2005[62] and 5.75 per cent 2010.[63] Although these targets are not mandatory, member states must keep the EC informed about the measures taken to reach them. Directive 2003/96/EC complements this policy providing a legal framework to differentiate taxation between biofuels and conventional fuels. The minimum excise rates for unleaded premium, diesel fuel and heating oil effective from January 2004 were: € 359/m3, € 302/m3 and € 21/m3, respectively. For diesel, the minimum rate will be raised to € 330/m3 by January 2010.[64] In addition, a number of EU countries have implemented tax credit for biofuels, including Germany, Sweden and Spain, at 100 per cent.[65]

[59] Informa Economic Inc 2005
[60] Elobeid A and Tokgoz S. 2006
[61] ASA-NBB 2004
[62] According to EC 2005, the 2005 reference value was not achieved and if all Member States achieve the target they have set, biofuels will attain a share of 1.4%.
[63] A 10 per cent target for 2015 is currently under review
[64] IFP, 2004
[65] Australia Task Force, 2005

On the agricultural side, the 2003 EU Common Agricultural Policy (CAP) Reform introduced the 'Carbon Credit', which pays € 45/ha to growers of energy crops, up to 1.5 million hectares. Carbon credit is available for all agricultural crops except sugar beets and hemp, as long as they are used for approved energy uses and have a contract for this purpose.[66] EU farmers cannot get carbon credit for energy crops grown on set-aside land. The amount of oilseeds that can be grown within the EU is set by the Blair House Agreement (BHA), which restricts the maximum EU oilseeds area for food use to 4.9 million/has and also limits the annual output of side products (oil meals) from oilseeds (rapeseed, sunflower seed and soyabeans) planted on set-aside land for industrial purposes to 1 million MT annually of soyabean equivalent. [67]

In 2005 the EU released the Biomass Action Plan, which suggests a possible revision of the 2003 Biofuels Directive. It encourages, among other things, a closer look at the second generation of biofuels, and the use of bioethanol to reduce demand for diesel, and public procurement of clean vehicles – including those using high biofuel blends.[68] In February 2006 the EU launched the Biofuels Strategy[69], which is a coordinated action plan to promote sustainable large-scale production and use of biofuels in the EU and developing countries. The strategy is a cross-sectoral initiative that contains seven policy axes, some of them based on measures described above but also including some new areas: stimulating demand; capturing environmental benefits; developing the production and distribution of biofuels; expanding feedstock supplies; enhancing trade opportunities; supporting developing countries; and supporting research and development.[70]

In addition to the examples above, many other countries – in the industrialised and developing world – have either implemented or are implementing policy tools to support biofuel market development. Table 3 summarises some of these.

These policies play a crucial role in the industry's development. However, the existence of a learning curve - as the Brazilian experience shows – suggests that the level of support can be diminished over time. On the other hand, they can also constitute very costly barriers to trade, especially for those most efficient developing countries that have less financial capacity to support their industry. The next chapter on biofuels and the rules of international trade elaborates further on this point.

[66] GAIN, 2005a
[67] GAIN, 2005a
[68] EC 2005
[69] EC 2006
[70] There are several initiatives at individual country level. In the UK, for instance, in November 2005 the Government announced the Renewable Transport Fuel Obligation (RTFO) which will require 5% of all UK fuel sold on UK forecourts to come from a renewable source by 2010. The RTFO was designed to work in conjunction with the tax break system and it looks to provide the industry with more security to invest in biofuel production in the long term, stimulating innovation and advances in technology. The Government proposed to develop a carbon and sustainability assurance scheme as part of the obligation to ensure that biofuels are sourced sustainably.

Table 3: Examples of policy tools for biofuel market development

Country	Target/mandate	Production support	Consumption support	Special vehicle and other requirements	Government support
Brazil	Ethanol: 1975 PROALCOOL Programme Mandate of E20 - E25 Biodiesel 2002 PROBIODIESEL Programme Mandate of a B2 by 2007; B5 by 2013 and B20 by 2020.	Credit to cover 60% sugar storage costs Tax exemptions on vehicles using ethanol or FFV Lower taxes on biofuels	Credit to cover 60% sugar storage costs Tax exemptions on vehicles using ethanol or FFV Lower taxes on biofuels Mandate to use on Government vehicles	Mandate to use on Government fleet vehicles	€8.7 billion revenue foregone from 1976
US	The 2005 Energy Bill requires increases in ethanol use from 4 billion gallons in 2006 to 7.5 billion gallons by 2012 (a increase target of 2.78% for 2006).	Volumetric Ethanol Excise Tax Credit (VEETC): a US$ 0.51/gallon to gasoline refiners. Small producers get US$0.10/gallon tax credit for the first 15,000 gallons Grant and loan programmes Imports protection: US$0.54/gallon secondary duty to the normal tariff to imports based on cheaper biomass and more efficient technology A tax credit of US$1/gallon of biodiesel blended with petrodiesel	Tax credits Fuel tax exemptions Federal and states incentives to acquire FFV Mandate to use ethanol on Government vehicles Loan assistance	All cars built after 1980s will operate on E10 FFVs on sale The 2005 Energy Bill will remove the oxygenate requirement	US$140 million (€117 million) in federal taxes for the Highway Trust Fund 1978-2004. Cost of US$375 million (€311 million) of the 2006-2012 tax incentives set by the 2005 Energy bill for biofuels. 2004 excise exemption of US$1.7 billion (€1.4 billion)
Canada	3.5% of ethanol in transport fuel by 2010	Some provinces exempt ethanol from road taxes	Exemption from €0.07/lt excise tax	All cars built after 1980s will operate on E10 FFVs on sale	€62.5 million in fuel excise exemption plus others in capital grants
EU (in general)	Directive 2003/30/EC set target for their consumption in the		Directive 2003/96/EC grant partial or total exemption		

Country	Target/mandate	Production support	Consumption support	Special vehicle and other requirements	Government support
	transport fuel mix: 2% by 2005 5.75% by 2010		from excise tax on biofuels. Approved minimum excise rates for unleaded premium, (€ 359/m3), diesel fuel (€302/m3) and heating oil (€21/m3) (effective January 2004). For diesel, minimum rate raised to € 330/m3 in 2010		
Sweden	3% in 2005 (in energy content)	Tax incentives for new plant construction Access to EU CAP provisions Capital grants Quotas	Ethanol: Capped fuel tax exemptions (a total tax exemption (€520/m3), to be revised annually.) Biodiesel: tax exemption (€344/m3)		1996-2006 Fuel tax exceptions = €2,000 million and expected to go up to €9,000 million by 2009
France	(see EU)	2003,the French tax exemption will amount to € 380/m 3 .It was €502.3/m3 in 2002	Biodiesel: a tax break of €330/m3 is allowed for motor fuel blends in 2004 (with a quota of 387,500 tons in 2004 and up to 5%. Pure biodiesel not covered		
Germany	Biodiesel blends should be authorised in the very near future (B5 and B30)	No production quota	Ethanol: tax break of €54/m3 Biodiesel: tax incentive of €470/m3, which includes a carbon tax exemption		
UK	(see EU)		From January 2005 a tax break of 20 p/l (€138/m3) for either ethanol or biodiesel		
Spain	(see EU)		Ethanol: does not levy tax, granting a total exemption equivalent to a tax break of € 390/m3 Biodiesel: no tax (savings at		

Country	Target/mandate	Production support	Consumption support	Special vehicle and other requirements	Government support
			the pump of € 294/m3)		
Italy	(see EU)		Biodiesel: tax break full exemption of €403/m3 (with a quota of 300,000 and used in motor fuel blends up to 5%) Total tax exemption when used for heating		
Austria	(see EU)		Biodiesel: tax incentive (€290/m3) when used in motor fuel blends (up to 2%).		
India	5% in the near future	Subsidies for inputs Tax credits and loans	Fuel tax exemptions Guaranteed prices		
Colombia	B5 mandatory since September 2005				
Peru	Bioethanol (B7.8) mandatory since 2006 in main cities and since 2010 at the country level				

5 Biofuels and the rules of international trade

As Chapter 3 suggests, whilst the bulk of biofuel demand is likely to come from the industrialised world, the most efficient producing countries are located in the developing world. Thus many of the sustainable development benefits of biofuels will depend critically on the possibility of international trade. However, at present there are several issues that could undermine the realisation of sustainable development benefits of trade in biofuels.

A key concern is the existence of trade barriers - tariffs and non-tariff barriers. Progress on biofuel trade liberalisation is jeopardised by the lack of a comprehensive trade regime applicable to biofuels, which means trade conditions vary from country to country. This picture is further complicated by the vast range of products involved in the biofuel trade - from the different types of raw material (feedstocks) to the final products (biofuels) - passing through a vast array of semi-processed products. This chapter seeks to identify the main trade barriers facing biofuels and the key trade rules governing the their trade.

5.1 Trade barriers for biofuels

5.1.1 Tariff barriers

At present there is no specific customs classification for biofuels. Bioethanol is traded under the code 22 07 which covers both denaturated (HS 22 07 20) and undenaturated alcohol (HS 22 07 10).[71] Both types of alcohol can be used for biofuel production.[72] Biodiesel in the form of FAME (fatty acid methyl ester) is classified under the HS code 3824 9099. [73] [74] However, in neither of these cases is it possible to establish whether or not imported alcohol or FAME are used for biofuel production.

Despite this lack of specific customs classification, there is already evidence demonstrating that the use of tariffs is common practice in countries keen to protect their domestic agricultural and biofuel industries from external competition. According to IEA (2004), bioethanol import duties are US$ 0.10/lt in the EU, US$ 0.14/lt in the US, US$ 0.06/lt in Canada, US$ 0.23/lt in Australia and zero in Japan and New Zealand. In addition the US also applies an extra US$ 54 cents/gallon, an amount that equates to Brazil's production costs.[75] In Brazil, imports of bioethanol are taxed at 30 per cent.[76] For biodiesel classified under HS code 3824 9099, on the other hand, the US applies duty of 6.5 per cent[77] while the EU applies a 5.1 per cent tariff on biodiesel from the US.[78] Furthermore, import tariffs on biofuel input materials,

[71] See the World Custom Organization Website at http://www.wcoomd.org/ie/en/Topics_Issues/HarmonizedSystem/DocumentDB/0422E.pdf
[72] EC 2005
[73] GAIN 2005a
[74] HS 38.24:9099 "Chemical products and preparations of the chemical or allied industries (including those consisting of mixtures of natural products), not elsewhere specified or included". See WCO Webpage at http://www.wcoomd.org/ie/en/Topics_Issues/HarmonizedSystem/DocumentDB/0638E.pdf
[75] Severinghaus J., 2005
[76] Schmitz G, Seale J and Buzzanell 2002
[77] GAINS 2005b
[78] DfT (no date)

including feedstocks but particularly on other more value added materials such as oils and molasses are also substantial (see section 5.1.1.2 on Tariff Escalation).

However, tariffs applied to different countries may vary as both the EU and the US have signed preferential trade agreements and have a Generalised System of Preferences that grant preferential market access conditions for certain countries and products (See point 5.3 on Other Trade Agreements).

5.1.2 Tariff escalation

The use of tariff escalation that favours production of crops over other more value added forms of biofuels is also common practice. In the case of soya, for instance, the EU, the US, Canada and Japan impose no tariffs on soyabean imports. However, the EU applies a tariff of 8.8 per cent and the US applies a 19.1 per cent duty on soya oil imports (both of which should be gradually reduced to 6.4 per cent to comply with WTO agreements). The US applies a 6.4 per cent tariff on rapeseed and Canada applies an 11 per cent duty.[79] Canada also applies a 9.5 per cent tariff on sunflower seed oil[80] and a tariff of 11 per cent on palm oil. The EU applies a 3.8 per cent tariff on imports of crude palm and 9.0 per cent and 10.9 per cent on imports of refined palm oil and stearin respectively, from Indonesia and Malaysia.[81]

In the case of bioethanol, it is alleged that as a result of pressure from domestic producers, the EU has recently removed Pakistan – the second largest bioethanol exporter to the EU – from the General System of Preferences (GSP).[82] This implies that a 15 per cent import duty has been levied on industrial alcohol and bioethanol produced in Pakistan, which favours the production and export of raw molasses over other more value-added products such as industrial alcohol and ethanol. [83] [84] As a result two of the seven operating distilleries have closed, and another five new distilleries will probably abandon plans to begin operations due to uncertainty market conditions.[85]

5.1.3 Quotas

The use of quotas to regulate trade in biofuels is also a common practice in industrialised countries. The CBI and CAFTA, for instance, have established a complex import quota system for bioethanol from Caribbean countries (see section 5.3 on other trade agreements). The use of quotas on feedstock trade is also important. For example, the EU regulates sugar imports through a complex system of duty free tariff quotas that favour imports from ACP countries and India.

[79] Early et al, *2005*
[80] Loppacher 2005
[81] FOE 2004
[82] See section 5.3 for an explanation of the GSP system
[83] The News 2005
[84] For further information see section on the EU GSP
[85] GAINS 2005b

5.1.4 Non tariff barriers

5.1.4.1 Domestic support

As discussed in Chapter 4, the use of domestic support in the form of subsidies is a common practice. Table 3 in Chapter 4 suggests that almost every producing country, especially in the industrialised world, has some form of domestic support for biofuel production. Policies include support for feedstock production and biofuel processing. Other types of domestic support, which are not indicated in the table – such as export subsidies or price support for different crops - may also affect the biofuel trade. There is a substantial body of literature dealing with the negative effects of agricultural subsidies on developing countries' competitiveness.[86]

Policy goals associated with biofuel production implies that countries have important incentives to protect local production from more efficient foreign production. The higher costs of biofuels production in relation to conventional fuels, together with their positive externalities, suggest that policies to support them can usually be justified to help the industry to develop in the early stages. However, what form these policies should take and how long they should apply are issues that require further analysis. A key issue therefore is the need to investigate which of the policy measures affecting biofuels trade are trade distorting and whether they are compatible with the multilateral trading system. Section 5.2.2 and 5.2.3 deal with World Trade Organization (WTO) rules on domestic support for industrial and agricultural goods, respectively.

5.1.4.2 Technical, environmental and social standards

The existence of diverging technical regulations in different countries can pose serious restrictions on biofuels trade. At the very least, a producer wishing to export to other markets will have to incur extra costs to have their biofuels tested according to the importer country's conditions.[87] For producers wishing to enter multiple markets, each with different standards, these costs become very high. Trade is even further impeded if producers cannot sell their existing biofuel in certain markets and must develop a different fuel that will adhere to importer standards.

Restrictive technical regulations are also problematic. In the EU, for instance, Directive 2003/17/EC on fuels quality limits the use of bioethanol to only 5 per cent. The European Standard EN590, which defines main fuel properties, states that diesel must contain no more than 5 per cent biodiesel by volume.[88] Both restrictions have been highlighted as limiting biofuel market development in the EU.[89] [90] However, it is often argued that blends of up to 10 per cent of bioethanol or biodiesel can be used in any car without the need to modify the engine. The EU biodiesel standard EN14214 also imposes a technical barrier because only biodiesel made predominantly

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[86] See for example Oxfam International (2002), *Cultivating Poverty: The Impact of US Cotton Subsidies on Africa*, Oxford, Oxfam International
[87] Oestling A 2001
[88] The Commission has announced that it will review the quantitative limits on ethanol, ethers and biodiesel in 2006 (EC, 2006).
[89] Oestling A 2001; EC 2005
[90] EC 2005

from rapeseed oil complies with the standard while biodiesel made predominantly from soya oil or palm oil does not. [91]

The EU, in its "Biomass Action Plan"[92] is looking into the idea of introducing "green certificates" that would certify 'biocrops' that have been grown in an environmentally sustainable manner. The EU is investigating whether it would be possible to amend existing legislation so that when energy providers within the EU import biofuels or feedstock from outside the EU, these imports are certified as coming from a sustainable source. The desired effects of such a measure include preventing non-EU energy crop producers from destroying their countryside and undercutting EU rapeseed growers.[93] Beyond governmental measures, there are several voluntary initiatives underway to develop good sustainable development practice (especially in environmental terms) for biofuel production and trade. The proliferation of different standards in the North, with insufficient consideration of producing countries' conditions, and lack of mutual recognition are bound to constitute significant trade barriers.

In addition, technical regulations including traceability and labelling for agricultural commodities derived from modern biotechnology (genetically modified organisms or GMOs) and sanitary and phytosanitary requirements relating to plant pests and diseases might also be relevant, especially for feedstock such as soya or corn. An example of this are the EU regulations on labelling and traceability of GMOs, though at present these only apply to food and feedstuff.

Section 5.2.4 deals with WTO rules on technical regulations and other standards.

5.2 World Trade Organization rules on biofuels

Whilst trade in biofuel feedstocks is governed by the Agreement on Agriculture (AoA), the World Trade Organization (WTO) currently has no specific regime to deal with biofuels. The WTO governs the international trading of goods through the GATT. Trade in oil is governed by the rules of GATT on industrial goods but there is no agreement among WTO Members on whether biofuels are defined as industrial or agricultural goods. Biodiesel was previously classified as an agricultural product, but the recent decision by the World Customs Organization's HS Committee to reclassify it under subheading 38 24. 90 on chemical products may have a bearing on whether it will continue to be regarded as an agricultural product.[94] Biofuels could be included in a list of "environmental goods" for accelerated trade liberalisation under the current Doha Round.

5.2.1 General Agreement on Tariffs and Trade (GATT)

The WTO governs the international trading of goods through the GATT. Core principles governing the GATT and other WTO Agreements are National Treatment (NT) and Most Favoured Nation (MFN), which constitute the crucial WTO discipline of non-discrimination. In simple terms, MFN requires parties to ensure that if special

[91] EC 2005
[92] EC :
[93] F.O Licht 2005b
[94] Singh S. 2005

treatment is given to the goods or services of one country, they must be given to all WTO members;[95] NT means that a member should not discriminate between its own and foreign products, services or nationals (giving them "national treatment"). An additional key issue refers to the WTO definition of 'like products" which does not provide for distinctions between products on the basis of their processes and production methods (PPMs).

5.2.2 Agreement on Subsidies and Countervailing Measures (SCM)

If biofuels are considered industrial goods, their trade is governed by the rules of GATT and domestic support from the Agreement on Subsidies and Countervailing Measures (SCM).

The SCM monitors the use of subsidies in order to reduce or eliminate their trade distorting effect.[96] The Agreement provides a definition of the term "subsidy", which contains three basic elements: (i) a financial contribution (ii) by a government or any public body within the territory of a Member (iii) which confers a benefit.[97] All three of these elements must be satisfied in order for a subsidy to exist.

There are three subsidy categories: prohibited, actionable and non-actionable. Prohibited subsidies relate to two practices: (1) the use of export subsidies – which are currently used in the biofuel industry[98] and; (2) having receipt of the subsidy contingent upon using domestic inputs over imports. This reduces expected market access benefits for foreign suppliers of competing inputs and, hence, is considered trade distorting. Several programmes of this nature are already in place and more could develop as the industry expands output. For example, the US Department of Agriculture has established a subsidy for refiners to use soya oil as a feedstock for biodiesel. As this subsidy is only available if soya oil is used as the input, firms negatively affected by this subsidy, either petroleum producers or competing input producers, could argue that the subsidy nullifies or impairs benefits accruing to them under the WTO. If the issue was brought to the WTO and argued successfully, the US would have to withdraw this subsidy.[99]

Non-actionable subsidies and actionable subsidies are non-trade distorting and trade distorting subsidies, respectively. According to Loppacher (2005) almost every subsidy that exists in the biofuel industry today would fulfil the conditions necessary to be considered an actionable subsidy under Part III of the SCM Agreement. If a subsidy exceeds 5 per cent of a product's value and is administered in such a way as to be trade distorting, it is an actionable subsidy. Subsidies in both the biodiesel and ethanol markets are significantly higher than the suggested 5 per cent of the value of

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[95] This rule has two major exceptions. The first applies to regional trade agreements. The second applies to developing countries, particularly the least developed countries.
[96] WTO *Agreement on Subsidies and Countervailing Measures* available at: http://www.wto.org/english/tratop_e/scm_e/subs_e.htm
[97] WTO *Agreement on Subsidies and Countervailing Measures* available at : http://www.wto.org/english/tratop_e/scm_e/subs_e.htm
[98] Loppacher et al 2005
[99] Loppacher et al 2005

the product – reaching over 100 per cent of the selling price in the case of US biodiesel.[100]

5.2.3 Agreement on Agriculture (AoA)

If biomass-based fuels are considered agricultural products, then they should be governed by the WTO Agreement on Agriculture (AoA).[101]

The AoA contains three pillars or areas: market access, domestic support and export competition. On market access the AoA states that measures other than tariffs (e.g. quantitative restrictions, variable import levies) are not legitimate, except in extreme circumstances.

On domestic support, subsidies have different definitions or there is a greater degree of tolerance for the size of subsidies allowed. This makes biofuel subsidies more difficult to challenge than under the SCM. It has been agreed that subsidies placed in the Green Box (non-actionable or unlinked to production subsidies) are allowed without limits and no action can be taken against them. These subsidies are often non-product specific and must be decoupled from current output or prices. They also include environmental protection programmes. Amber Box (actionable or trade distorting) subsidies are all domestic support programmes that have not been placed into the Green Box. The sum of these payments is capped at a pre-agreed level for each country. Finally, Blue Box subsidies are Amber Box subsidies that satisfy certain conditions designed to reduce the trade distortion; for example, requiring farmers to limit production in order to receive the support. There are currently no limits on Blue Box subsidies but many countries are trying to change that in the current Doha negotiations by setting limits on Blue Box subsidies or creating reduction commitments.[102] Both the Green and Blue boxes have also been criticised in the US and the EU because of their continued high level and implicit impact on trade, in particular the direct payments to producers including decoupled income support and government financial support for income insurance and income safety net programmes.[103] [104]

In a preliminary assessment, the bulk of subsidies to biofuel feedstock would seem to fall into the Amber Box. This type of support is due to be cut off but if governments decide it is a high priority subsidy they may be willing to make cuts in other subsidies in order to make room for them within their capped level.[105] The difficulty in differentiating between crops that are grown for food/ feed purposes and those grown for biofuel could present a problem.

Dedicated energy crops - such as those that benefit from the EU 'carbon credit' or that are grown on set aside land - would fall into the Green Box category. The conditions

[100] Loppacher et al 2005
[101] Loppacher et al 2005
[102] WTO 2002
[103] Early, et al, 2005; WTO 2002
[104] For a critique of these subsidies see fro example 'Green but not clean Why a comprehensive review of Green Box subsidies is necessary' joint paper by ActionAid International, Caritas Internationalis, CIDSE, and Oxfam International available at:
http://www.oxfam.org.uk/what_we_do/issues/trade/downloads/joint_green.pdf
[105] Loppacher 2005

for these payments are that they must be part of clearly-defined government environmental or conservation programmes and they must conform to certain pre-specified activity norms.[106] Furthermore, the amount of payment is limited to the extra cost or loss of income involved in complying with the government programme. So, if a government wants to classify biofuel subsidies as Green Box, three crucial issues may arise. First, scientific evidence examining the environmental benefits must confirm they fit within a clearly defined environmental programme. Second, there must be an explanation of how the 'extra costs' are measured.[107] Finally, the government may need to prove they are not trade distorting, or only minimally so, since the guiding principle of the boxes is to avoid or minimalise trade distortion. Several Northern governments are actually considering counteracting the reductions in the Amber and Blue Boxes by reallocating the resources under the form of support to energy crops (renewable fuels).

On export subsidies, the 2005 Hong Kong Declaration states that the parallel elimination of all forms of export subsidies and disciplines on all export measures with equivalent effect are to be completed by the end of 2013.[108]

Biofuels have begun to permeate discussions at the WTO. Indeed, the subject of biofuels was used as an incentive to get WTO members to restart the Doha negotiations and finish the Round at the latest WTO Public Forum held in late September 2006. The Doha negations were suspended in July 2006 after WTO Members failed to agree on how to cut agricultural subsidies and tariffs.

5.2.4 Agreement on Technical Barriers to Trade (TBT)

The Agreement on Technical Barriers to Trade (TBT) aims to ensure that regulations, standards, testing and certification procedures do not create unnecessary trade obstacles. While technical regulations are governed by the main body of the TBT, the Annex contains a Code of Good Practice regarding international voluntary standards such as those elaborated by the International Organization for Standardization. Standards administered by the private sector and other non-governmental entities fall outside the scope of the WTO rules.

The TBT permits technical standards that fulfil legitimate environmental objectives, such as climate change goals.[109] Only product-related barriers are permitted and they should not discriminate against other members' products, or create unnecessary barriers to trade.

As suggested earlier, at present there are several initiatives underway aiming to address environmental and social practice in biofuel production. To the extent that these are non-governmental voluntary initiatives, they would fall outside the scope of the TBT. However, there is growing concern about the impact of the proliferation of private environmental and social standards on market access for developing countries. These standards are driven by Northern countries' concerns and are considered a new form of protectionism or so-called 'market entry' barriers. Though it is important to

[106] Loppacher 2005
[107] Loppacher 2005
[108] WTO 2005
[109] ICTSD 2005

have guidance to ensure compliance with minimum environmental and social standards on biofuels, as there is potential for environmental and social damage, these initiatives need to be created in such a way that they do not constitute unnecessary barriers to trade. The complex procedures and high costs usually associated with these assurance schemes also raise concerns about the regressive effect these may have on small producers in developing countries.

5.2.5 Doha negotiations on environmental goods

At the WTO Ministerial in Doha in November 2001, members agreed to negotiate accelerated trade liberalisation of environmental goods and services.[110] Biofuels derived from sustainable agricultural practices have many attributes that qualify as environmental goods (EGs).[111] Indeed, several WTO country members have suggested that renewable energy technologies be included because of their positive environmental and economic potential.[112]

Environmental goods negotiations, however, have made very little progress so far, as members are broadly divided upon what approach to take for trade liberalisation. Industrialised nations favour a "list approach", but developing countries claim this is biased towards goods from industrialised countries.[113] The so-called 'OECD list' identifies 'bioethanol' as an environmental good. The only alternative to the list approach that is seriously being considered at this stage is the 'environmental project approach' put forward by India, in to which tariffs on environmental goods and services that are being used in specific projects would be reduced or eliminated for the duration of the project.[114] This approach, however, has been criticised as too bureaucratic and difficult to implement and that it would only bring better market access to large multinational companies. [115]

One sticking point would be the differentiation between biofuels and standard fuels. Given that the main differences between fossil fuel and biofuels in terms of their environmental performance (GHG reductions) come from a Life Cycle Assessment (LCA), it would involve a discussion on production and process methods (PPMs). The WTO definition of 'like products", on the other hand, does not provide for distinctions between products on the basis of their process and production methods (PPMs). This means the only accepts product-related measures. However, considering that the EC-Asbestos case extended the "likeness" definition to include health benefits, it could be said there might be some opportunities to differentiate biofuels without opening the PPMs debate, as biofuels are alleged to have health benefits (e.g. less harmful emissions compared to conventional fuels).[116] On the other hand, as there are environmental risks associated with biofuel production and trade which vary depending on the type of biofuel, feedstock and conversion method (see Chapter 6), it would be appropriate for them to be considered as environmental goods after a LCA that covers all potential environmental impacts.

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[110] WTO 2001 .
[111] De La Torre D, 2005
[112] Bridges Trade BioRes 2005
[113] While ethanol is included in the OECD list, it is not in the APEC list
[114] Bridges Trade BioRes 2005
[115] Bridges Trade BioRes 2005
[116] See section 6.2 on environmental impacts of biofuels

Overall, given that developing countries have significant potential for biofuel production and trade and, on the other hand, industrialised countries are expected to become major biofuel sinks, the inclusion of biofuels within EG scope therefore offers the opportunity to simultaneously achieve the goals of enhancing and diversifying developing countries' exports, improving the conditions of rural inhabitants and also achieving environmental goals. Therefore, existing WTO provisions must be clarified in order to clearly categorise biofuels as environmental goods according to a LCA and to allow them to benefit from accelerated *'reduction or, as appropriate, elimination of tariff and non-tariff barriers to environmental goods and services'*.[117]

5.2.6 Special and Differential Treatment (SDT) and the "infant industry argument"

Special and Differential Treatment (SDT) had its origins in a view of trade and development that questioned the desirability of developing countries' liberalising border measures at the same pace as industrialised countries. [118] It emphasises graduation of trade liberalisation according to the development level of the country involved.

There is a considerable gap between those countries already exporting biofuels and those that are just starting to produce them. Disparities exist both in terms of the development of their biofuel industries and the development level of the countries themselves. There are those countries that are at the forefront of the development of these industries, such as Brazil, the US and the EU and those that, despite having a significant amount of feedstock, still have some way to go in the development of the technology.[119] Many developing and least developed countries can be found within the latter group. These countries may possess significant advantages for biofuel production and trade but need the right incentives for the industry to develop. Many of these countries are those in which the impacts of biofuels, especially in terms of social and economic development, are likely to be felt most strongly.

The countries that today have well developed biofuel industries owe their progress to a set of economic incentives and domestic policies that have fostered the development of their biofuel industries.[120]

The trading system should recognise these differences and allow sufficient policy space for coherent domestic policy mechanisms to allow the development of the biofuel industry in the poorest countries above all. Policies also need to implement measures that support climate change issues.

From the mix of policy tools available to support industry development, it is necessary to identify those that are the most effective but also the least trade distorting, or to create new tools if those available are insufficient.

[117] WTO 2001
[118] IISD 2003
[119] De La Torre 2005
[120] Coelho S, 2005

5.3 Other trade agreements

In addition to the WTO, there are several regional and bilateral trade agreements, particularly involving the US and the EU, that directly or indirectly regulate the biofuels trade. Among the most important are:

US-Caribbean Basin Initiative (CBI): This agreement allows countries covered under the CBI[121] to export bioethanol produced by foreign feedstock (i.e. sugar from another country) into the US duty free to up to 7 per cent of total US bioethanol production. After the 7 per cent of US production threshold has been reached, an additional 35 million gallons can be imported into the US duty free, provided that at least 30 per cent of the bioethanol is derived from "local" (Caribbean region) feedstocks. Anything above the additional 35 million gallons is duty-free if at least 50 per cent of the bioethanol is derived from local feedstocks. The US International Trade Commission recently set the CBI cap on duty free bioethanol imports at 240.4 million gallons for fiscal year 2005.[122]

Central American Free Trade Agreement (CAFTA): CAFTA supersedes the CBI, making the CBI allowances on bioethanol exports into the US permanent.[123] CAFTA also establishes country-specific shares for Costa Rica and El Salvador within the overall CBI quota. El Salvador is guaranteed 5.2 million gallons in the first year, with annual increases of 1.3 million per year, not to exceed 10 per cent of the quota. Costa Rica is allocated 31 million gallons annually.

Generalised System of Preferences (GSP): The GSP is a scheme of tariff preferences favouring developing countries. The EU GSP that was in force until December 2005 classified ethanol (code 22 07) as a sensitive product and all imports of this alcohol from all GSP beneficiary countries qualified for a 15 per cent reduction of the MFN duty. The special drugs regime envisaged by Council Regulation (EC) 2501/2001, gave duty-free access to ethanol exports from a number of countries (see Table 4). The latest version of the EU GSP - the "GSP+", applicable from 1 January 2006 to 31 December 2008, no longer envisages any tariff reduction to code 22 07 (still classified as a sensitive product). The GSP+ put in place a special incentive arrangement for sustainable development and good governance that grants unlimited and duty-free access to code 22 07 and includes all the countries which have already benefited from the previous drugs scheme, with the exception of Pakistan. The latter no longer qualifies for GSP preferences as Pakistani ethanol exports are just over 1 per cent of total EU imports under GSP and therefore is subject to the full MFN duty.[124]

The EU's "Everything but Arms" (EBA): In addition to the EU GSP, "Everything But Arms" grants least developed countries (LDCs) duty-free access to the EU for all products, except arms and ammunition

Cotonou Agreement: Under the Cotonou Agreement, ACP countries qualify for duty-free access for denatured and undenatured alcohol under code 22 07 with the

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[121] CBI countries include Belize, Costa Rica, El Salvador, Guatemala, Guyana, Honduras, Nicaragua, Panama, Antigua, Aruba, the Bahamas, Barbados, British Virgin Islands, Dominica, Dominican Republic, Grenada, Haiti, Jamaica, Montserrat, Netherlands Antilles, St.Kitts and Nevis, St.Lucia, St.Vincent and the Grenadines, and Trinidad and Tobago.
[122] IATP 2005
[123] IATP 2005
[124] GAIN 2005b

exception of South Africa, which until December 2005 enjoyed the 15 per cent tariff reduction under the GSP scheme. From January 2006, therefore, it has had to pay full MFN duty.

EU-MERCOSUR: The trade agreement currently under negotiation between MERCOSUR (Argentina, Brazil, Paraguay and Uruguay) and the EU will also be relevant as sugar and bioethanol are Brazil's main interests and are therefore essential elements of these negotiations.[125] Outcomes of the negotiations are not yet clear as sugar and ethanol are sensitive products for the EU and for ACP countries (to whom the EU already grants preferential market access), and the EU therefore has strong incentives to exclude the products from the negotiations. Another product likely to be covered by negotiations is soya, as Argentina and Brazil are two of the main global producers and the EU is the main global importer.

Table 4: Import conditions under code 22 07 of the EU's main preferential agreements

	GSP Normal		GSP +	EBA	Cotonou
Duty reduction	15% up to 31.12.05	0% as of 01.01.06	100%	100%	100%
Quantitative restrictions	NO		NO	NO	NO
Beneficiaries	All GSP if not graduated		Bolivia, Colombia, Costa Rica, Ecuador, Panama, Peru, El Salvador, Venezuela, Georgia, Sri Lanka, Mongolia	LDCs	ACPs

Source: EC, 2005

Development of an open trading system that delivers the expected positive biofuel impacts is paramount, particularly for the poorest countries. In addition to the more obvious economic gains, it could also bring significant environmental and social benefits.

Current tariff barriers, especially in the form of tariff escalation, and domestic support could mean that developing countries will not be able to reap the full benefits of trade. Not only do they undermine their competitiveness, but they could also lead to inefficiency and negative environmental and social outcomes. Indeed, they may damage the potential of biofuels to reduce poverty and reduce GHG emissions, as the nearer to the cultivation the biofuel conversion takes place, the higher the impact on rural job creation and on GHG reduction. Moreover, industrialised countries policies could be promoting the development of a biofuels industry based on the least efficient energy crops.

[125] EC 2006

The environmental and social externalities associated with biofuels mean that some form of public policy is crucial to the development of the industry. But the experience of Brazil suggests that support levels could reduce over time. This points to the need to identify the most effective but also least trade-distorting policy tools to promote market development of biofuels. In order to take full advantage of the opportunities that biofuels trade offers for sustainable development, the emerging trading system should be flexible enough to encourage countries with a large production potential like Brazil and Thailand. At the same time, it should enable the conditions to generate investment in countries with smaller production potential, but which are still capable of taking advantage of domestic resources.[126]

Finally, as the next chapter suggests, not all the interactions between biofuels and sustainable development are positive. So the challenge is to set up an international trading system able to coexist with structures that support the positive contributions of biofuels to sustainable development, and to develop mechanisms to deal with the negative aspects. The next chapter reviews the main interactions between biofuels and sustainable development.

[126] De La Torre 2005

6 Biofuels and the sustainable development debate

Links between biofuels and sustainable development are varied and complex. On the one hand, biofuels may imply improved energy security, economic gains, rural development, greater energy efficiency and reduced GHG emissions compared to standard fuels. On the other hand, production of energy crops could result in the expansion of the agricultural frontier, deforestation, monocropping, water pollution, food security problems, poor labour conditions and unfair distribution of the benefits along the value chain. The positive impacts and trade-offs involved vary depending on the type of energy crop, cultivation method, conversion technology and country or region under consideration. Thus, the review of issues provided below is by no means exhaustive, but rather aims to highlight the major issues of the biofuels and sustainable development debate requiring further investigation. These issues should be weighed up against those associated with standard fuels.

6.1 Economic aspects of biofuels

6.1.1 Energy diversification

Although more a national security objective than an economic issue, a key strategic objective associated with biofuels is the achievement of greater energy security[127] through a diversified energy portfolio. Indeed, reduced reliance on imported oil was the main driver behind the earliest experiences with biofuels in Brazil and the US.

The volatility of world oil prices, uneven global distribution of oil supplies, uncompetitive structures governing the oil supply (i.e. the OPEC cartel) and a heavy dependence on imported fuels are all factors that leave many countries vulnerable to disruption of supply. This may impose serious energy security risks, in particular to those countries that are heavily dependent on energy imports. In 2000, oil imports of OECD countries accounted for 52 per cent of their energy requirements, but this is expected to rise to 76 per cent by 2020. Almost all least developed countries are oil importers. Crude oil imports to ACP countries were expected to increase to 72 per cent of their requirements in 2005.[128] Non-OECD countries share 41 per cent of the world oil consumption. Oil supplies, on the other hand, are very unevenly distributed and concentrated in few countries (75 per cent in the Middle East) and are governed by uncompetitive structures.

The above factors, together with the current high oil prices; the future oil demand of new large economies such as China and India, causing uncertainty about future oil availability; the recent dispute between Russia and Ukraine over the price of natural gas (which put EU gas supplies at risk), suggest that the energy security issue will become a higher priority on government agendas.

6.1.2 Improved trade balance

Heavy reliance on foreign energy sources means countries have to spend a large proportion of their foreign currency reserves on oil imports. This is especially relevant

[127] i.e. the availability of energy at all times, in sufficient quantities and at affordable prices (Coelho 2005)
[128] IEA, 2002 quoted by Coelho 2005

for the poorest developing countries where any saving of foreign currency means increased resources available for other urgent development needs. In this context, domestic biofuel production offers an opportunity to replace oil imports and improve the trade balance. In Brazil, for instance, it has been calculated that the replacement of gasoline by bioethanol saved some US$ 43.5 billion between 1976 and 2000 (US$ 1.8 billion/year).[129]

The improved trade balance argument, however, encourages the introduction of protectionist measures against biofuel imports. In the EU, for example, some actors in the biofuel sector are criticising the heavy dependence on imports that it might be creating. They argue that one of the primary reasons for the biofuel directive was to reduce dependence within the energy sector. While for the moment it is easy to buy cheap bioethanol on the international market, there may be problems in the future when countries like China start buying up huge amounts of this cheap energy.[130]

6.1.3 Higher costs than conventional fuels

One of the biggest barriers to large-scale development of biofuels remains their higher economic costs compared to conventional fuels. Some estimates show biofuels to be twice as costly as conventional fuels.[131] Economic costs, however, tend to differ depending on the type of biofuel, the country of provenance and the technology used, with Brazil being the most cost-efficient producing country. Estimates show that bioethanol in the EU becomes competitive when the oil price reaches US$ 70 a barrel[132] while in the US it becomes competitive at US$ 50 - 60 a barrel.[133] For Brazil the threshold is much lower – between US$ 25 and US$ 30 a barrel.[134] Other efficient sugar producing countries such as Pakistan, Swaziland and Zimbabwe have production costs similar to Brazil's.[135]

There are also differences depending on the feedstock used. Corn, for instance, is more expensive and produces less bioethanol per hectare than tropical crops such as sugarcane that are grown in many developing countries. This is important as the high levels of agricultural support prevailing in many industrialised countries have the potential to undermine the important production potential that biofuels can offer to the most cost-efficient developing countries.

The current high oil prices mean that biofuel production has become competitive in some parts of the world. However, more intense competition from alternative fuels that are traded in large quantities globally will certainly drive down oil prices in the medium to long term. Therefore, the issue of cost differentials would need to be addressed through policy incentives (e.g. lower taxes), market incentives (carbon markets) and technology improvements. There is a need to identify those instruments that are least market-distorting, and to identify mechanisms to help developing countries to develop their own industries.

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129 Langevin 2005
130 GAIN, 2005a
131 Petroleum Economist 2005
132 Petroleum Economist 2005
133 Sexton E, Martin L. and Zilberman D 2006
134 Petroleum Economist 2005
135 EC 2006

6.1.4 Foregone government revenue

At a policy level, one of the main shortcomings of biofuel development is the large amount of foregone government revenue in the form of domestic support. The final column of Table 3 in Chapter 4 provides a rough estimate of foregone revenue for some selected countries. The UK Government for example estimates that, under present arrangements, annual foregone fuel duty revenue will total £ 90 million if biofuels achieve a 1 per cent market share; and the desired target is 5 per cent by 2010. In Germany, the uptake of biofuels is now so rapid that there is speculation about whether Germany can continue to sustain the likely revenue foregone.[136] In the case of developing countries this poses a significant challenge as financial resources are scarcer and there are a multitude of urgent needs competing for these scarce financial resources.

Given the existence of important potential benefits associated with biofuels, governments need to assess the foregone revenue against the potential benefits. The international community can also help by providing evidence on the costs and benefits of biofuels; evidence on the impacts of different policy tools; and the development of global market incentives and financial resources for market development in the poorest countries.

6.1.5 Production diversification and value-added

Biofuels generate a new demand for agricultural products that goes beyond traditional food, feed and fibre uses. This may reduce the volatility of and likely rises in commodity prices while reducing commodity surpluses. In addition it provides an opportunity for more value-added for agricultural output. All of these aspects are needed to support poverty reduction, especially in developing countries. The Colombian Government estimates that sugarcane-based bioethanol production will increase the country's GDP by 3 per cent.[137] According to Parson (2005), the processing of crude oil into biodiesel would add a further 15 per cent to the Jatropha based biodiesel sales in Africa.

Many of these benefits will depend, however, on changes in the agricultural policies of industrialised countries, as discussed earlier. In addition, the tariff escalation system prevailing in many industrialised countries (see section 5.1.2), together with local technological capacities could encourage developing countries to export the feedstock and the unprocessed crude oil and molasses while the final biofuel conversion takes place in the importing country.

6.2 Environmental aspects of biofuels

6.2.1 Energy balance

Energy balance refers to the point at which the energy required to produce one unit of biofuel is greater than the energy than comes out, and production is therefore not viable. There is debate about whether biofuels have a better negative energy balance

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[136] IEA 2004

[137] FUEL ETHANOL PROGRAM IN COLOMBIA, available at: http://www.iea.org/textbase/work/2002/ccv/ccv1%20echeverri.pdf

than conventional fuels. This debate started in the early 1970s and criticisms are mostly based on experiences of corn-based ethanol. However, as the following analysis suggests, biofuels do have a better energy balance but there are important differences depending on the different types of biofuel.

Estimating the net impacts of biofuels' energy balance is a very complex issue. Energy balances need to consider the entire fuel cycle, from feedstock production to final consumption – the so-called 'well-to-wheels' approach. Assessments should also include energy paybacks associated with the co-products - the so-called 'co-products credits'.[138] Energy balances vary depending on the type of feedstock used and methods of cultivation as well as the conversion technology. There are also differences depending on the methodology used to calculate the energy balance (e.g. assumptions regarding co-products energy balances).

Brazilian sugarcane-based bioethanol, for instance, is deemed to be one of the most energy efficient forms of bioethanol, with energy balance estimates varying between 3.7 and 10.2 units, with an average of 8.3 units.[139] Brazil's natural conditions mean that soil productivity is very high, requiring almost no additional inputs, and sugarcane crops are rain fed. In addition, nearly all conversion plants' processing energy is provided by 'bagasse' (the remains of the crushed cane after the sugar has been extracted), which means energy needs from fossil fuel are zero.[140] The surplus bagasse is even used for electricity co-generation. Estimates for corn-based bioethanol in the US, on the other hand, show that it generates about two units of energy for each unit required in production. The lower energy balance comes about because US corn cultivation requires higher quantities of petrochemical fertilisers and toxic pesticides and the corn processing for bioethanol requires additional fossil fuel. Estimates for wheat-based bioethanol in the EU range between 0.81 and 1.03 units whilst figures for bioethanol from sugarbeet vary between 0.56 and 0.65 units.[141]

Most studies for biodiesel focus on biodiesel from rape, and suggest an energy balance of between 0.33 and 0.82 units. But Macedo (2004) compares the energy balance of biodiesel from palm oil, castor oil, and soya oil in Brazil. He suggests the best energy balance is for palm oil (5.63 units) while the worst is for soya oil (1.43 units) (see Figure 12).

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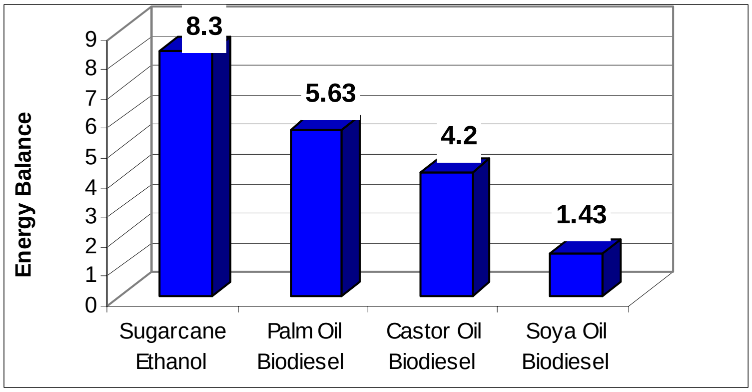
[138] According to IEA 2004: the amount of energy and GHG emissions that co-products of biofuel production processes, such as animal feed, oil, glycerine and co-generated electricity, help displace by reducing the production of competing items.
[139] Langevin M, 2005
[140] IEA 2004
[141] IEA 2004

Figure 12: Energy balance of biofuels in Brazil



Other lesser-known energy crops such as jatropha and some new technologies based on perennial crops such as lignocellulosic are proving to have the best energy balances. Jatropha, for instance, is alleged to have the highest energy balance of any biofuel. Unlike corn or sugarcane, jatropha is a perennial, yielding oil seed for decades after planting. It can grow without irrigation in arid conditions where corn and sugarcane could never thrive.[142] Lignocellulosic ethanol is based on grasses such as woody crops, which can be grown on marginal land, require little fertiliser or water and have higher energy contents. According to the US Department of Energy, for every unit of energy available at the fuel pump, only 0.2 units of fossil energy are used to produce cellulosic bioethanol, 1.23 units of fossil energy is used to produce gasoline and 0.74 of fossil energy is used to produce corn-based bioethanol.[143]

Differences in energy efficiency balances imply that there are better opportunities for crops such as sugarcane, sweet sorghum, palm oil and jatropha to become global energy sources. Crops with lower yields require so much land that they would not be able to compete economically with those with higher yields.[144] Soya beans, for instance, despite being the preferred source of biodiesel in Brazil, are expected to be replaced by more efficient vegetable oils such as palm oil and castor oil as the biodiesel industry develops.[145] However, the existence of policy incentives could mean that the biofuels market develops in favour of those crops that are not necessarily the most energy-efficient. This is important as the highest levels of domestic agricultural support are in industrialised countries while the crops with the best energy potential are grown in tropical developing countries.

6.2.2 Greenhouse gas (GHG) emissions

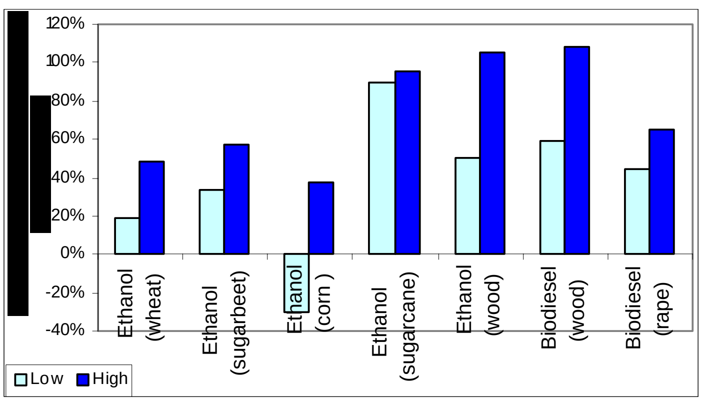
One of the greatest advantages associated with biofuels and one of the main driving forces behind worldwide biofuel uptake are their alleged reduced GHG emissions, and hence their potential to help minimise climate change. The basic argument is that because growing feedstocks absorb CO2, the release of CO2 emitted during biofuel combustion does not contribute to new carbon emissions since the emissions are already part of the fixed carbon cycle.

[142] Parsons K 2005,
[143] Becker K. and Francis G. 2003
[144] Moreira R. 2005
[145] Trindade S 2005b

However, there is considerable variation in GHG savings – ranging from negative to more than 100%. Estimates vary according to the type of feedstock, cultivation methods, conversion technologies, energy efficiency assumptions and disparities regarding reductions associated with co-products.

Bioethanol shows the widest variations. A recent article published in the journal *Science*, which evaluated six studies on GHG reduction of corn-based bioethanol found a variation from a 33 per cent decrease to a 20 per cent increase, averaging a 13 per cent reduction in GHG emissions compared to petrol.[146] The study also argued that the reduction could actually be improved, as figures calculated did not reflect incentives available for GHG emission control. Estimates for wheat-based bioethanol point to reductions ranging from 19 to 47 per cent, while for sugar beet-based bioethanol estimates vary between a 35 to 53 per cent decrease.[147] One estimate for sugarcane-based bioethanol in Brazil shows a 92 per cent reduction compared to standard fuel.[148] Estimates for newer technologies such as lignocellulosic ethanol are only available from engineering studies, as very few large-scale facilities exist. They typically suggest a 70 – 90 per cent reduction but can achieve a 100 per cent reduction compared to conventional gasoline.[149] Figure 13 shows estimates of GHG reduction for different types of biofuels.

Figure 13: GHG reductions for different biofuels



Source: based on E4 Tech, et al 2005 'Feasibility Study on Certification for a Renewable Transport Fuel Obligation', Final Report

The variation in levels of GHG emissions for different types and sources of biofuels make it difficult to predict the achievement of GHG reduction targets for policy makers in countries that rely on various sources of biofuels. This highlights the need to identify biofuels with lower GHG emissions and create incentives for their production. There are currently some initiatives being developed to address this issue through biofuel certification according to carbon intensity.[150]

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[146] Koonin S. 2006
[147] IEA 2004
[148] Macedo et al 2004
[149] IEA 2004
[150] See for example ECCM, Imperial College and IIED initiative.

At the same time it is important to bear in mind that biofuels are not deemed to provide a final solution to global warming but they form an important component of an integrated approach to tackling the issue.

6.2.3 Air quality

In addition to reduced GHG emissions, biofuels also have the potential to reduce emissions of key toxic substances usually associated with standard fuels. Table 5 summarises emissions associated with bioethanol, biodiesel and Fisher-Tropsch for transport use, based on data from the United States Environment Protection Agency (USEPA). It suggests that engines running on these types of biofuels or on a blend of standard fuels and biofuels tend to have lower particulate and CO emissions and lower sulphate emissions. However, while bioethanol also shows reductions in ozone-forming volatile organic compounds, it has higher ethanol and acetaldehyde emissions. Biodiesel shows higher emissions of nitrogen oxide, though the differences are not substantial.

Table 5: Typical biofuel toxic emissions compared to standard fuels

BIOETHANOL (E85)	BIODIESEL (B20 & B100)	FISCHER-TROPSCH
• 15% reductions in ozone-forming volatile organic compounds. • 40% reductions in carbon monoxide. • 20% reductions in particulate emissions. • 10% reductions in nitrogen oxide emissions. • 80% reductions in sulphate emissions. • Lower reactivity of hydrocarbon emissions. • Higher ethanol and acetaldehyde emissions.	• 10% (B20) and 50% (B100) reductions in carbon monoxide emissions. • 15% (B20) and 70% (B100) reductions in particulate emissions. • 10% (B20) and 40% (B100) reductions in total hydrocarbon emissions. • 20% (B20) and 100% (B100) reductions in sulphate emissions. • 2% (B20) and 9% (B100) increases in nitrogen oxide emissions. • No change in methane emissions (either B20 or B100).	• Nitrogen oxide reductions due to the higher cetane number and even further reductions with the addition of catalysts. • Little or no particulate emissions due to low sulphur and aromatic content. • Expected reductions in hydrocarbon and carbon monoxide emissions.

Source: USPA 2002a 'Clean Alternative Fuels: Biodiesel'; USEPA 2002 b 'Clean Alternative Fuels: Ethanol' USEPA 2002c 'Clean Alternative Fuels: Fisher-Tropsch'. All available at: www.epa.gov
Estimates based on the specific biofuel's inherently "cleaner" chemical properties with an engine that takes full advantage of these fuel properties.

There are also reductions in household air pollution when crop-based biofuels substitute other traditional forms of fuels usually used in the poorest countries, such as charcoal, fuelwood and paraffin. These forms of fuel have been identified as major killers of women and children in developing countries.[151]

On the other hand, the burning of sugarcane fields just prior harvest, which is a common practice in developing countries, has been linked to air pollution, GHG

[151] Woods 2005

emissions and health risks in cities such as São Paulo in Brazil. Likewise, the use of fires to clear fields for the cultivation of large-scale palm oil plantations in Indonesia, for instance, has resulted in considerable increases in air pollution.

6.2.4 Expansion of the agricultural frontier and forest conversion

One of the greatest concerns associated with increased biofuel production is the impact on the agricultural frontier. Biofuels are expected to contribute around 20 to 30 per cent of global energy demand by 2030. This is very likely to exacerbate the already intense competition for land between agriculture, forests and urban uses. Brazil, for example, by 2013 will need to increase sugarcane cultivation by 3 million hectares (from the 5.7 million currently) in order to meet the domestic and foreign demand for bioethanol.[152] The Brazilian Government argues there is sufficient unused agricultural land for the proposed increase in production (up to 90 million hectares of unused agricultural land).[153] Other scenarios, however, suggest the increased sugarcane production in Brazil or a similar expansion in other tropical regions would lead to increased environmental pressure. Sugarcane production has been linked to the clearing of some of the most unique and biodiverse regions on the planet, including the entire natural habitat of thousands of islands, and thousands of hectares of fragile coastal wetlands. Likewise, if the increased biofuel demand were met by soya-based biodiesel, this would imply further environmental pressure, especially in the sensitive drier savannah areas of north-central Brazil (the Cerrado ecoregion) in the states of Piaui and Mato Grosso and in the Amazon forests. Forest conversion has also been linked to oil palm production in countries such as Malaysia and Indonesia, which are both likely to become important biofuel producers.

On the other hand, certain energy crops like trees and grasses require fewer inputs and can sometimes be grown on very degraded land, promoting land restoration. These energy crops have the potential to extend the land base available for agricultural activities and also create new markets for farmers.[154] Jatropha, for example, can store moisture, stabilise soil, and slow down, if not reverse, desertification while it grows.[155]

The impacts on agricultural frontiers and forests are issues that need careful analysis. One of the main driving forces behind biofuel development is the benefit of reduced GHG emissions. However, all the positive effects this benefit heralds risk being lost if the expansion of energy crops leads to further deforestation.

6.2.5 Spread of genetically modified organisms

Due to the need to improve both the economic efficiency and the energy efficiency of biofuels, biotechnologies are expected to play a key role in the development of the biofuel industry. Genetic improvement has been highlighted as the key to increased yields and environmental benefits of energy crops while reducing agricultural inputs. While genetic improvement for some feedstocks such as soya and corn are more advanced, for other energy crops such as switchgrass, poplar, and jatropha it has

[152] Costa 2006
[153] Costa 2006
[154] De la Torre, 2005
[155] Parsons K 2005

barely begun. The combination of modern breeding and transgenic techniques are expected to achieve greater results for food crops than the Green Revolution achieved, and in far less time.[156]

The use of genetically modified organisms (GMOs) is a very sensitive issue. The main arguments against GM technologies relate to food safety concerns, and their impacts on biodiversity and on farmers' livelihoods. In the US, Canada and some South American countries such as Brazil and Argentina, planting of GMOs is already widespread. But in the EU, expansion of GMOs is heavily regulated and only 20 GM varieties - mostly corn and soya - have been approved for planting. GM crops grown for food and feed purposes must be labelled, but this is not the case for crops grown for energy production.

There is considerable concern that biofuel development will lead to a wider spread of GMOs, the pros and cons of which require further investigation.

6.2.6 Other environmental impacts associated with crop production

There are several additional environmental impacts associated with intensive feedstock cultivation. Among the most important are:

- monocropping and biodiversity loss, usually associated with large scale cultivation
- water consumption and reduced water flows, especially for irrigated crops
- water quality and effluent run-off problems (whether the crop is irrigated or rain-fed) from agrochemicals and sediment; in some cases these impacts can extend to downstream ecosystems.
- land degradation, also associated with monoculture and the use of agrochemicals.

6.2.7 Other indirect impacts

Biofuel production and exports require infrastructure development. In Brazil emphasis has been placed on the need for investment in port capacity to keep ahead of expected export demand from Japan, China, India, the EU and Venezuela. Investment is also needed for roads, pipelines and railways.[157] In May 2005, Japan signed a US$ 500 million loan agreement with Brazil to finance domestic infrastructure development projects and capital investment in Brazilian export companies, which include local Japanese affiliates.[158] These developments may have further environmental and social impacts that need to be investigated.

[156] Koonin Steven 2006
[157] PlanetArk 2005
[158] Australian Task Force, 2005

6.3 Social benefits of biofuel production

6.3.1 Opportunities for rural development

6.3.1.1 Employment creation and quality

In addition to the environmental benefits of biofuels, a primary motivation for the promotion of biofuels in the EU is rural economic development. Biofuel production can also have a positive impact on agricultural employment and livelihoods, especially when the cultivation involves small-scale farmers and the conversion facilities are located near the crop sources in rural areas.[159]

Sugarcane in Brazil (which is directly related to bioethanol production), for instance, employs around 1 million workers[160] and the number is expected to grow by 204,000 in the next five years.[161] This is more than the jobs created by fossil fuel production.[162] Most bioethanol-related jobs involve low skilled and poor workers in rural areas and the quality of the jobs is better because of lower seasonality and increasing wages over time.[163] In Sao Paulo, 23 per cent of cane cutters, who comprise the largest category of unskilled workers, are women. In the north east, the proportion is comparable to that of other unskilled job categories.[164] In the US, bioethanol production is now responsible for creating more employment in rural areas than any other activity.

Biofuel production in other parts of the world can also create additional opportunities for family farmers and rural workers. For instance, the Colombian Government estimates that every farming family will earn two to times the minimum salary (US$ 4,000 per year) through bioethanol production.[165] In China, the liquid biofuel programme is predicted to create up to 9.26 million jobs across the country, thus leading to significant increases in income generation and rural development.[166]

The final impact on employment and wealth will depend, to a large extent, on the possibility of the countries not only to grow the feedstocks, but also to be able to convert them into biofuel. However, as highlighted earlier, the tariff escalation system prevailing in many industrialised countries may well encourage developing countries to export the feedstocks and the unprocessed crude oil and molasses while the final conversion takes place in the importing country, thus causing them to miss out on some of the positive impacts of biofuels.

The cultivation of some energy crops such as soya is linked to large-scale cultivation, with very little impact on rural labour. While there are some cooperatives of small-scale soya producers, a key factor for their long-term viability is whether they can organise themselves in such a way that will enable them to achieve economies of

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[159] IEA 2004
[160] Moreira J 2005
[161] Langevin M 2005
[162] Langevin M 2005
[163] Macedo I, 1995
[164] Macedo I, 1995
[165] FUEL ETHANOL PROGRAM IN COLOMBIA, available at: http://www.iea.org/textbase/work/2002/ccv/ccv1%20echeverri.pdf
[166] Bhojvaid 2006

scale. The need to lower production costs of biofuels offers considerable incentives for the wide-scale adoption of new and less labour-intensive technologies. Thus, achieving a balance between mechanisation and the number and quality of new jobs created by the industry is crucial.

Finally, there are also concerns that widespread biofuel production may result in, or exacerbate, poor labour practices. There is evidence in some developing countries that the cultivation of some feedstocks, notably sugarcane and palm oil, has been linked to poor working conditions, health and safety risks, child labour and forced labour. [167]

6.3.1.2 Improved livelihoods

In addition to the income generated by job creation, biofuel production offers opportunities for better livelihoods.

At the macro level, the current high level of agricultural support prevailing in many industrialised countries has led to surpluses of many agricultural commodities that are then exported under heavily subsidised price regimes. As production of biofuels requires many of these crops as inputs, policymakers see the promotion of biofuels as a viable option to change the composition of agricultural output from surplus food commodities that must be exported under subsidies to fuels that can be consumed domestically. This increased demand for agricultural commodities and shifting supply away from other agricultural outputs could significantly increase the price of agricultural commodities, and therefore farmers' incomes. A problem that has been highlighted in this respect relates to the potential trade-offs that might arise in terms of food security in the poorest countries; the 'fuel versus food debate' discussed in Section 6.3.3.

Livelihoods could also improve because of the positive impacts on land restoration associated with crops such as jatropha. Becker et al. (2003) argue that once the jatropha trees establish themselves and fertilise the soil, their shade can be used for intercropping shade-loving vegetables such as red and green peppers, tomatoes, etc, which would provide additional income for the farmers.[168]

6.3.1.3 Opportunity for Clean Development Mechanism projects

Another aspect that needs to be further explored is the possibility for developing countries to attract Clean Development Mechanism (CDM) projects and investment under the Kyoto Protocol through biofuel production. The partnership between Brazil and the German Government described in Box 2 illustrates that there are significant opportunities to be exploited.[169] In addition to contributing to climate change mitigation, this may also serve as a way to meet the Millennium Development Goals of poverty reduction and rural development.

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[167] See for example ProForest and IIED 2003
[168] Becker K. and Francis G. 200??
[169] See Section 4, Box 1.

6.3.2 Social effects associated with market power structures and the distribution of costs and benefits along the value chain

An understanding of the management of the value chain of products, including analysis of the distribution of benefits during the whole cycle of organisation, conception, production, delivery and re-use or recycling of the product is very important. The experience of several agricultural products underlines the fact that rents from export production in the developing world have increasingly accrued to those agents in the upper parts of the chain while squeezing out those in the lower part – the primary producers.

In the case of biofuels, many of the supply chains are, or would, target export markets and in many cases they are likely to separate primary production (i.e feedstock production and molasses/crude oil production) from the final products (i.e. processing the crude oil or alcohol into biofuel). This, coupled with the uncompetitive international market power structures – at present only two companies, Cargill and Archel Daniels Midlan (ADM), control about 65 per cent of the global grain trade[170] - raise serious concerns about the possible impacts on the distribution of the costs and benefits along the value chain.

Indeed, many of the social benefits of biofuels – particularly those related to poverty reduction – accrue from the pro-poor/small farmer nature of the technology needed to produce them. However, if producers are dependent on a very few international traders bringing their products into the international market there is a risk of exploitation and squeezing of primary producers. Moreover, the need for economies of scale can also act as a driver for establishing large-scale cultivation of energy crops, thereby crowding out small farmers' cultivation.

The available evidence on value chain analysis in agriculture concentrates on the food sector. Therefore, in order to get a better understanding of the biofuel-related impacts, it is important to explore whether there are differences in the distribution of costs and benefits among supply chains managed by the food industry and those managed by the fuel industry.

6.3.3 Fuels versus food debate

Greater international demand for biofuels has many implications for the production, price and availability of staple commodities, and these impacts need to be investigated.

On the one hand, there is some concern that large-scale biofuel production will lead to food security problems, especially in the poorest developing countries. It is argued that greater demand for biofuels will lead to land being drawn away from other purposes including food production. This could lead to food shortages and higher food prices for consumers. In China, for example, different reports have pointed out that food security is a great concern.[171] In Malaysia, demand for palm-based biofuel is growing so fast that the country has decided to stop licensing new producers while industry works out how to divide the raw material between the food and energy

[170] Vorley B 2003
[171] For example, see EC, 2006

sectors.[172] The country recently announced that it had reached an agreement with Indonesia in which both countries commit to set aside nearly 40 per cent of their crude palm oil output for biodiesel production.[173] These two countries together account for about 90 per cent of global palm oil production. Overall, the stronger pull on commodity markets of the oil industry compared to the food industry could lead to land being taken away from other uses, thus causing concern about negative impacts in the food market.

On the other hand, there are those who argue that large-scale production of biofuels does not imply food security trade-offs. Among the main arguments supporting this are that:

- There is enough land available to accommodate bioenergy production without endangering future supply of food or further deforestation.[174] [175]
- Biofuels will not totally displace oil-based fuel. Rather, they will be an alternative or a complement to it within a wide range of alternative renewable sources of energy. Biofuels could supply something between 20 and 30 per cent of global demand in an environmentally responsible manner without affecting food production. [176]
- There are possible synergies between fuel and food production as certain perennial energy crops like trees and grasses require fewer inputs; they can be grown on very degraded land too marginal for food crops and can even promote land restoration before food production is able to take place.
- Food shortages and famine are related more to poor distribution and a shortage of jobs and disposable income to buy food[177] than to agricultural production. In this sense, the livelihoods created by biofuel revenue could increase food affordability in producing areas.

Overall, a thorough analysis of this issue is urgently required, including an examination of how to achieve the right balance between food and fuel co-production in different regions.

6.3.4 Land rights

The likely expansion of agricultural land for production of energy crops could exacerbate conflicts over land rights and 'landlessness' issues in several developing countries, forcing rural dwellers to migrate, losing their access to key forest resources and ecosystem services. Large-scale plantations of palm oil in Indonesia, for instance, have been linked to the violation of traditional land rights of local communities.

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[172] Reuters 2006a
[173] Reuters 2006b
[174] See for instance Sachs I, 2005 '*Biofuels are coming of age*' page 7
[175] Faaij 2004
[176] Koonin 2006
[177] Trindade S 2005b

7 Conclusions and recommendations

Biofuels represent important opportunities and challenges for sustainable development, both globally and domestically. Biofuels can help to tackle climate change and improve rural employment and livelihoods. They may also help to diversify energy portfolios, ameliorate trade balances and improve air quality. However, they are not a panacea and they have many limitations. The cultivation of energy crops could cause or exacerbate environmental problems associated with agricultural commodity production. Of these, the expansion of the agricultural frontier is a key concern, especially the impacts it may have on tropical forests, savannahs and biodiversity. On the social side, there are important concerns about the impacts of biofuel production on labour practices and on food security. The creation of uncompetitive market power structures and the impacts this may have on the distribution of the benefits along the value chain is also a key concern.

The vast array of issues involved, the lack of knowledge about many of these issues, together with the different policy objectives and business interests associated with biofuels, mean that the debate about their real potential is developing and some very different views are emerging. What is certain is that the sustainable development benefits of biofuels are not straightforward. There is a need therefore to identify the sustainable development opportunities associated with biofuels and how to maximise them, and a need to identify the trade-offs and problems involved and how to minimise these. This is essential in order for the biofuel industry to develop without leading to a scenario in which biofuels provide a solution to one specific problem while creating many more.

The benefits and costs of biofuels vary widely, according to the type of feedstock, cultivation method, conversion technology and geographical area. Energy crops differ in terms of their energy efficiency, their impacts on GHG emissions and other environmental effects, and their impacts on employment creation. This would suggest that a ‘feedstock approach’ should be taken. The range of sustainable development impacts and the different policy goals associated with biofuels make it necessary to identify those types of energy crops that fulfil a given policy goal with the least negative impacts on sustainable development. Substantial information is already available on the key environmental and social impacts associated with the cultivation of various energy crops. But this information must be updated and extended to include the impacts of biofuel conversion and processing. Information on the linkages between energy crops and food security and the impacts along the value chain is also needed.

Understanding the impacts on sustainable development are complicated by the fact that many of the expected development gains associated with biofuels will depend on whether they can be traded internationally, as the most efficient producing countries are or will be developing countries while the main international consumers are or will be industrialised countries. Current trading conditions and the threat of protectionism could be undermining developing countries’ competitiveness, leading to inefficiency and negative environmental and social outcomes. Key issues to be addressed at the international level include tariff barriers, especially the tariff escalation systems in many industrialised countries that encourage developing countries to export the feedstocks and unprocessed crude oils while the final biofuel conversion takes place in the importing country.

Another key challenge is how to deal in a sustainable way with policies on domestic support. Whilst agricultural subsidies classified under the Amber box are to be reduced according to what is agreed under the current Doha negotiations, these are being replaced by increases in subsidies classified under the Green box, which enable farmers to diversify into production of energy crops. The impacts that these policies may have on developing countries' competitiveness are a key concern as any government support in these countries is likely to be limited. These policies may not only undermine their competitiveness, but could also lead to inefficiency and negative environmental and social outcomes. They could damage the potential of biofuels to reduce poverty and GHG emissions, while promoting the development of a biofuels industry based on the least efficient energy crops.

The various policy incentives used by countries that today have well developed biofuel industries suggests that some form of policy intervention is necessary for the industry to take off. But learning-by-doing processes have shown that support levels could diminish over time. The significant disparities between countries, both in terms of the development of their biofuel industries and the development level of the countries themselves, implies that the issue of policy support should be addressed in a way that does not undermine opportunities for developing countries.

The trading system should recognise these differences and enable the development of a sustainable biofuel industry, particularly in the poorest countries.

Finally, there is no clear classification of biofuels under the current trading system, which means there is no specific place to discuss how to make progress on trade liberalisation for biofuels.

Thus, there is a long list of issues on biofuels trade and sustainable development that need to be addressed. Among the most important are the following.

- Identifying the sustainable development impacts of trade in biofuels in different producing countries and different energy crops
- Identifying the main tariff and non-tariff barriers to specific types of biofuels and their associated impacts.
- Addressing the policy support issue so it does not undermine opportunities for developing countries; and analysing the pros and cons of the various policy tools available for promoting the biofuel market, in the following terms:

    - Which have proven to be the most effective in achieving that end?
    - What are their main trade-offs?
    - For how long should they be applied?
    - Which are the least trade distorting?
    - Which most affect developing countries' competitiveness?
    - And more broadly: What forms of policy tool should be created that will promote market development of those types of biofuels with the greatest positive sustainable development impacts but will not distort trade?

- Regarding biofuels within the current trading system, identifying the relevant trade rules applicable to biofuels and how these can be improved in order to maximise the positive impacts of trade on sustainable development and minimise the negative ones. Other questions to be addressed include: how might the current multilateral trade negotiations affect the biofuels market and what can be done to enhance the sustainable development benefits associated this? Which other trade regimes are relevant and how do they affect the biofuels market?
- Given the limitations of the trading system, identify and create synergies (or coordination) with parallel assurance mechanisms that can identify the biofuels that offer the greatest sustainable development benefits. Several international biofuel certification initiatives are already underway to address cross-compliance. It is necessary to ensure that they do not constitute unnecessary barriers to trade. However, these initiatives cannot address all of the sustainable development impacts. Therefore other forms of coordinated action need to be developed – but what are they and how should they be formed?
- The impacts of agricultural policies such as the EU CAP reform on sugar and policies on energy crops and set-aside land may also have important impacts on biofuels production and trade. And the impacts of these on developing countries' sustainable development need to be analysed.
- Uncompetitive market power structures can lead to unfair distribution of benefits along the trade chain. This also requires careful analysis: are there differences in terms of the distribution of costs and benefits among supply chains managed by the food industry and those managed by the fuel industry?
- Thorough analysis of the global links between international trade in biofuels and food security is required urgently.
- Another important issue requiring a careful analysis is the impact that the second generation of biofuels – lignocellulosic ethanol and Fisher-Tropsch biodiesel - will have on the biofuel market. Though these technologies are still under development in Northern countries, they are expected to be ready for commercial use within the next five to ten years. The second generation of biofuels are likely to have a huge impact on the biofuels market as they have a much better energy balance and are more energy-efficient than the existing generation of biofuels and will therefore require less land. Moreover, they will not be competing with food crops.

At a more local level there are also several issues that need to be addressed. None of the trade benefits will materialise if there is not enough capacity from the supply side. Among the most urgent issues are:

- Incentives: policy support could come in the form of policy and financial incentives, such as access to credit, tax benefits, greater use of the CDM.
- Economies of scale: the high production costs mean economies of scale are crucial to the viability of the industry in the future. The need to match social and environmental benefits with the achievement of these economies of scale means that action needs to be taken to organise small producers.
- Access to technology: there is a considerable gap between countries already exporting biofuels and those that are just starting to produce them. There are differences both in the countries' levels of development and the current state

of their biofuel industries. In addition, although technologies for sugarcane-based bioethanol and oilseed-based biodiesel are already well developed, technologies for other types of feedstocks such as jatropha require further development. The same will occur when the second generation of biofuels become available in the next decade. Better access to technology is therefore required, especially for the poorest countries. Thus, cooperation between countries would be beneficial, and should be explored, for example South-South cooperation, where other developing countries could learn from the Brazilian experience.

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