27 November 2006
ENGLISH ONLY

UNITED NATIONS CONFERENCE ON TRADE AND DEVELOPMENT

Challenges and opportunities for developing countries in producing biofuels

UNCTAD/DITC/COM/2006/15

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Introduction

The increase in oil prices has had the effect of improving the commercial viability of alternatives to oil. One group of energy bearers that has benefited particularly and that is of major potential importance to developing countries, is biofuels. Biomass was the world's primary source of energy until the late 1920s. Today about 10 per cent of the world's energy use is still derived from biomass and as much as 80 per cent in developing countries. While the use of traditional biomass such as fire wood and cow dung is associated with health hazards and environmental damage, modern biofuels offer the promise of considerable improvement in these areas. They also hold out the prospect of reduced energy import bills and improved energy security.

The production of energy from biomass involves a range of technologies, including solid combustion, gasification and fermentation. These technologies produce liquid and gas fuels from a diverse set of biological resources – traditional crops (sugar cane, maize, oilseeds), crop residues and waste (wheat straw, rice hulls, cotton waste), energy-dedicated crops (grasses and trees), dung and the organic component of urban waste. The results are products that provide multiple energy services: cooking fuel, heat, electricity and transportation fuels.

This study will present the evolution of international trade of biofuels and feedstock, and current trade regulations (tariffs and non-tariffs measures). It will also briefly detail current incentive policies in the EU and the United States for developing biofuels and look for indications of the policy they will adopt regarding consumption and import of biofuels. The study will then turn to issues relevant for biofuels production in developing countries. It will try to analyse what is at stake about food security, land uses, employment, public finance and environmental concerns. The final section of the study will identify some recent development of prices.

Chapter I

RECENT DEVELOPMENTS IN BIOFUELS DEMAND AND TRADE

In developed countries several signs indicate that the biofuels market is not chimeric and may last. The price of oil will not fall to its 2003 level of approximately $30 per barrel. There are multiple causes for this, unlike the case in 1973 and 1980. Fast development of Asian countries, refining capacity close to its maximum and thus increase in refining margins, weather hazards and geopolitical tensions have each played a small role, but have together given momentum to price increases, which have also been reinforced by speculative positions. With high oil prices, substitutions are taking place, such as replacing fossil fuels for transport by electricity and more recently by bioethanol and biodiesel. Brazil has shown that bioethanol production is competitive with gasoline at a crude oil price as low as $35 per barrel. Although latest price developments have led to a decrease from $80 to $60, OPEC intervention to reduce supply clearly means a political will not to let crude oil prices fall too far. At last, strong environmental concerns have made developed countries realise how damaging their addiction to crude oil can be. The last points played a strong positive role in favour of crude oil substitution by more environmentally friendly sources of energy, including biofuels.

Recent energy laws around the world that encourage the use of less greenhouse gases (GHG) emitting sources of energy are clear messages for a change towards a more sustainable production of energy. Investors have noted this change and are building all around the world hundreds of new refining plants to convert feedstock into biofuels.[1] With such growing production, new markets are being established and international trade of biofuels has already started.

Identifying trade patterns in biofuels is not an easy task because of the current lack of access to proper statistics in the trade classification relative to biodiesel and some feedstock such as Jatropha. In this study, the list of products analysed comprises:
- for ethanol: sugar beet, sugar cane, raw sugar, cane molasses, other molasses, wheat and maize;
- for biodiesel: rapeseed oil, Palm oil crude, sunflower-seed oil, castor oil (also known as Mamona), groundnut oil, cottonseed-oil, coconut (copra) oil, palm kernel oil, soya-bean oil.[2]

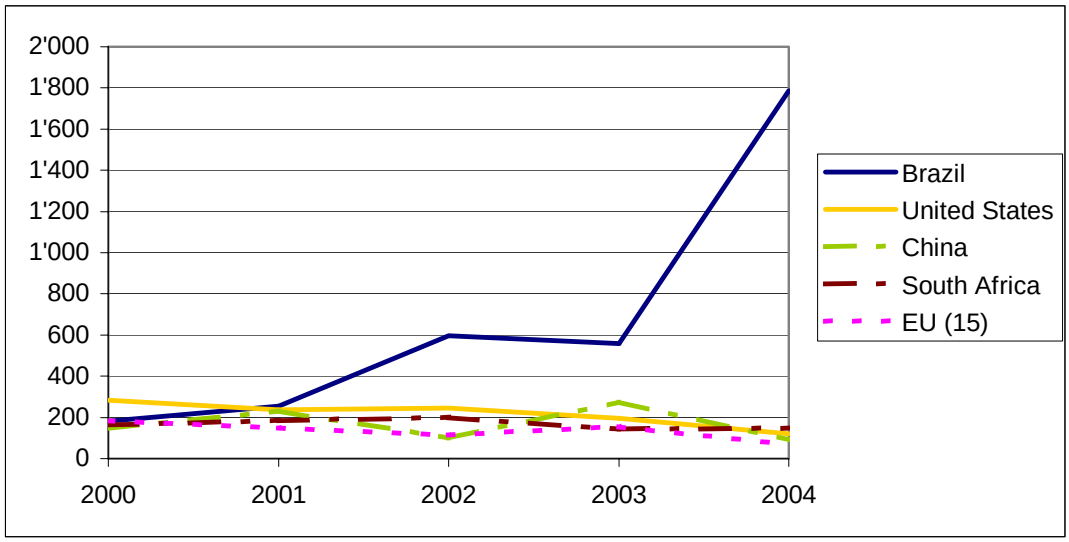
[1] In 2006 in the United States, 36 new biofuels production plants will be added to the existing 101 ones (see Les Echos 2.10.2006). In Europe, targets set by the European Union for biofuels production in 2010 are six times higher than the 2005 production volume (Eurobserv'ER 2006).

[2] Data on Jatropha oil has not been available. Statistical data used here comes from the COMTRADE database using the Harmonized System of Classification of 1996. Since the trade of liquid biofuels is a recent phenomenon, results are from 2000 to 2004 (latest reliable information from COMTRADE).

A. Trade of ethanol and feedstocks

The following graph shows the evolution of the main ethanol exporters from 2000 to 2004.

Figure 1: Main exporting countries of undenaturated[3] ethanol of strength >= at 80 per cent (quantity in '000s tons).



Source: UNCTAD calculations based on COMTRADE.

One can clearly note the strong evolution of ethanol trade. In 2000, the United States and EU were the main exporters of ethanol; then a trend began in 2002 where Brazil became the dominant world exporter. Recent development shows that many countries, especially from Central America, have started to produce and export ethanol. Some countries such as Jamaica even specialize their production on anhydrous ethanol, importing hydrated ethanol, processing it and exporting it as anhydrous.

Feedstock for ethanol is essentially comprised of sugar cane and sugar beet. The two are produced in geographically distinct regions. Sugar cane is grown in tropical and subtropical countries, while sugar beet is only grown in temperate climate countries. Since bioethanol trade is mainly from the South, feedstocks may eventually impact cane sugar trade.

Table 1: Evolution of world exports of raw cane sugar.[4]

Year	2000	2001	2002	2003	2004
Value ($ billion)	3.2	4.3	2.8	3.4	2.9
Quantity (million tons)	16.5	17.9	12.9	16.7	14.5

Source: COMTRADE

[3] Statistics of undenaturated ethanol are presented here because denaturated ethanol is improper to be blended with gasoline. Denaturated ethanol is often use as a solvent, it consists of a mix between undenaturated ethanol and 3 to 5 per cent of refined petroleum products. Moreover, its world trade is 14 per cent of undenaturated ethanol trade and stayed almost the same during the 2000-2004 period.

[4] Sugar beets have not been included because their trade figures concern European countries (where it is essentially produced). EU trade relates to sugar from East European countries to EU (15) or from EU (15) to Arabic countries. This trade is not yet related to the production of ethanol.

World cane sugar export have not increased over the period 2000-2004. However, Brazilian sugar exports increased over the same period from 4.5 million tons in 2000 to 9.5 million tons in 2004, while ethanol exports increased from 200'000 tons to 1.8 million tons over the same period. Ethanol production in Brazil uses only a part of the total sugar production of Brazil. As cane sugar trade does not seem to be affected by the surge in ethanol production, one can assume that sugar is not traded for ethanol production purposes. Several factors concur with this fact: ethanol production from sugar is a widely accepted and cheap process and the cost of transport raw sugar compared to the equivalent ethanol makes the former prohibitive.[5]

Cane molasses is particularly well-suited as ethanol feedstock. Its trade has remained stable over the period, showing no signs of impact due to increasing ethanol production. Another feedstock used to produce ethanol, mainly in the United States, is maize. As with cane sugar, world maize export figures do not show any impact from the surge of ethanol production. The United States, the main maize producer, is also a big ethanol producer and consumer, which limits incentives to trade maize internationally for ethanol production.

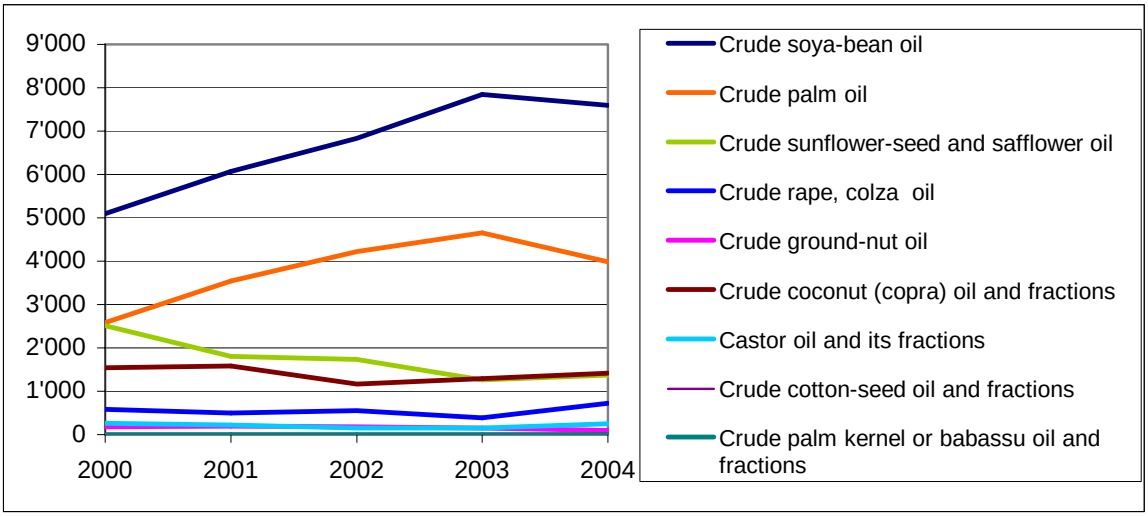
As feedstock trade does not appear to evolve with ethanol, one can assume that the current sugar cane production used for ethanol is processed inside feedstock-producing countries. In order to keep the value added of ethanol production and export markets, producing countries must pay attention to the increasingly stringent standards applied by importing countries. Already, some EU standards regarding anhydrous ethanol are not met by Brazil. As a consequence most of Brazilian ethanol exports were banned from the EU. Attention must be drawn to the potential use of such non-tariff barriers to protect the internal agribusiness industry of developed countries against competition from the industry in developing countries.

B. Trade of biodiesel and feedstocks

The international market of biodiesel is at a very early stage compared to that of ethanol. The inclusion of biodiesel as a product in the Harmonized System dates back to only 2005. Thus, no reliable statistics of trade of biodiesel are currently available. However, feedstock trade to produce biodiesel has shown a significant evolution that may be partly attributed to the production of biofuels.

[5] Assuming 150 kg of sugar are necessary to produce 100 litre of ethanol (equivalent to 80 kg).

Figure 2: World exports of selected vegetable oils (quantity in '000s tons)



Source: UNCTAD calculations based on COMTRADE.

The figure above shows that the trade of two types of oil, palm oil and soya bean oil, have increased since 2000. Palm oil export quantities have almost doubled from 2000 to 2003, reaching almost 4 billion tons in 2004. Soya-bean oil export quantities have increased by 50 per cent from 2000 to 2003 to reach 7.6 billion tons in 2004.

Table 2: Crude soya-bean oil exports and imports from 2000 to 2004, share of main exporters and main importers (in percentage of total).

Year	Total export in '000s tons	1st exporter	Per cent	2nd exporter	Per cent	3rd exporter	Per cent	4th exporter	Per cent	5th exporter	Per cent	6th exporter	Per cent
2000	5'101	Argentina	57	Brazil	18	European Union	10	United States	7	Bolivia	3	Paraguay	2
2001	6'065	Argentina	53	Brazil	23	United States	8	European Union	8	Bolivia	3	Paraguay	2
2002	6'835	Argentina	48	Brazil	25	United States	12	European Union	8	Paraguay	2	Bolivia	2
2003	7'853	Argentina	52	Brazil	27	United States	9	European Union	7	Bolivia	2	Paraguay	2
2004	7'602	Argentina	55	Brazil	28	European Union	6	United States	4	Paraguay	3	Bolivia	2
	Total import in '000s tons	**1st importer**	**Per cent**	**2nd importer**	**Per cent**	**3rd importer**	**Per cent**	**4th importer**	**Per cent**	**5th importer**	**Per cent**	**6th importer**	**Per cent**
2000	3'172	Iran	19	Morocco	9	China	9	India	7	Venezuela	6	Turkey	5
2001	5'132	India	22	Iran	17	Bangladesh	13	Morocco	7	Peru	4	Korea	3
2002	5'854	India	16	China	14	Bangladesh	13	Iran	10	Morocco	6	Peru	4
2003	7'046	China	26	Iran	13	India	12	Bangladesh	11	Morocco	5	Venezuela	3
2004	6'160	China	39	India	16	Morocco	5	Venezuela	4	Korea	4	Peru	3

Source: UNCTAD calculations based on COMTRADE

The reasons for such considerable increases are different for each product. The main exporters of soya-bean oil are Argentina, Brazil, the United States and the EU. The main importing countries are developing countries in Asia where the oil is used for food purposes. This pattern has remained very stable over the studied period. As such, the recent development of biodiesel production has had no perceptible impact on soya-bean oil trade.

The evolution of palm oil trade is different than from soya-bean oil trade. The main difference relates to the amplitude of the increase: total palm oil exports have increased by 80 per cent from 2000 to 2003, reaching 4 billion tons in 2004.

Table 3: Crude palm oil exports and imports from 2000 to 2004 in tons, share of main exporting and importing countries (in percentage of total).

Year	Total export in '000s tons	1st exporter	Per cent	2nd exporter	Per cent	3rd exporter	Per cent	4th exporter	Per cent	5th exporter	Per cent
2000	2'586	India	70	Malaysia	16	Colombia	3	Costa Rica	3	Togo	1
2001	3'547	India	52	Malaysia	36	Thailand	5	Colombia	2	Costa Rica	2
2002	4'224	India	66	Malaysia	28	Colombia	2	Costa Rica	1	Guatemala	1
2003	4'646	India	62	Malaysia	28	Colombia	2	Hong Kong	2	Thailand	2
2004	3'984	India	56	Malaysia	32	Colombia	5	Costa Rica	3	Guatemala	1
	Total import in '000s tons	**1st importer**	**Per cent**	**2nd importer**	**Per cent**	**3rd importer**	**Per cent**	**4th importer**	**Per cent**	**5th importer**	**Per cent**
2000	2'802	European Union	39	India	35	Kenya	6	Mexico	5	Saudi Arabia	3
2001	4'713	India	37	European Union	34	Bangladesh	7	Kenya	6	Mexico	3
2002	5'931	India	45	European Union	22	Bangladesh	10	Malaysia	6	Kenya	5
2003	7'332	India	39	European Union	25	Bangladesh	11	Malaysia	5	Kenya	3
2004	5'639	European Union	36	India	27	Malaysia	14	Mexico	4	Kenya	3

Source: UNCTAD calculations based on COMTRADE

Palm oil is the second most traded oil worldwide. The main producing countries are from Southeast Asia and Africa. The main exporters are Indonesia, Malaysia, Papua New Guinea and Colombia. Diets in developing countries include palm oil, it is not the case in developed countries, except in food manufacturing. While it is hard to determine the final use of palm oil, only developed countries, especially in Europe, use palm oil as a source of both food and energy.

The main biodiesel producers are European countries. Rapeseed oil is their primary feedstock. This oil is also used for animal feed, for human consumption (when it is low in erucic acid, also known as Canola), by the cosmetic and the food industries.

Table 4: Crude rapeseed oil exports and imports from 2000 to 2004, share of main exporting and importing countries (in percentage of total).

	Total export in tons	1st exporter	Per cent	2nd exporter	Per cent	3rd exporter	Per cent	4th exporter	Per cent	5th exporter	Per cent
2000	581'697	European Union	36	Canada	31	Hong Kong	13	United States	7	Australia	7
2001	505'850	Canada	47	European Union	15	United States	14	Hong Kong	11	Australia	5
2002	550'527	European Union	40	Canada	33	United States	11	Australia	7	Hong Kong	3
2003	385'997	Canada	61	United States	17	European Union	10	Australia	6	Hong Kong	3
2004	721'661	Canada	58	United States	17	European Union	9	Australia	8	Poland	2

	Total import in tons	1st importer	Per cent	2nd importer	Per cent	3rd importer	Per cent	4th importer	Per cent	5th importer	Per cent
2000	596'023	United States	24	Hong Kong	14	China	12	Mexico	11	Turquey	7
2001	496'751	United States	26	Mexico	12	Hong Kong	11	China	9	Algeria	5
2002	723'633	Algeria	26	United States	20	Mexico	12	China	10	Iran	3
2003	537'483	China	24	United States	21	Mexico	16	Algeria	7	European Union	4
2004	895'044	China	37	United States	14	Mexico	13	European Union	7	Algeria	5

Source: UNCTAD calculations based on COMTRADE

Between 2000 and 2004, world crude rapeseed oil exports have increased by 25 per cent while the EU export have fallen from 36 per cent of world exports in 2000 to 9 per cent of world exports in 2004. Since 2003, Canada has been the main rapeseed exporter with more than half of the world total. China, with its constant increase in share of rapeseed imports, has been the main importer since 2003.

It is hard to identify any impact on rapeseed oil trade owing to the development of biofuels. The increase of biodiesel production in Europe from 715,000 tons in 2000 to 1.9 million tons in 2004[6] while rapeseed oil production remained constant at around 3.6 million tons[7], could partly explained the decrease of rapeseed oil exports over the period. Any other impact of biofuels production on rapeseed trade would be limited since other exporting and importing countries were not biodiesel producers by 2004.

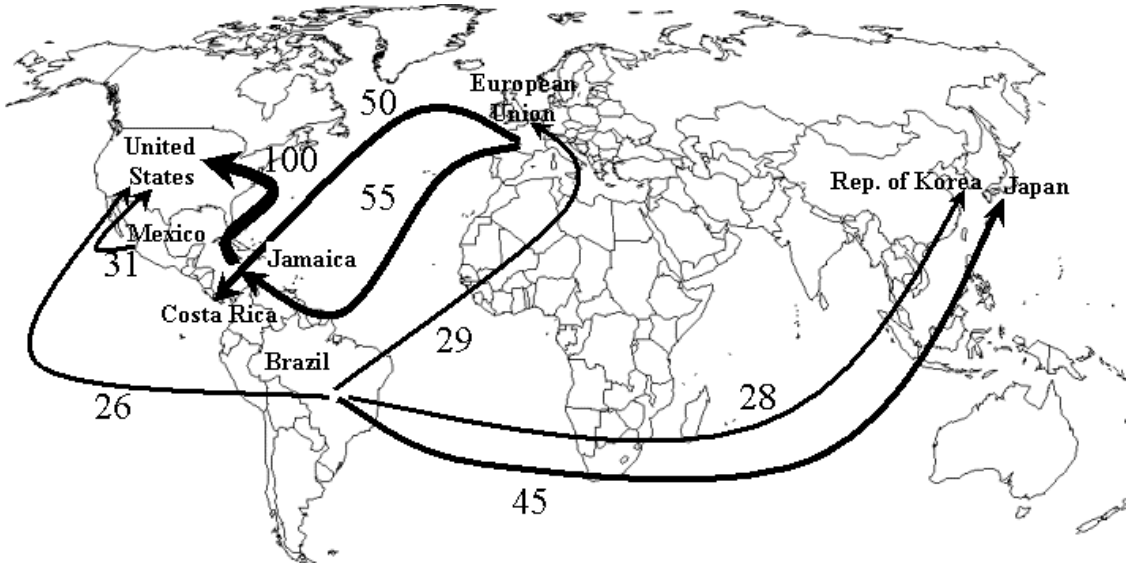
The situation of biodiesel is rapidly evolving, especially in Asia were legislation has recently imposed targets for biodiesel blends to substitute diesel. One of the main plants to be used is Jatropha, which can be cultivated in tropical and semi-arid regions. Since these developments are fairly recent, statistics are not yet available.

[6] Source: *Biofuels Barometer*, EurObserv'ER. May 2006.
[7] Source: FAOSTAT available at http://faostat.fao.org

C. Trade flows of ethanol and vegetable oil

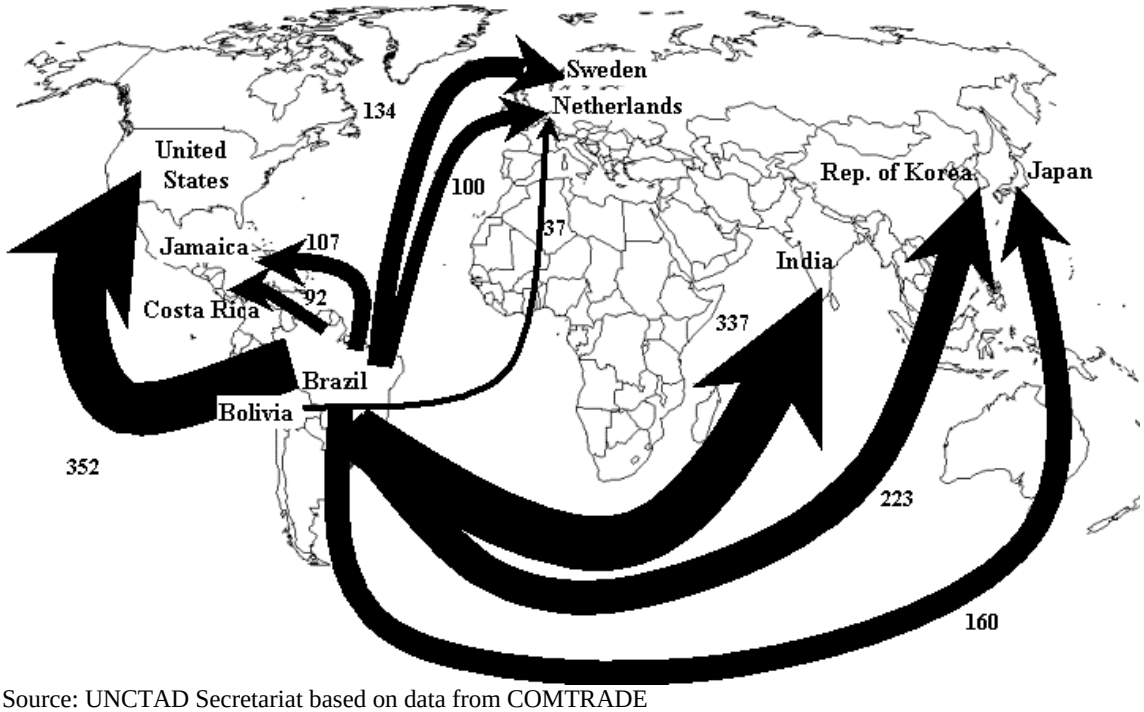
1. Flows of ethanol

Map 1: Main flows of ethanol in 2000 (in '000 tons). Flows under 25,000 tons are not shown.



Source: UNCTAD Secretariat based on data from COMTRADE

Map 2: Main flows of ethanol in 2004 (in '000s tons). Flows under 25 thousand tons are not shown.



Source: UNCTAD Secretariat based on data from COMTRADE

The maps above show the rapid increase in ethanol trade over just four years. In 2000, the main exporters of ethanol were the United States and the EU (although the map shows only the main flows), while South Africa, China, Jamaica and Brazil were smaller exporters. The

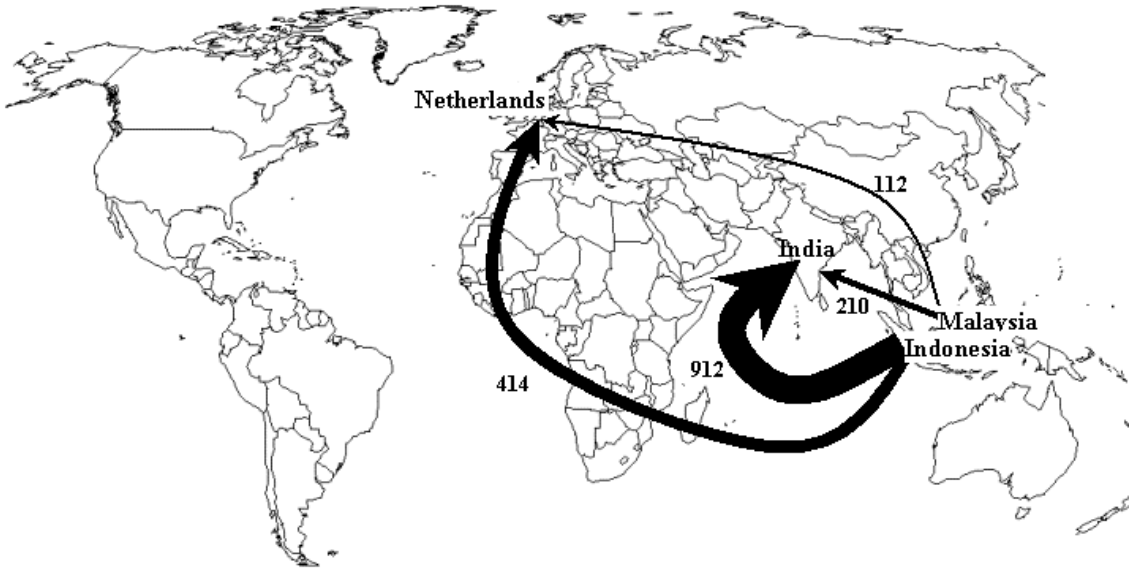
United States and the EU have processed ethanol into a fuel additive (ETBE and MTBE[8]) to replace lead in gasoline. At the time, exports were directed to Japan, the Republic of Korea, and the United States. The primary evolution shows a strong increase of world exports due mainly to Brazilian exports.

New importers from countries such as India, Sweden, the Netherlands and Jamaica have also entered the market.[9] A recent change in legislation in Sweden gives more incentives to blend ethanol with gasoline. Swedish petrol stations are already equipped to distribute gasoline blends. The Netherlands does not have sufficient agricultural resources for sugar production and therefore must rely on imports to undertake an ethanol programme. On the other hand, some European countries do not rely on ethanol imports. Spain is the biggest European ethanol producer and converts it to ETBE for blending with gasoline. Developing countries like Ghana, Sri Lanka, Myanmar, an others are also importing ethanol (these flows are too small to be shown on the maps). Although the final use of this ethanol is not known, these imports illustrate the potential for ethanol production in developing and even the least developed countries.

In 2004, total ethanol trade was around 3 billion litres, total ethanol production was around 32 billion litres, and total crude oil trade was around 920 billion litres. Although it is obvious that ethanol is not meant to fully replace crude oil, such gaps indicate the potential of biofuels.

2. Flows of crude palm oil

Map 3: Main flows of palm oil in 2000 (in '000s tons). Flows under 100,000 tons are not shown.

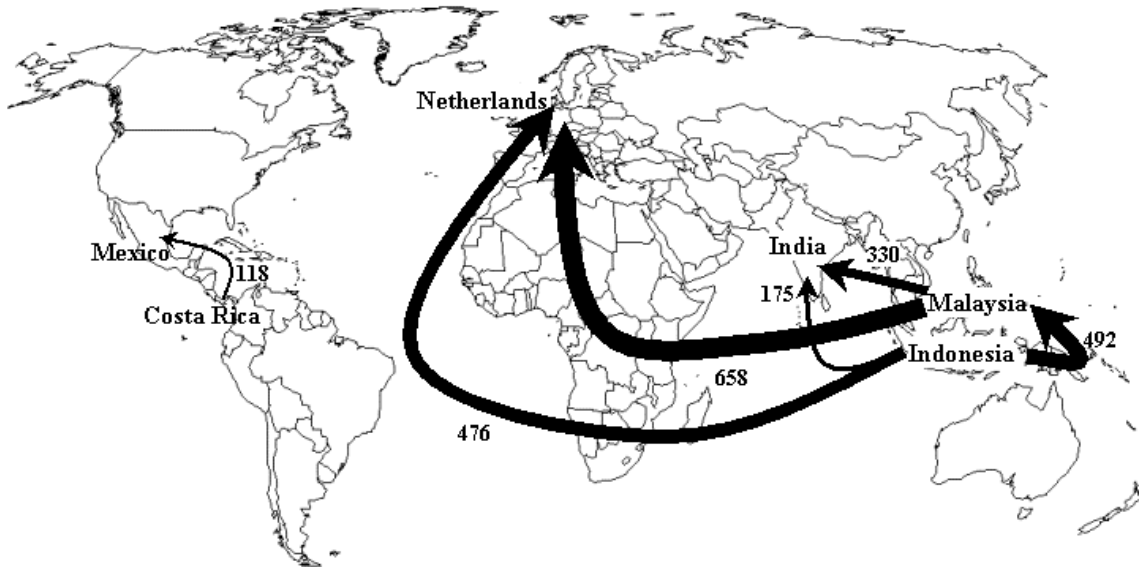


Source: UNCTAD Secretariat based on data from COMTRADE

[8] ETBE: ethyl tertio butyl ester which is a component from ethanol and isobutylene (a petroleum product). MTBE: methyl tertio butyl ester

[9] As already mentioned, Jamaica has moved from an exporter to an importer of because of its industry change to process ethanol into anhydrous ethanol.

Map 4: Main flows of palm oil in 2004 (in '000s tons). Flows under 100 ,000 tons are not shown.



Source: UNCTAD Secretariat based on data from COMTRADE

The above maps show the flows of palm oil from Indonesia and Malaysia to developing countries like India, Bangladesh, Kenya, and Mexico, as well as developed countries like Germany, the Netherlands and the United Kingdom. It is difficult to identify what is the end use of palm oil: food or energy. However, European countries are facing stringent limits on CO^2 emissions; already some power generators in the United Kingdom and the Netherlands have been converted to burn biomass (such as palm oil) instead of coal. This could partly explain the rapid increase of palm oil imports to the EU.

Although biodiesel trade is not yet evaluated, raw materials tend to be traded while the processing tends to be carried out in developed countries. This seems to be particularly the case with palm oil which is imported to European countries where it is processed into biofuels. This keeps the value-added in the production of biofuels out of reach for developing countries. Potential reasons for this include tariff and non-tariff barriers, access to technology, problems of competition, inadequate infrastructure and transport limitations, should be identified.

D. Market barriers and incentives to production

1. Tariffs

Table 5: Tariffs of ethanol in selected countries[10]

	Applied tariffs	Equivalent ad valorem
Australia	5 per cent	5 per cent
Brazil	20 per cent	20 per cent
Canada	4.92 $ cts/l	5.5 per cent
EU	19.2 € cts/l	34 per cent %
Japan	0 per cent	0 per cent
United States	54 $ cts/gal	20 per cent

Source: UNCTAD calculations based on TRAINS

[10] Tariff equivalent in per cent have been calculated with an ethanol price of 0.7 $/l at an exchange rate of 1.25 $/EUR; 1.3 CAD/$.

Table 6: Vegetable oil

MFN tariffs	Crude palm oil	Rape seed oil	Soya bean oil
Australia	0 per cent	5 per cent	5 per cent
Brazil	11.5 per cent	11.5 per cent	11.5 per cent
Canada	6 per cent	6 per cent	4.5 per cent
EU	1.9 per cent	4.8 per cent	4.8 per cent
Japan	3.5 per cent	10.9 yen/kg	10.9 yen/kg
United States	0 per cent	3.2 per cent	19.1 per cent

Source: UNCTAD calculations based on TRAINS

2. Non-tariff barriers

The Fuel Quality Directive of the European Union sets requirements on fuels including volatility (evaporation) criteria that bioethanol-based mixes (even at 5 per cent) cannot meet because their composition makes them particularly volatile. Bioethanol is thus currently processed with a petroleum by-product (isobutylene) to produce ETBE, which is in turn mixed with gasoline.[11]

Two possibilities could authorize the direct blending of bioethanol into gasoline: a change in the European standards or a blending with less volatile gasoline (which would require the oil industry to produce this specific gasoline). The oil industry is not in favour of a direct incorporation of bioethanol because they would lose market share in the petrol volume they sell. Sweden, however, made an agreement with oil companies to produce less volatile petrol and directly incorporate ethanol blends at 5 per cent. This constraint is a limiting factor to the development of bioethanol because, currently the oil industry is the only actor monitoring the use of bioethanol for transportation fuels.

Imports into the EU are also limited by stringent standards on ethanol quality. These standards impose limits for hydrocarbon content of ethanol. However, the tanks used to freight ethanol are the same as those used for petroleum products. Technically, it is almost impossible to completely remove petroleum traces in the tanks and, by extension, the ethanol when stored in these tanks will contain these traces. Since ethanol is processed into ETBE these standards may be even technically questionable.

The Fuel Quality Directive also sets blending ratio limits for diesel and petrol, citing technical reasons. Diesel must not contain more than 5 per cent in volume of biodiesel (equivalent to 4.6 per cent in energy terms). This volume constraint limits the development of biodiesel, and is even in contradiction with the Biofuels Directive which had set reference values of 5.75 per cent of market share for biofuels by 2010 (in terms of energy). The European Commission is currently modifying this Directive. The new standards will demonstrate the direction the EU wishes to pursue regarding biofuel imports.

[11] ETBE is introduced to replace the lead as a gasoline additive. In the United States, MTBE was used until it was banned because of its presumed carcinogenic activity.

3. Incentives

Table 7: Production costs of ethanol

Feedstock used	Cost in Euro cents/litre
Sugar cane, Brazil	20
Sugar beet, EU	50
Wheat, EU	45
Maize United States	30

Source: Biofuels for transport, an international perspective, IEA, 2004 and São Paulo Sugarcane Agroindustry Union, 2005.

Table 8: Production cost of vegetable oils

Feedstock	Production cost in $ / ton
Soyabean oil Brazil	210
Soyabean oil United States	420
Palm oil Malaysia	220
Palm oil Brazil	230

Source: Liquid biofuels for transportation in Brazil, Fundação Brasileira para o Desenvolvimento Sustentável, funded by the German Government, coordinated by Agenor O.F.Mundim, November 2005

As table 7 and table 8 show, a huge gap exists in costs of production of ethanol and vegetable oils between developed and developing countries. To compensate the gap and to support the needed effort done by the industry to incorporate new technology, governments often offer tax incentives in the form of some tax exemption. Such exemption done by Brazil at the beginning of the promotion of alcool production. Since then, Brazil has withdrawn from this type of support. Developed countries tend also to protect their internal market from imports in order for their own biofuels sector to acquire enough maturity to become more competitive.

3.1. The case of the European Union.

In the EU Directive 2003/96/EC of 27 October 2003 offers the possibility to support the use of biofuels by national fuels tax exemption (up to 100 per cent). The implementation of this Directive varies from a full tax exemption in Germany to no exemption in Denmark, for instance. In France, gasoline with a certain ethanol content are exempted from the "General Tax on Polluting Activities". The mandatory percentage of ethanol content is raised every year to reach 5.75 per cent by 2010. If the required blending of biofuels is not met, the fuel sold is thus subject to the so-called "general tax". France has also implemented a reduction in the "Internal Tax on Petroleum Product": 33 € cents/ l for vegetable oil, 37 € cents/l of direct bio-ethanol mix and 38 € cents/l of ETBE (The full tax is 63.96 € cents/l on unleaded gasoline). Sweden follows Germany with 100 per cent tax exemption on biofuels, but exempt ETBE from this reduction.

To comply with the 2010 voluntary requirements of 5.75 per cent of biofuels incorporated in fuels, it is estimated that the European Union must supply 18.2 million tons oil equivalent of biofuels to the market. In 2005, production reached 3,184,000 tons of biodiesel and 720,927 tons of ethanol, which is equivalent to 3.3 million toe.[12]

[12] All figures are from Biofuels Barometer, EurObserv'ER, May 2006.

The European production is mainly limited by two factors: the current industrial process capacity and the availability of raw material. Process capacity is growing fast but is still at 1.2 million tons for ethanol and 4.2 million tons of biodiesel in 2005 (biodiesel may reach 6 million tons in 2006).[13]

The supply of raw material for energy needs a considerable amount of land. In order to illustrate the situation, the production of 18.2 million toe, half in ethanol and half in biodiesel would require growing 6.8 million ha of wheat and 7.7 million ha of rapeseed. The area for ethanol would be reduced to 2.9 million ha if it were produced from sugar beet rather than wheat.[14] In the European Union, the current area dedicated to cultivating sugar beet is 2.2 million ha, rapeseed 4.7 million ha and wheat 22 million ha, as compared to 39 million for cereals.

Within the limit of 2 million ha for the 25 EU Member States, energy crops are subsidized with 45€ per ha. The non food on set-aside scheme (NFSA) consists for farmers to cultivate crops for non-food purposes on 10 per cent of their land in order to receive a single area payment (SAP). The SAP is also a subsidy to support farmers' income. Energy crops are eligible to be cultivated on the set aside area. These two schemes contribute to promote the cultivation of energy crops in the EU. Nevertheless, the energy crop production is far from supplying the needed volume to reach the 5.75 per cent target by 2010.

The Commission is expected to present to the Council an evaluation of the measures supporting biofuels production by the end of 2006. The Commission is likely to either count on internal production only and reinforce subsidies, either soften the barriers to allow more imports of biofuels, which seems more realistic given the international pressure, especially in the current WTO negotiations, and the limited land that can be devoted to energy crops without seriously impacting other crops.

3.2. The case of the United States

The United States have also adopted measures to support the production of biofuels. The American legislator has set mandatory blending of biofuels in transport fuels (while it is so far voluntary in the EU). From 2006 onwards, the mandatory blending is established at 2.78 per cent of transportation fuel sold, i.e. 4 billion gallons (15.14 billion litres). This volume must reach 7.5 billion gallons by 2012 (28.39 billion litres). Since 2005 ethanol benefits from a tax credit in force until 2010, corresponding to $0.51 per gallon of ethanol tax credit or refund of the $0.184 per gallon of fuel full rate tax.[15] A tax incentive is also applied on biodiesel. It corresponds to one penny per per cent of biodiesel in a fuel blend made from vegetable oils, and one-half penny per per cent of recycled oils. A 20 per cent blending of biodiesel into diesel will reduce the price of the blend by 20 cents per gallon.

Maize is essentially used to produce ethanol. To comply with the 2012 target, 9.1 million ha of maize must be devoted to energy. The current maize growing area is around 30 million ha and the proportion of maize devoted to energy in 2005 is around 3.9 million ha. Although the United States seem more able to meet their targets without imports than the EU, the raw

[13] Source: EurObserv'ER.
[14] Calculations are based on yields of 2560 l Et-OH /ha from wheat, 6000 l Et-OH /ha from sugar beet and 1550 l biodiesel/ha from rapeseed.
[15] A 2.78 per cent blend of ethanol corresponds to a refund of $1.42 cents per gallon of blended fuel from the $18.4 cents tax.

materials used at the moment are much less competitive than the sugar cane, and imports of ethanol from Brazil are competitive with ethanol produced, internally even when augmented with import taxes. The evolution of United States regulation and the development of new technologies may change the perspective in the coming years and allows it to supply its demand from internal biofuels production only.[16]

E. Conclusion

Subsidies for biofuels production (and consumption) in developed countries are distorting the international market and international price, maintaining the latter artificially low, in the same way as for agricultural products. These subsidies are counter-productive because they may not allow developing countries to fully benefit from the potential of an open international market. With a lower return than in a free market, one could expect a lower global production than it would have been in a subsidy-free market. Although developed countries see biofuels as an opportunity to support once again their farmers and to literally burn agricultural production surpluses in biofuels, production is limited owing to the limited energetic potential of their crops (wheat, corn, sugar beet, rapeseed), compared to the one in tropical zones (cane, palm oil, sweet sorgum, Jatropha)[17] and internal supply will be insufficient to comply with their demand. Subsidies are not only creating barriers to the development of biofuels in developing countries, they are also delaying response to global warming. The viable economic future of biofuels production in developed countries is cellulose technology, which will use agricultural wastes as raw material to produce biofuels. However, this technology does not seem to be available at industrial scope before ten years.

[16] Figures are UNCTAD calculations based on data from FAO.

[17] This situation will totally change when cellulosic conversion will be operational. The whole plants will then be transformed into biofuels. Nowadays it is only the plant reserve like starch, sugar or oil content that are converted (between 8 and 15 per cent of their total energetic content).

Chapter II

BIOFUELS IN DEVELOPING COUNTRIES

A. Producing biofuels for local consumption.

Most of the analyses that are carried out are based on the assumption that biofuels are used for transport. While this approach is well designed for developed countries seeking only to find solutions for reducing their CO^2 emissions, many developing countries and especially LDCs may not take full advantage of biofuels if they are only intended for transport. In sub-Saharan Africa, 60 per cent of the energy sources come from biomass, mainly in the form of wood, wood dust and charcoal. They cover 90 per cent of the households' needs for cooking and heating. Wood and charcoal are most of the time burnt in ovens and emit pollutants. According to WHO, this form of air pollution is the most important factor of disease after malnutrition, AIDS and the lack of potable water. Every year, it is responsible for 1.5 million deaths, more than two-thirds of these deaths occur in South-East Asia and sub-Saharan Africa.[18] Biofuels (bioethanol and vegetable oils) are part of a possible solution, especially if produced locally. They will remove the burden on women looking for fuels, and on forest if commonly used.

Biofuels are also an opportunity for small communities to become self-sufficient in energy. Attempts to substitute diesel by vegetable oils from Jatropha in power generators, grain mills or water pumps is already successful in some rural communities. This oil can also be sold to be processed into biodiesel, or be turned into soap. Egypt, Madagascar, Zimbabwe, Kenya, Zambia and Mali, among others, have seen Jatropha crop expending, while this plant is not suited for human consumption.

Processing of feedstock is likely to happen in rural areas, nearby fields of crops. Crop production monitoring and, more importantly, transport costs of raw material are the main factors which influence the location of the process. The process of feedstock into biofuels located in rural areas will also contribute to rural development, creating employment, improving infrastructure and making agricultural activities more profitable.

The needs of processing infrastructures are, however, different according to the purpose of production, be it for local communities, national markets or exports. In remote communities vegetable oils are being used as biofuels to run diesel power generator. This is the case in some places in West Africa where power generators are used to produce electricity for artisan activities in villages (e.g. blacksmiths, mechanics, carpentry, etc.), but also power various tools, such as a cereal mill, husker, alternator, battery charger, pump, welding and carpentry equipment, etc. It can also generate electricity and be used to distribute water.[19] In such case, the process of feedstock into biofuels stay at an early stage and already exists. Jatropha for instance, is used in these countries to fence the fields, but the plant was not exploited otherwise owing to its toxicity. Oil production from Jatropha nuts has been experimented with success to run generators, contributing to greater energy dependency of villages.

[18] WHO (2006), Fuel for life: household energy and health, available at: http://www.who.int/indoorair/publications/fuelforlife/en/index.html

[19] The multifunctional platform. http://www.ptfm.net/old/mfpwhat.htm

B. Producing biofuels for export

Biofuels production may be intended for the national market or for export. Good infrastructures are necessary since raw agricultural materials are industrially processed and quantities are important. The example of Brazil shows that the location of biofuels industry in rural areas has significantly contributed to employment and the development of the region. This has been helped by proper public infrastructure policies, which are needed to give incentives for the development of a new industry.

The economic viability of biofuels production mainly depends on any economies of scale that may be realised. If the size of internal demand in biofuels is too low compared with the critical mass biofuels production must reach in order to be sustainable, developing biofuels in such a country may be suitable if there are opportunities for exporting.

The biofuels industry very much relies on the availability of agricultural output delivered on time and in appropriate quantity and quality. Industrial processing of agricultural goods increases the pressure for farmers to deliver. Processing companies tend to minimize their risk, and thus transfer it to farmers by multiplying their sources of supply and integrating crop production in their business. Farmers' integration will provide security in selling their production; however, farmers become highly dependent on such processing companies. For example, they can hardly diversify their production, may not be allowed to sell to a third party and may have to buy company's fertilizers.

With biofuels demand expanding, international agro-energy industries are already looking toward the most agricultural endowed developing countries to invest in biofuels production. Already, when a biofuels plant is set, sugar cane farmers have no price bargaining power since sugar cane must be processed soon after harvest. Moreover, only the processing company has the possibility to arbitrage cane production between sugar or biofuels, not the farmers. Biofuels will positively affect rural development if sound studies of supply chain are made in each region and if an adequate policy framework is designed with an emphasis on small farmers.

C. Food security concerns

Because biofuels are produced from feedstock, the competition that could occur between agricultural production for food or for energy is the origin of various concerns. These concerns seem even more well founded when a net food importing country starts biofuels production. However, the agricultural production capacity is often underdeveloped in poor countries which affects their capacity to feed their population. Many reasons explain this fact: market liberalisation which put in competition low production farmers with highly subsidized and intensive agriculture; storage, transport, grading, sanitary control, investment and all types of infrastructure, which on the one hand reduce costs to market the products, and on the other hand create barriers. Increasing agricultural productivity in developing countries is a primary condition in order to mitigate food security concerns. Biofuels could help in this endeavour since the production of bioethanol from sugar cane is much more efficient than sugar production, for instance. Indeed, bioethanol can be extracted from molasses, while raw sugar is still extracted from cane juice, and bagasses can be burnt in boilers to generate electricity.

Biofuels may often be produced from feedstock which are not for human consumption. While this is not the case in developed countries, developing countries benefit from a much more wide variety of species to use. Indeed, wheat, maize and sugar beet are the main feedstock in developed countries, manioc, sweet sorghum, cane sugar are some examples that can be added to the list of feedstock for bioethanol. While rapeseed oil is privileged in developed countries to produce biodiesel, palm oil, coconut oil, Jatropha oil and others would be more adequate in developing countries.

A specificity of many developing countries is their commodity dependency. Their exports earnings often rely on a few commodities, be they minerals or agricultural. In the latter case, agricultural exports do not contribute to food security, thus a diversification of such exports into biofuels will have small or no consequences on food security.

Diversification of agricultural production with biofuels may help reduce commodity dependency. It provides also an opportunity to increase rural investment for infrastructures and for local transformation plants. Biofuels production may contribute to economic growth and income growth for food producers. The latter could introduce and apply new technologies with higher productivity. According to the FAO, "[…] economic growth can enhance food security by increasing the individual's command over resources and thus their access to food […]".[20] Economic growth may thus contribute toward domestic food production and food imports.

D. Land substitution from food to energy, risks and reality

Food security is closely related to land use. Current agricultural production does not use all available land worldwide. Thus, starting biofuels production will not necessarily be at the expense of an already cultivated crop. The ratio of used land versus unused land is different in developed and developing countries. In developed countries most of the available land is used, while in developing countries, the proportion of unused land is significant. Thus, in developing countries there is a considerable amount of unused land that could be cultivated for biofuels.

Table 9: Share of arable, permanent and pasture areas to agricultural area

	Africa	Developed	Developing	India	Net Food Importing Countries	United States	Western Europe	World
Agricultural area (in million ha)	1142	1823	3156	181	248	409	146	4980
Permanent crops area in per cent of agricultural area	2.2	1.7	3.4	5.4	5.2	0.5	7.7	2.8
Non-permanent crops area in per cent of agricultural area	17	33	25	88	24	42	52	28
Pasture area in per cent of agricultural area	81	65	71	6	71	57	41	69

Source: UNCTAD calculations based on FAOSTAT.

[20] FAO (1996), Food and International Trade, Technical background document, available at http://www.fao.org/docrep/003/w2612e/w2612e12.htm

Table 9 shows how the agricultural area is distributed among permanent crops such as cocoa, rubber, palm trees (excluding all forests), pasture land and arable land for non-permanent crops (cereals, grass, tuber, etc.). One can see the tendency for developing countries to promote the use of land for pasture more than for crops. Pasture land is recognized to be less productive than arable lands. Using part of pasture land for biofuels would increase the total agricultural output. Moreover, this conversion of pasture land may not necessarily be at the expense of the size of cattle since biofuels by-products can be used to feed animals. This is the case for oil cakes, bagasse, straws and leaves. Substitution of permanent crops area which does not contribute to local food consumption to biofuels crops represents a good opportunity for export diversification. Cocoa, coffee and rubber plantations may provide land for biofuels, either by substitution or by co-cropping on the same land.

Many developing countries have tackled the issue by identifying degraded lands as suitable to receive crops for biofuels. For instance, Indonesia is planting Curcas (Jatropha) on non-forestry and non-agricultural land. Mozambique is preparing to plant C4 plants,[21] such as sweet sorghum which is resistant to arid conditions, in non used land. Experience in Mali shows that some species for biofuels are cultivated in degraded or abandoned land: this is the case for Jatropha, which can grow on arid lands.[22] These areas are not counted under agricultural lands and expand the potential areas where feedstock for biofuels can be cultivated.

E. Environmental issues

The main interest of biofuels as opposed to petroleum products lies in the reduction of CO^2 emission. While burning gasoline is a net CO^2 emissions, burning bioethanol results in emitting CO^2 which was previously captured by the plants.[23] Ethanol is also an octane booster. It can replace lead in gasoline and contribute to reduce air pollution. Many countries have implemented this solution since the 1990s. WHO and others international health organizations have been advocating for many years a complete and global phase-out of gasoline lead additives. Developing countries and particularly LDCs are primarily concerned.

However, production of biofuels raises a number of environmental concerns with regard to:

Agricultural productivity:
According to the feedstock cultivated to produce biofuels, soil and water resources can be overexploited, and pollution by fertilizers may appear. Biofuels production may lead to an intensive agriculture while it was formerly extensive. Not all feedstock are suited to all environmental conditions. Each region must adopt an adequate crop for producing biofuels, in order to minimize the impact on agricultural resources.

Deforestation and biodiversity:
Looking for new areas to crop, temptations are important for farmers to cut down wild forests. These practices have shown to be disastrous and not sustainable in the long run. Owing to

[21] C4 plants are plants with a physiology which allows the plants to grow in arid conditions.
[22] Source: ICDES and Ethical sugar
[23] In reality, the net emission of CO^2 when burning bioethanol is not nil, since the production of bioethanol requires energy, fertilisers, transformation, transport etc. which are CO^2 emitting activities. Nevertheless, in the case of sugar cane for instance, the net emissions of CO^2 are above 80 per cent less than emissions from fossil fuels.

rapid soil exhaustion, farmers are moving to new deforested areas every four to five years. Wild forests are qualified as mature forests, meaning that they consume the same amount of CO^2 and oxygen as they produce.[24] The real threat is on biodiversity, which is definitely reduced for each square meter of "cleaned" wild forest. This poses also a threat on the environment of indigenous populations which in turn obliges them to leave.

Biofuels consuming countries, such as the Netherlands, are already developing certification criteria for the producing countries to be sure that the palm oil they buy is not produced on plantations grown at the expense of former wild forests. Certification may add cost to production for farmers. Moreover, we have seen in the past examples of certification scheme that were elaborated in developed countries and were not applicable in producing countries. Certification may lead to additional non-tariff barriers to trade.

F. Employment consideration

The introduction of biofuels can create employment either when additional land is cropped or when certain crops are replaced by more labour intensive ones. Sugar cane for instance is approximately seven times more labour intensive than pasture. In 2004, the Brazilian sugarcane sector accounted for 700,000 direct jobs and about 3.5 million indirect jobs, producing 350 million tons of cane.[25] Each additional million tons of sugar-cane produced and processed generates 2200 direct jobs among which 73 per cent are in agriculture,[26] although these jobs are partly seasonal. Since sugar cane cannot be stored, the process must take place soon after the harvest, which is seasonal. Moreover, harvesting sugar cane is extremely labour-intensive. In addition, it appears that wages paid into sugarcane production are higher than average wages.[27]

However, much of these jobs are seasonal and tendency to mechanisation in cane plantations is threatening them. While the work will be much less arduous, many jobs will disappear. Biofuels production may reduce unemployment in the short term.

G. Finance

Financial savings may be possible from the savings made by substituting oil imports with biofuels as soon as it is economically viable. Biofuels may help net oil importing countries endowed with agricultural resources to save foreign exchange. It is estimated that the use of bioethanol as a fuel reduced Brazil's import bill between 1976 and 2004 by around $60 billion, and if it is assumed that gasoline imports had been financed with external debt, the estimated foreign exchange reach about twice this figure.[28]

The switch by farmers to new biofuels crops requires investment in seeds, time, land and other inputs. There are also additional financing needs at the industry level, for the financing of capital investment and the acquisition of specific efficient technology. Needs are also in infrastructure for export and trade. Exporting bioethanol is relatively similar to exporting

[24] Wild forest being the lung of the planet is a myth. Well conducted tree plantations are really CO2 capturing and oxygen releasing.
[25] Suani T. Coelho (2005), Biofuels - advantages and trade barriers, UNCTAD/DITC/TED/2005/1.
[26] Plinio Mário Nastari, Isaías de Carvalho Macedo, Alfred Szwarc, (2005), Observations on the Draft document entitled "Potential for biofuels for transport in developing countries" by the World Bank.
[27] In the São Paulo state for instance, in the early 1990s, sugar cane cutters were paid $140 per month, which was higher than wages of 86 per cent of agricultural workers and of 46 per cent of industrial workers.
[28] Nastari, P.M. (2005) "Informativo Datagro" Report on the cane, sugar and ethanol industry, São Paulo, Brazil.

petroleum products, but some quality requirements make the bio-ethanol export more costly than gasoline for instance. On the consumer side, a blend higher than 5 per cent of biofuels with fossil fuels needs motor engines to be adapted. Integration of new technology in the automotive sector is very low and needs to be supported, often by fiscal incentives as is the case in developed countries.

From all the experiences that have been conducted so far on biofuels production, it has been noted that none have succeeded without government intervention with direct subsidies, mandatory blending laws and/or tax exemptions. Indeed, the introduction of a new source of energy, especially for transport needs financing support to overcome new infrastructure costs, entry barriers and additional learning curve costs at the beginning of the production. The Brazilian example shows that after initial incentives, subsidies were removed in order to prevent distortion of competition between bioethanol and gasoline. Depending of each country economical framework, the implementation of economic incentives for developing biofuels, such as subsidies, should be based on an economic analysis.

The additional financing needs for investment in biofuels production may partly be covered by the use of structured finance techniques, which aim at reducing the risk taken by the financier and shift parts of the risk from the borrower to other parties which are more creditworthy. Structured finance can facilitate access to capital and interest rates can be lower and repayment rates higher than with classic mechanisms. However, each project to be financed must "structure" a proper financing mechanism.

One technique of financing medium-sized infrastructure projects which has proven efficient is to use receivables. In a biodiesel production plant for instance, the plant should have entered into a long-term agreement with a biodiesel buyer. This is the case in the state of Andra Pradesh in India, where a Jatropha processing plant was able to sign long term sales contracts with railway and trucking companies. The contracts were used to show the long-term viability of the project. The agreement, in this case sales contracts, can be used either as security or for directly meeting the financial obligations to the financier. In the same example, the viability of the project was even reinforced by the fact that the project financed not only the plant but also the crop campaign for several smallholder jatropha plantations. The whole project was able to finance a $4 million processing plant.[29]

Developing countries have no commitment for carbon emissions reduction under the Kyoto Protocol. In these countries, the implementation of biofuels production is therefore essentially driven by economic incentives, not by environmental ones. Biofuels production will take place in these countries if it is competitive with oil prices on the international market. As shown in paragraph G, the recent developments of sugar, ethanol and gasoline prices show a positive statistic correlation. This means that when crude oil prices move up, so do ethanol and sugar prices. The economic incentives may then be leveraged by crude oil prices, but not only.

The Kyoto Protocol has designed schemes for developing countries to support projects aimed at reducing greenhouse gas (GHG) emissions. One of them is called clean development mechanism (CDM). In the Kyoto Protocol, Annex I countries engaged to reduce by 5 per cent minimum their GHG emissions below their 1990 emissions level by 2012. Each GHG emitting company in Annex I countries has a quota of maximum emissions. Each company

[29] For more information on such financing, see "Potential uses of structured finance techniques fro renewable energy projects in developing countries", UNCTAD/DITC/COM/2005/4, 2005.

has several options to comply with the quota. They can adapt their technology of production to reduce accordingly their emissions. They can buy additional quotas on the European carbon market. They can acquire additional quotas by financing projects in developing countries which contribute to reduce GHG emissions. This last option is CDM. The projects to be financed must have been approved by the CDM Executive Board, which is an organ within the Secretariat of the UN Framework Convention for Climate Change. In order to be approved, the projects must have quantified in tons the effort in terms of reduction of CO^2 emissions compared to a baseline which is the quantity of CO^2 that would have been emitted if the project was not considering reducing emissions. The quantified effort is equivalent to the additional quota the financing companies will get. For developing countries, CDM will help to implement projects integrating environmental components.

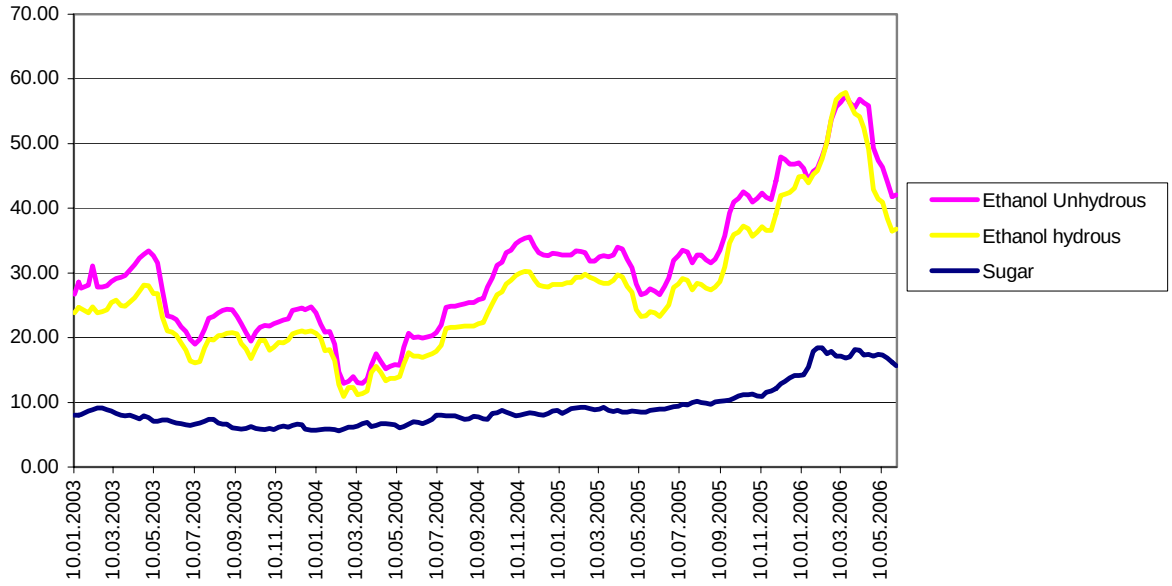
For the European Union, the Kyoto Protocol represents an effort of 13 per cent CO^2eq reduction, as of 2005 emissions. The EU forecasts that it will need the CDM for at least 3 per cent of the total effort. CDM funds have been put in place to help private companies benefiting from the CDM. A company participating in the fund will benefit from the services of the fund. The fund looks for investments in potential CDM projects in developing countries. It tries to identify projects at an early stage of development. It will help the project to go through the CDM process, and once approved will provide the funding company with the equivalent CO^2 emissions rights. It is estimated that in the EU alone, several hundred millions of euros will be invested by these types of funds.

CDM is mainly intended to integrate environmental externalities in the economic equation of developing countries. It may also help to start projects, but is not a proper mechanism to rely on for reaching sustainability in biofuels economic. Moreover, there are currently no biofuels projects that have been approved by the CDM Board.

H. Prices

There is no international price reference on ethanol. While the Chicago Board of Trade (CBOT) has launched a successful futures contract on ethanol, it is used for the United States internal markets only. Prices are also defined in Europe, but since the production is intended for internal consumption and it is subsidized, these prices are not taken as a reference in the rest of the world. Prices are also available FOB Brazil. As the ethanol production of Brazil is not subsidized and Brazil is the main exporter, FOB Brazil prices are often taken as a reference by importers.

Figure 3: Daily prices of ethanol and sugar in $ cents/l, FOB Brazil



Source: UNCTAD calculations based on data from the International Sugar Organization

The increase of the Brazilian price is concomitant with the boom of ethanol exports and world demand. The correlation between sugar and hydrous ethanol is almost 1, meaning that for each movement of ethanol price, there is a similar movement of price of sugar. This confirms the strong link that exists between the food sugar market and the energy market for ethanol. It is moreover likely that the increase of sugar price is due to the increase of ethanol price. Unless the feedstock for biofuels is not intended for human consumption (such as jatropha), the bio-energy market may have a significant impact in the food market through price correlation. Moreover, such correlation could be explained by the arbitrage carried out by the processing companies between food or energy. Indeed, if ethanol prices seem more interesting, cane will be diverted toward energy production, which will reduce supply of sugar and have a direct positive effect on sugar price.

Since ethanol is a substitue for gasoline, increase in crude oil price should affect positively biofuels, increasing demand and price and potentially affect food prices. In a non distorted market, it should be the most competitive biofuels to get affected (i.e. bioethanol from sugar cane). However, subsidization in developed countries may promote less efficient crops such as sugar beet, wheat, or corn.

Conclusion

Developing countries are major commodity exporters and most of them, mainly LDCs, are highly dependent on such exports. Moreover, they are often dependent on one or two commodity exports, which makes the economy of these countries vulnerable to market fluctuations.

Production of feedstock for biofuels can be an additional commodity to trade, and thus represent a source of diversification of a country's income. Demand in biofuels comes mainly from developed countries not least because biofuels are a good alternative to petroleum products to reduce GHG emissions and to replace lead additives. They are in some cases competitive with gasoline and diesel. Although tariffs and non-tariff barriers are still high, developed countries are importing biofuels produced in developing countries. It is up to developing countries to find out if it is suitable for them to be part of this expanding international market, and there are several aspects to investigate.

The production of raw materials for biofuels is an opportunity to diversify agricultural production. However, there is a risk that the production will use land for non-food production and thus could impact food security. Indeed, biofuels production may displace lands used for food production. However, it has been argued that this is not necessarily the case. For some of them, feedstock for biofuels can be cropped in degraded lands. They can also be used as a substitute for pasture lands, which in agricultural terms is the least efficient use of land. They can displace crops intended for exports and thus reduce risks of worsening food security status. More importantly, biofuels could give developing countries a better return for their agricultural activity, thus stimulating agricultural output.

Biofuels production in a developing country can also be intended for local market use. An efficient market would go to the cheaper energy source. Home-made biofuels represent a credible alternative to gasoline or diesel, especially for transport and power generation. Biofuels may thus reduce the burden of the energy bill, especially for net oil importing countries. However, financial support is needed to kick-off biofuels production, and a proper risk evaluation of the viability of biofuels is necessary.

While biofuels production may increase efficiency in land use and increase agricultural output at the global level, rural development benefits are linked to several conditions. Job creation will happen if feedstock for biofuels are cropped in additional land or if they are more labour intensive than traditional crops. On the other hand, some jobs in biofuels crop production are seasonal and some job opportunities are sensitive to mechanization of production.

In the future, the agricultural efficiency of feedstock production could even be more increased by the use of agricultural wastes (cellulose materials) that will be directly converted into bio-ethanol. It is believed that such new technology will make biofuels much more sustainable because the source of biomass used will not be the same as for food. However, 10 years are likely to be needed to develop this complex technology at an industrial stage. This technology may be difficult to apply in developing countries. In the meantime, producing biofuels can be a real opportunity to strengthen rural development in developing countries only if proper investigation is made to address all the issues tackled in this paper: the selection of the most suitable crop, the identification of land to be used, the best suited support for improving infrastructure, the kind of impact it will have on employment, the size of the internal demand and the opportunities to export, the legal framework that will be developed for the private

sector investing in the process, the required financial support needed to start biofuels production and consumption and the size of any savings that may be expected for public finance, substituting crude oil imports by home made biofuels.

The decision to start energy crops and biofuels production is, of course, dependent on oil price assumptions. As mentioned earlier, only Brazil has reached economic sustainability in producing bioethanol as long as the price of crude oil is above $35 per barrel. This threshold may be higher or lower for other developing countries owing to their agricultural endowments, capacity to absorb new investments, employment, environmental regulations and policy framework on bioenergy. The uncertainty about oil prices evolution has to be taken into consideration to evaluate the risk exposure of developing biofuels especially when investing in this sector. Adequate policies should be designed at the national level but more importantly, at the international level to reduce this uncertainty and better attract financing. One possibility in this respect is CDM financing.