HOW GREEN ARE BIOFUELS FROM TROPICAL COUNTRIES ?

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SUMMARY: The objective of this paper is to present basic data on biofuels production in tropical countries, to provide a preliminary discussion of some elements related to the agro-environmental impact of biofuels development in tropical countries and to identify possible areas where more research is needed. Specific attention is paid to the situation in Brazil and Malaysia, considered at short term and mid term as the major possible exporters to the EU or other destinations and to the data requirements for the assessment of direct and indirect effects of EU biofuels policies.

1. INTRODUCTION

In the context of this paper on bioenergy, biomass is considered to be the organic fraction of agricultural products (including vegetal and animal substances), from sylviculture and related industries, as well as the organic part of industrial and municipal waste. This includes for example wood, straw, energy crops, agricultural waste, agro-industrial waste, plants and animal waste.

Agriculture contributes to various extents to provide food but also fiber, fodder and fuel (the 4Fs) and started more recently to provide feedstock for green chemistry. If the production of biofuel or biogas by agriculture is often presented as a new option valid for the future, it should be mentioned that in the 19th century in Europe, about 20% of agricultural land was used to grow crops for non-food purposes and fodder. This land use disappeared with the development of mechanization and now again the issue of bioenergy is being discussed in some cases for its utility at farm level but most of the time in order to produce energy for the entire society.

Bioenergy is the production of energy from biomass for uses in transport, heat or electricity. In the specific field of liquid biofuels for transport (called biofuels in this document), important programmes have been launched in Brazil since the end of the seventies but also more recently in the United States. In the United States mainly corn is used for ethanol production. In Europe, rapeseed, sugar beet and corn are used for 1st generation biofuels. Second generation biofuels from ligno-cellulosic material might become operational in a few years.

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1.1 A few points regarding the production, use of liquid biofuels for transport in the European Union and imports

The European Union (EU) has ongoing plans based on the implementation of European, national, regional and local activities in the field of bioenergy. The targets defined at EU level in the 2003 Biofuels Directive (EC/2003/30) are 5,75% of biofuels on the transportation fuel market in 2010. In addition the European Commission called for 10% in 2020 (EC Proposal, Draft Directive 23/1/2008). This proposal is presently under review by the European Parliament and the Council.

In order to encourage the development of the production of feedstock dedicated to biofuels production, the European Commission (EC, DG AGRI) introduced in 2003 as part of the Common Agricultural Policy a new payment granted to energy crops produced from set-aside areas (45 Euros/ha). The European Commission also authorized EU Member States to grant tax relief to biofuels. In October 2007, it has been proposed by the EC to reduce the area on which each farmer may claim the special aid for energy crops in 2007 because the eligible area of 2 million hectares has been exceeded, applications having risen to approx 2.84 million hectares. The 2007 year was the first for which 10 of the EU New Member states using the single area payment have been eligible for this aid. As a consequence, farmers received the 45 Euros/ha aid for just over 70% of the land on which they claimed the aid. This proposal followed a high price increase of agricultural products in 2007 especially in cereals.

Unlike the other biofuel key players, the EU produces more biodiesel than bioethanol. 54.6 % of transport fuels consumed in the EU are diesel versus 45.4% for gasoline. This proportion is not reflected in the production of biofuels: biodiesel accounts for more than 80% of EU total biofuels production. In 2007, the EU major producers of biodiesel were Germany (50.6%), France (15,3%), and Italy (6.35%) [EBB 2008]. The main feedstock for the production of biodiesel is rape oil which corresponds approximately to 90% of the EU biodiesel production. In the EU, the expansion of biodiesel production has put pressure on the rapeseed market. The areas dedicated to the cultivation of rapeseed and sunflower seeds for energy use have increased from 780.000 ha in 2004 to 1.634.000 ha in 2006, corresponding to 22.5 % of the total area dedicated to both crops. This expansion is taking place in areas traditionnaly dedicated to food crops. Currently, the EU is using about 40% of its rapeseed production and about 62% of its rape oil production for the manufacturing of biodiesel. The pressure on rapeseed areas is mainly due to the low productivity of this feedstock in terms of liters of biodiesel per ha. As a consequence, between 2002-2003 and 2006-2007, rape oil prices have increased by 63%.

Biofuels incorporation rates show great variations per EU Member State but the total for EU 25 was around 1% in 2005, thus behind the targets set towards the 2010 objective (Source EC). Moreover there has been a biodiesel yearly growth of only 16.8% in 2007 compared to 54% in 2006 and 65% in 2005 (production increased from 4.9 million tonnes in 2006 to 5.7 million in 2007) [EBB 2008, EuRObserv' Er 57 2006]. According to Jank et al. [2007], if the EU decides to limit the oilseed area dedicated to biodiesel feedstock to 50% of the total oilseed area, the EU will need to import 4.16 million tons of vegetable oil or biodiesel.

In Brazil, sugar cane and more recently soya are the main crops used for energy purposes. Although in 2007 the EU is the world's third largest producer of ethanol (2.1 Billion Liters [RFA 2008], it is far behind the United States (24,6 BL) and Brazil (19 BL) [RFA 2008]. EU ethanol production increased only by 11% compared to 2006 (in 2006 the increase was 71 % compared to 2005, with 1.5 BL). The main producers of ethanol in the EU were (2007) France (32.6%), Germany (22.2%), Spain (19.6%) and Poland (8%) [eBio 2008]. Contrary to the situation in Brazil with the development of biofuels so far mainly based on a single crop i.e. sugar cane, ethanol in the EU is produced from a large variety of feedstock (wheat, corn, barley, rye…) which account for the major part of the production, followed by sugar beet. Sugar beet is the most efficient crop for bio-ethanol in Europe, with production estimates around 7.250 liters of ethanol per hectare (3.125 for cereals). But environmental balance of ethanol produced from sugar beet is not as satisfactory as in the case of cereals based ethanol. Presently only France produces ethanol from sugar beet and there is a potential for expansion. Since EU ethanol production is much smaller than biodiesel production and since it is based on the utilisation of various feedstocks of which the EU is a net exporter of some, ethanol has so far had no significant impact on agricultural land availability and commodity prices. On the contrary it provides a new option to sugar beet producers after the reform of the sugar Common Market Organisation adopted in February 2006 that reduced the sugar beet price by almost 40% and limited the sugar export opportunities to the World Trade Organization WTO quota. In 2007, Brazil exported more than 887 million liters of ethanol to the EU (50% of 2007 EU production) [eBio 2008, MAPA 2008]. In the EU, main countries of destination were Netherlands, United Kingdom and Finland. In addition, ethanol production might also be considered in the future in some ACP countries.

1.2 Production and use of liquid biofuels for transport: a controversial issue

In order to reach European targets, there is a consensus on the need for Europe to complement at short and mid term biofuels produced from European feedstock with imports of biofuels from tropical countries. The amount of biofuels imports needed by the EU depends on the scenarios chosen and the sustainability benefits expected or taken into account by various groups. It is clear that in relation to imports from non EU countries, there is a wide variability of dominant trends between the attitudes on this issue of European countries as different as Sweden (low agricultural potential, presently importing ethanol from Brazil), Netherlands (strongly involved in international trade of biomass and biofuels, limited land availability, competitive harbour infrastructure), France, Germany or Poland (all countries with strong agricultural sectors), Cyprus and Malta (limited land availability).

Biofuels for transport are often considered as a tool to mitigate greenhouse gases emissions, reduce climate change, increase energy supply diversity and security of supply, as well as a new opportunity for agriculture and rural development. Biofuels have a domestic economic appeal because locally produced fuel creates jobs and keeps part of the energy bill within the country, the financial fluxes being totally different in the case of bioenergy or use of fossil oil.

According to Ifo (Institute for Economic Research at the University of Munich) 19,000 jobs have been created in Germany for producing 1million ton of biodiesel [PWC 2007]. Outside the EU, for example in South Africa according to the South African Biofuels Industrial Strategy [DME 2007], the proposed 2% biofuels penetration scenario by 2013 will create 25 000 jobs.

In the context of increase of oil prices, the interest in biofuels has escalated sharply and the competitiveness of biofuels is improving.

On the other hand, biofuels are often criticized at various levels, for reports on their low environmental impact, their negative consequences on tropical deforestation and the diversion of land use ("fuel against food"). Biofuels policies, especially in Europe and the United States are not a field of consensus, with very different scientific conclusions presented by different research groups as technical support for decision-making. In addition, the debate on biofuels is often made confusing by a lack of agreement or even preliminary discussion of the policy drivers and their respective weights: climate change, environment, security of supply, employment, transport, agriculture, rural development, international cooperation… The criticicism towards biofuels development comes from parts of the industry, scientific community [Crutzen et al. 2007, Searchinger et al. 2008], from some international organizations [OECD 2007] and to a large extent from part of the media [Holt-Gimenez, 2007]. Some NGOs are calling for a moratorium on biofuels (e.g. [Biofuel Watch]). Another aggravating factor is the lack of consensus on Life Cycle Analysis results in relation to biofuels (see for example [Farrell et al. 2006] on the issue of US corn ethanol and [Connor et al. 2006]).

It should be noted that biofuels policies are not only a case of disagreement on technical results or governance but also a field of international dispute: Brazil initiated a WTO case against US ethanol and farm subsidies. US presently protects its own ethanol producers by a 0.54$ per gallon tariff [Licht 2007]. This takes place in an ethanol global market still at a very preliminary stage but characterized by strong differences in production costs according to the feedstock and the geographic origin. Jank et al. [2007] reports production costs (expressed in US$ cents/liter) of 22 for sugar cane ethanol from Brazil (2005), 40 for US corn ethanol, 50-75 for EU ethanol and 44-81 EU biodiesel (2004).

2. BIOFUELS IN BRAZIL

2.1 Bio-ethanol

The Pro Alcool Programme started in Brazil in 1975, after the first oil crisis and mainly for security of supply concerns. Initially benefiting from public-support mechanisms, the activities were liberalized at the end of the 1990's, even if there are still some differential taxation schemes at State level. Information on the use of biomass for bioenergy in Brazil can be found in Focus on Brazil [IEA 2006]. From 1983 to 1988, 90% of the 800 000 new cars sold each year on average were using ethanol. Due to the strong increase in consumption, a severe shortage of ethanol happened at the end of 1989, provoking a loss of consumer trust in the security of ethanol supply and Pro Alcool Programme. Due to these problems, by the end of the 1990s, the sales of ethanol fuelled cars amounted to less than 15% of total car sales. In 2003, car manufacturers introduced "flex fuel" vehicles and it is estimated that "flex fuel" vehicles correspond now to more than 3 quarters of new car sales in Brazil. Pure gasoline is no longer sold. The share of biofuels in road-transport fuel was estimated at 14% in 2004.

Most of the reduction in the cost of production of ethanol in recent years came from the agricultural part of ethanol production. It is estimated that around 60% to 70% of the final cost of ethanol corresponds to the cost of the sugar cane. Agricultural yield has therefore a strong impact on the final cost of ethanol. Average productivity in Brazil is around 65 t/ha but it can reach 100 to 110 t/ha in Sao Paulo State which is the main ethanol producing region. Since the beginning of Pro Alcool Programme, yields have improved of 33% in Sao Paulo due to the introduction of new varieties and the improvement of agricultural practices. There has also been a development of mechanization. In the period 2001-2006, in the mid-west, southeast and southern regions, about 35% of the area planted with sugar cane has been harvested mechanically and the mechanized harvesting rate can reach 90% in some regions.

It should also be noted that there has been an historical evolution of Proalcool with a progressive change of technological priorities. This is especially to be taken into account when comparing respective advantages/disadvantages of EU local production or imports. Initially the main focus of the Pro Alcool was put on the increase of equipment productivity. The size of Brazilian mills also increased. The focus then shifted to the improvement of conversion efficiencies. Over the past 15 years, special attention has been paid to a better management of the processing units. As a consequence, presently, almost all sugar-cane distilleries in Brazil use bagasse-fired steam turbine systems to provide steam and electricity to cover their site needs. For example, most biomass cogeneration takes place in Sao Paulo State with 40 sugar mills selling 1.3 GW of surplus power to the electrical grid. Bagasse-based co-generation is developed in order to reduce the country's traditional reliance on hydropower and in addition this improves the competitiveness of Brazilian ethanol.

Regarding processing conditions, on average 5 m^3 of water are used for each ton of sugar cane processed, even if values range from 0.7 m^3/t to 20 m^3/t. According to [Macedo 2005], the levels of water withdrawal and release for industrial use have substantially decreased over the past years from around 5 m^3/t sugar cane collected in 1990 and 1997 to 1.83 m^3/t sugar cane in 2004 (sampling in Sao Paulo State). In the conversion to ethanol, such lower amount was mainly due to water reuses and recycling, process improvements and substitution of wet cane washing with dry cane washing; in the higher values of water use (5 m^3/t) sugar cane washing, evaporation and cooling in condensers and fermentation cooling accounted for 87% of the water use. It seems possible to decrease water collection to 1 m^3/t with no release, by optimizing both the reuse and use of waste water for irrigation [Moreira 2007].

In the past, direct discharge of vinasse (liquid residue from the distillation of ethanol, rich in potassium and organic matter) to water streams was a cause of significant environmental damage. For each liter of ethanol, 10 to 15 liters of vinasse are produced. Vinasse began to be recycled to the cane fields in 1978 when the first legislation governing the disposal of vinasse was passed. The current practice is full recycling of vinasse and industrial wastewaters. The application of vinasse is optimized for specific topographic, soil, and environmental conditions. Filtercake, another waste stream is also recycled as a fertiliser. Nutrient recycling in turn has reduced application of fertilisers. The highly intensive production systems for ethanol has been in the past a cause of environmental damage mainly due to the use of fertilisers and pesticides. Sugar cane cropping is also a source of air pollution due to burning prior to manual harvesting. The phase-out of burning is taking place in Brazil with a deadline for complete phase out in 2022.

According to UNICA, sugar cane culture in Brazil is considered to have relatively small soil erosion loss compared to soybean and corn for example. This situation keeps improving as harvesting without burning expands and reduced preparation techniques are introduced, thereby reducing losses to very low rates that are comparable to those for direct planting in annual crops.

According to Dufey et al., the main issues of concern related to sugar production development are: natural habitat conversion and species loss, water take and reduced water flow, soil erosion and loss of fertility, water pollution, pollution from burning cane fields, air pollution and solid waste from processing cane.

Average ethanol production yields have grown from 3 900 litres per hectare per year (l/ha/year) in the early 1980s to 5 600 l/ha/year in the late 1990s. In the most efficient units, yields are as high as 8 000 to 10 000 l/ha/year. Sugar cane crops are virtually non-irrigated in Brazil except for some small areas (supplementary irrigation). The annual rainfall in Sao Paulo State is roughly 1000-2500 mm/year.

Regarding the area requirements, in 2007, 11.6% of the cultivated area was used for sugar cane, compared to 23.8% for corn and nearly 35% for soybeans [IBGE 2008] (out of presently about 59 Mha of arable land [IBGE 2008] and about 172 Mha of pasture land [IBGE 2006]).

World sugar production in 2007/08 (October/September) is estimated by FAO to reach 169 million tonnes (raw sugar equivalent), 2.7% more than in the previous year, and about 12 million tonnes higher than the projected world sugar consumption of 157 million tonnes. Virtually all of the growth in output would stem from developing countries. Brazil is set to produce 32.2 million tonnes of sugar in 2007/08, relatively unchanged from 2006/07. This is despite a record level cane harvest, following relatively favourable weather conditions, which boosted yields. It is estimated that between 54 and 55% of Brazil's 2007/08 sugar-cane harvest will be converted into ethanol rather than into sugar [FAOSTAT 2007].

It has been estimated [Earth Policy Institute] that expanding the sugarcane area from about 6.7 million hectares in 2007 to some 8 million hectares would allow Brazil to become self sufficient in automotive fuel within a few years while conserving its sugar production and exports.

According to projections from the sugar/ethanol sector in Brazil, increasing internal and export market demands for sugar and ethanol can easily be met. It is assumed that the industry should be able to produce 33.7 Million tons of sugar (12.8 Million tons for internal consumption and 20.9 Million tons for export) and 26.4 Million m^3 of ethanol (of which 4.4 Million m^3 for export) by the year 2015. This would mean an increase of about 230 Million t of sugarcane in ten years – a doubling in the ethanol production and an increase of 44% in sugar production [WWI 2007].

On 21 July 2007, the Brazilian Government announced a new set of measures to eliminate part of the misunderstanding related to the country's sugar cane ethanol. Part of the new legislation will be largely symbolic. Brazil will now explicitly outlaw the growing of cane in both the Amazon and the Pantanal through the creation of a zoning system for sugar cane with a restrictive map. It should be noted that even before these new measures, sugar cane was not grown anyway in the Amazon due to agro-technical reasons. It must be noted that as stressed by Girard et al. [2006], the Centre-South region of Brazil has not only good climatic and soil conditions. In addition, it has a good infrastructure, a functioning capital market and a sugar industry structure that allows cooperation between different players in the supply chain to achieve high efficiency and low costs. The agro-industry involved has reached a high level of control of biomass planting, harvesting and logistics, with species diversification thus improving adaptation to climate variability (more than 500 commercial varieties of sugar cane for different microclimates and local conditions) and finally ensuring stability in volumes and prices against variability of production conditions. The combination of all these factors exist in the South of the country, not in the Amazonian region, so the reports on direct negative impact of ethanol production on Amazonian deforestation are not based on facts. Nevertheless, the main criticism on biofuels development coming for example from environmental NGOs is not on direct impact but on indirect impact and displacement effects which are far more complex to address.

Regarding the social impact, according to Coelho [2005], the Brazilian sugar cane sector is presently responsible for 700.000 direct jobs corresponding to the production of 350 million tons of cane. In July 2006 the Governor of Maranhão launched a program for the production of bio-fuel with the planned generation of 120 thousand jobs [Rodrigues and al. 2006] corresponding to a production potential of 45 million tons of sugar cane per harvest, and a plantation of 1.2 million hectares (a potential production of 2 billion liters of ethanol, equivalent to 13% of the current Brazilian production could be obtained by using half the production of sugar cane to produce ethanol).

2.2 Biodiesel

Soybean (Glycine max) is an annual crop, grown in temperate, sub-tropical and tropical regions. Soy yields the protein rich soybeans, which contain up to 50% protein. With a yield up to 3.600 kg/ha per crop cycle, it is a high source of vegetable protein. Soy is the most important protein in animal feed and soy oil is the most consumed oil in the world.

In 2007, Brazil was the second biggest producer (61 million tons or 28% of world production) world wide after the US (32%) [Soystats 2008].

Rapid expansion of soy cultivation started in Brazil in the early 1970's. Starting from 3 million hectares in 1970, planted area expanded continuously, reaching a harvest of 58 million tons on 20 million hectares in 2007. Soybean is thus an important component of the Brazilian economy. It represents 6% of the GDP and employed approximately 5.5 million people in 2002. Soybeans are very suitable for capital-intensive, large scale cultivation. As soybeans yield 18% oil and 78% meal after processing, the market for soybean products is mostly driven by the livestock industry. New perpectives and a different framework appear with bioenergy.

The Brazilian Biodiesel Program [PNPB] is at an early stage compared to the Pro Alcool. Nationwide 2% mandatory blend will be required from 2008 and will be increased to 5 % in

2013. Different tax exemptions for biodiesel production are planned depending on the type of feedstock (for example with castor seed and palm oil having larger exemption and a stimulation of family farm production). The Brazilian Government estimates that the planted area required to supply the 2% biodiesel/diesel fuel mix would be 1,5 Mha, estimated to be 1% of the 150 Mha planted and available for agriculture [PNPB, IEA 2006]. This figure does not include pasture and forest areas. The development of oil crops cultivation in semi-arid regions is considered to be a tool to support family agriculture.

The impacts of soybean cultivation on Brazilian Ecosystems has been the object of several studies, including one from WWF (Forest Conversion Initiative) in 2003, with case studies in Southern Piaui, Mato Grosso and State of Amazonas.

Because of the mechanized character of cultivation, soy is planted almost exclusively on flat zones offering easy access for farm machinery. Several State Governments in Brazil are planning to convert their sparsely populated subtropical and tropical plains to soy production areas to develop their economies. Since there is little room for agricultural expansion in the south and south east of Brazil, future soy expansion might take place in central and northeastern Brazil and the southern Amazon region where cheap land is available. It should be noted however that rapid expansion of soy may have direct and indirect impact on natural habitats of high conservation value. The problems to be faced include widespread deforestation of the Cerrado and southern Amazon frontier and large applications of pesticides.

The cropland expansion and its impact on deforestation dynamics in the Southern Brazilian Amazon has been studied by Morton et al. [2006], based on the analysis of time series of satellite imagery and field survey. It appears from this study that intensive mechanized agriculture in the Brazilian Amazon increased of 3.6 million ha during 2001-2004. It has not been quantified if this cropland expansion came from intensified use of land previously cleared for cattle ranching or new deforestation. In Mato Grosso, the State with the highest deforestation rate and soybean production since 2001, statewide direct conversion of forest totaled more than 540.000 ha during the period 2001-2004 with a maximum at 23% of 2003 annual deforestation [Morton 2006]. Cropland deforestation averaged twice the size of clearings for pasture (mean sizes 333 and 143 ha respectively) and conversion occurred rapidly; more than 90% of clearings for cropland were planted in the first year after deforestation. Pasture remains the dominant land use after forest clearing in Mato Grosso but there is a growing importance of larger and faster conversion of forest to cropland [Morton 2006].

In the nine States of the Brazilian Legal Amazon, mechanized agriculture increased by 36.000 km^2 and deforestation totaled 93.700 km^2 during 2001-2004. The State of Mato Grosso itself accounted for 87% of the increase in cropland area and 40% of new deforestation during this period.

According to Dufey et al., in the case of soy, main environmental issues include: natural habitat conversion and species loss, loss of ecosystems functions, burning during clearing, soil erosion and loss of fertility, effluents and use of agrochemicals.

3. Biofuels in Malaysia

The Malaysia national biofuels policy [Malaysia Energy Centre 2005] was launched in August 2005. The Government is promoting among other the use of biodiesel in public fleets. The blend is not compulsory yet but it will be in the next phase of the implementation plan.

For oil palm (Tenera), the oil extraction rate is 20% and the palm oil yield about 4 tons/year/ha. It should be noted that the best fields can produce 7-8 tons annually. The planting density ranges from 136-160 palms/ha. The economic lifespan is 20-30 years. An oil palm usually bears fruits from 30 months after planting. Malaysia humid tropical climate with a temperature range of 24^{0}C to 32^{0}C throughout the year, an annual rainfall of about 2000 mm evenly distributed is very adapted to the cultivation of oil palm. According to Oil Worlds 2007, average oil yield t/ha/year is 3.74 for oil palm (mesocarp) against 0.38 for soy bean, 0.48 for sunflower and 0.67 for rape seed. This means that in comparison with other oil crops, oil palm corresponds to the highest tonnage of oil per hectare per year.

Malaysia produced 200 Million liters of biodiesel in 2006, consuming 1% of the 15.88 Mt of palm oil produced. In 2007, the production remained almost unchanged and has already totaled 5.3 Mt in January-April 2008 (of the 17 Mt expected for this year) [Department of Statistics Malaysia 2008]. In 2006 less than 13 per cent, or 4.17 Mha [Thiagarajan 2007] (from 54,000 hectares in 1960) [Basiron 2007] of Malaysia's land is planted with oil palm (the bulk of oil palm estates was previously planted with rubber, coconut and cocoa) (with 7.9 Mha of land used for agriculture [FAOSTAT, 2005]).

Malaysia is the world's largest exporter of palm oil selling around 13.5 Million tons. Malaysia share of global oils and fats trade was 27.9% in 2006 [Oil World]. According to MPOB 2008, the EU was, after China, the second destination for Malaysian palm oil in 2007 with 2Million tons (about 18% against less than 1% to the USA), almost half of the total palm oil imported in EU in 2007.

For the future, improved planting materials and better management techniques are foreseen. Domestic consumption is relatively low and Malaysia exports most of its palm oil and kernel oil.

MPOB is reporting costs of oil production (US $ per ton), of 228 for Malaysia, 400 for soya bean (USA), 648 for rape seed (Canada), 900 for rape seed (Europe). The palm sector in Malaysia corresponds to the employment of 860.000 persons with 100.000 small holders with 650.000 ha.

The issue of sustainable resource development, specifically of palm tree cultivation, has been discussed for example in Brussels in June 2007 during the Meeting on Sustainable Resources Development organized by the Malaysian Palm Oil Council. This Meeting was attended by stakeholders representants (industry, exporters, research, international organizations, NGOs, see [MPOC]). WWF presented experience of animal biodiversity conservation in relation to oil palm in Sabah.

In 2006, the palm oil plantations had the following distribution in Malaysia: 2.34 Million ha (56%) in Peninsular Malaysia, 0.59 Million ha (14%) in Sarawak and 1.24 Million ha (30%) in Sabah. If there are clear advantages of oil palm in relation to other options, concern has been expressed especially by NGOs about the impact of oil palm plantations development on tropical deforestation. According to FAO 2007, based on country reporting, the total forest area in Malaysia (in thousands of ha) was 20.890, i.e. 63.6% of the land and the forest plantation area 1.573. The annual change (in thousands of ha) 1990-2000 was -78 (-0.4%) and -140 (-0.7%) for the period 2000-2005.

According to Stibig et al. [2007], based on TREES (Tropical Ecosystem Environment Observations by Satellites) Project activities, "since the mid 1990's Malaysia's and Indonesia's oil palm plantation area has grown from 2.4 to 4 million ha and from 1.7 to 6 million ha respectively: in Indonesia almost 3 times as much has been cleared for expansion and further huge expansion is foreseen. However, it should be stressed that not all oil palm development on Borneo or Sumatra will lead to forest conversion. In Peninsular Malaysia the conversion of state land forest to oil palm plantation is of limited extent.

Concerning the use of peatlands in South East Asia, an assessment of CO_2 emissions from drained peatlands in SE Asia (PEAT-CO_2 project) has been performed by WL/Delft Hydraulics in cooperation with Wetlands international and Alterra Wageningen [Hooijer et al. 2006]. In this study, present and future emissions from drained peatlands were quantified using available data on peat extent and depth, present and projected land use and water management pratice, decomposition rates and fire emissions. It was estimated in this study that current likely CO_2

emissions caused by decomposition of drained peatlands amounts to 632Mt/y (between 355 and 874 Mt/y). The study authors consider that these emissions will increase in coming decades unless land management practices and peatland development are changed. In addition, over 1997-2006 an estimated average of 1400 Mt/y in CO_2 emissions was caused by peatland fires also associated with drainage and degradation. The current total peatland CO_2 emission of 2000 Mt/y equals almost 8% of global emissions from fossil fuel burning. These emissions have been rapidly increasing since 1985. Over 90% of this emission originates from Indonesia. Nevertheless, it should be stressed that the authors discuss the following uncertainties sources: Input data (Peat thickness, extent and distribution of peat lands, carbon content of SE Asian peat, carbon storage, land use/land cover, % of peatland drained, drainage depth, % of oil palm plantations on peat lands). Other uncertainties sources mentioned by the authors were:

- emission relations (relation between drainage depth and CO_2 emissions, CH_4 emissions, peat fires)
- trends and projections (Deforestation trend assessment, drainage trend assessment, land use projections).

It appears that there is a large variability of CO_2 emissions assessments due to the type of peat soil considered, the drainage depth and the land use [Hooijer et al. 2006, Melling et al.].The WL/Delft Hydraulics Report previously mentioned estimated that 25% of plantations in Malaysia and Indonesia are on peat (present + future plantations). MPOB reports only 6% of existing plantations in Malaysia on peatland.

4. Life Cycle Analysis of biofuels

According to the JEC Well to Wheel study [2007], the environmental balance of bio-ethanol based on neat fuel (defined as the GHG emissions in g CO_{2eq} per km) ranges from 58 to 130 for sugar beet, 32 to 57 for wheat, 19 to 22 for wheat straw and 19 to 22 for sugar cane. These ranges are due to the different pathways studied in the report (for example concerning the use of by-products). As an order of magnitude the following GHG savings could be found in the same report [JEC - WTW 2007] in terms of kg CO_{2eq} / (ha·per annum): 660 for wheat and 4429 for sugar beet for ethanol production; 1505 for rapeseed, 1545 for sunflower and 4806 for farmed wood for biodiesel production.

According to ADEME [Jank et al. 2007], the environmental balance of bio-ethanol (defined as the GHG emissions per ton of oil equivalent toe, expressed in toe CO_2 is 2.17 for sugar beet, 1.85 for wheat, 0.41 for sugar cane and 0.33 for straw. In the case of biodiesel production, it is 2.6 for soy, 1.73 for palm and 0.27 for wood.

The environmental assessment of biofuels for transport and the aspects of competition for land have been addressed by Reinhardt [2007]. Biodiesel from oil palm can save more ton CO_2 equivalent in ha/year than other types of biofuels (e.g. from sunflower, rapeseed or soy bean), but it should be stressed that the possible land use change (from natural forest, existing plantations for example of rubber or degraded land) affects significantly the result.

It thus appears that the comparison of GHGs emissions of tropical biofuels compared to first generation US and European biofuels is very much in favour of the tropical pathways. Nevertheless, it should be stressed that there is always much uncertainty in the field of LCA of GHGs emissions and a great variety of methods, data and assumptions used. In particular the assumptions about the co-products processing and the land use change are important. In addition, the quantification of emissions of N_2O is a complex issue depending on the soil carbon content for which measurements or mapping information are insufficient.

According to the Worldwatch Institute, "the vast majority of studies have found that, even when all fossil fuels throughout the life cycle are accounted for, producing and using biofuels made from current feedstocks result in substantial reductions in GHG emissions relative to petrol fuels". Several studies have assessed the net emissions reductions resulting from sugar cane ethanol in Brazil, and all have concluded that the benefits far exceed those from grain-based ethanol produced in Europe and the US. The lower life cycle climate impacts of brazilian sugar cane ethanol are related to two main factors: high cane yields and use of bagasse for energy or cogeneration.

Another way to assess the benefits of biofuels is to quantify how many years it takes for the biofuel carbon savings from avoided fossil fuel combustion to offset the losses in ecosystem carbon from clearing land to grow new feedstocks (or Ecosystem ‘Carbon Payback Time’, ECPT). Fargione et al. [2008] estimated that converting rainforests, peatlands, savannas or grasslands to produce food-crop based biofuels in Brazil, Southeast Asia and the United States creates a "biofuel carbon debt" by releasing 17 to 420 times more CO_2 than the annual greenhouse gas reductions that these biofuels would provide by displacing fossil fuels. On the other hand, it was considered that biofuels made from waste biomass or from biomass grown on degraded or abandoned agricultural lands planted with perennials are associated to a small or no carbon debt and can provide immediate GHG advantages.

Similarly, the indirect or ‘leakage’ land use impacts of US corn ethanol have been estimated by Searchinger et al. to double the greenhouse gas emissions per fuel mile compared to conventional gasoline over 30 years [2008]. Gibbs et al. [2008] also concluded that clearing tropical forests and grasslands to produce biofuels leads to long-term carbon debt while only converting degraded lands will provide carbon savings (even if the highest yielding biofuel crops from clearing forests are taken into account). It should be noted that growing crops on these marginal lands may require significantly more land area than other regions due to relatively lower yields, and will likely require more energy-intensive management such as fertilizer application or irrigation to remain productive that should change the obtained ECPT value.

The content of the Fargione et al. and Searchinger et al. papers has been questioned by a Letter to Science of Kline and Dale [July 2008] suggesting that an improved understanding of the forces behind land-use change leads to more favorable conclusions regarding the potential for biofuels to reduce greenhouse gas emissions.

5. Biofuels environmental certification

In Europe, the main ongoing initiatives related to biofuels certification are performed at national level, especially in Netherlands [Cramer 2007], United Kingdom and Germany. Other EU Member States are also starting the preparation of certification schemes within the framework of the preparation of the National Biomass Plans. A detailed synthesis overview of recent developments in sustainable biomass certification has been prepared by Van Dam J. et al. [2007] and Scarlat [2008]. A new recent international initiative is the Round Table on Sustainable Biofuels coordinated by the "Ecole Polytechnique Fédérale de Lausanne", Switzerland (see [RSB]).

Regarding the specific issue of tropical feedstock used for biofuels production, the Roundtable on Sustainable Palm Oil [RSPO], the Better Sugar Initiative [BSI] and the Round Table on Responsible Soy [RTRS] are extremely important since they are the basis for the definition of sustainability schemes based on the combination of NGOs activities (mainly WWF) with those of industrial partners, exporters and other stakeholders.

5.1 Roundtable on Sustainable Palm Oil (RSPO)

In 2001, WWF started to explore the possibilities for the creation of a Roundtable on Sustainable Palm Oil (RSPO). The result was an informal co-operation among Aarhus United UK Ltd, Golden Hope Plantations Berhad, Migros, Malaysian Palm Oil Association, Sainsbury's and Unilever together with WWF in 2002. These organisations constituted themselves as an Organising Committee for the first Roundtable meeting in order to prepare the foundation for the organizational and governance structure for the formation of the RSPO.

The inaugural meeting of the Roundtable took place in Kuala Lumpur, Malaysia in August 2003 and was attended by 200 participants from 16 countries. The seat of the association is in Zurich, Switzerland, while the secretariat is currently based in Kuala Lumpur. The 5^{th} Roundtable Meeting (RT5) was the occasion of the launch of the RSPO Certification System for Sustainable Palm Oil. With the certification system in place the market is expected to see the availability of RSPO Certified Sustainable Palm Oil in 2008.

Regarding the RSPO Certification Systems, the Final document approved by RSPO Executive Board (26 June 2007), details the principles to be followed and criteria to be used. For example, regarding Principle 4 (Use of appropriate best practices by growers and millers), the following criteria are proposed:

- operating procedures are appropriately documented and consistently implemented and monitored.
- practices maintain soil fertility at, or where possible improve soil fertility to a level that ensures optimal and sustained yield.
- practices minimise and control erosion and degradation of soils.
- practices maintain the quality and availability of surface and ground water.
- pests, diseases, weeds and invasive introduced species are effectively managed using appropriate integrated pest management techniques.
- agro-chemicals are used in a way that does not endanger health or the environment.
- an occupational health and safety plan is documented, effectively communicated and implemented.
- all staff, workers, small holders and contractors are appropriately trained.
- environmental responsibility and conservation of natural resources and biodiversity.

At this stage, the RSPO proposed certification system does not include a GHG emissions saving criterium.

5.2 Better Sugar Initiative (BSI)

The Better Sugar Initiative [BSI] is another example of sustainability initiative in the field of tropical feedstock, even if it must be noted that RSPO is at a more advanced stage.

So far, many industries have been unable to extend their social and environmental corporate profile to the way in which sugarcane is cultivated and processed; while many national or local producer groups have social and environmental production guidelines, there is not a global set of sustainable-sugar practices, principles and criteria by which industries, companies and investors can define their sugar interests.

The Better Sugarcane Initiative (BSI) is a collaboration of sugar retailers, investors, traders, producers and NGOs who are committed to sustainable sugar by establishing principles and criteria that are applied in the sugar growing regions of the world through regionally specific strategies and tools. The BSI aims to reduce the impact of sugarcane production on the environment in measurable ways that will also enable sugar production in a manner that contributes to social and economic benefits for sugar farmers and all others concerned with the sugar supply chain. The objective of BSI is, through the encouragement of better management practices (BMP's), to reduce farm and other sugar processing impacts.

To achieve its objectives, the BSI is establishing Technical Working Groups (TWGs) - teams of technical and scientific experts - with global representation. These TWGs will assess Better Management Practices being used by sugar growers across the globe.

Based on good practice achievements, the TWGs will develop a set of universally-applicable guidelines for consideration by the BSI membership. The guidelines will aim to:

- Minimise the effects of sugarcane cultivation and processing on the off-site environment.
- Maintain the value and quality of resources used for production, such as soil, health and water.
- Ensure production is profitable.
- Ensure that production takes place in a socially equitable environment.

Guidelines requiring further consideration will be tested in different cane-growing scenarios around the world to ensure that they are practical and achievable, and have the desired effect of improving the economic, environmental and social sustainability of sugarcane farming.

5.3 Global Roundtable on Responsible Soy

With a similar approach to those of RSPO and BSI, the goal of the Global Roundtable on Responsible Soy Association is to set up a multi-stakeholder and participatory process that promotes economically viable, socially equitable and environmentally sustainable production, processing and trading of soy. In April 2006, a group of experts and stakeholders worked out on a preliminary basis the main impacts of soy production. At a second Roundtable Conference later that year the participants agreed to recognize them as the basis for further discussion of what will become the principles of the RTRS standard for responsible soy production.

The First General Assembly of RTRS was organized on May 8 and 9 2007 in Sao Paulo, Brazil. RTRS is scheduled to set up the Criteria Development Process in order to seek consensus and draft the criteria that shall apply to responsible soy production, processing and trading of soy on a global basis. A Draft document on RTRS Principles and criteria for responsible soy production and trade (30 October 2007) is open for public comments and input until 22 December 2007.

A critical assessment of sustainability schemes for biofuels has been published by Friends of the Earth Europe [April 2008]. This document questions the expected effectiveness of applying sustainability criteria to agrofuel and animal feedstock production in the Mercosur Region.

5.4 Certification : Looking ahead from a European perspective

Regarding the biofuels certification schemes in preparation or discussion in the European Union and its links to tropical countries exports, a few issues need to be clarified:

- Is there the need of a certification system for biofuels or biomass or bioenergy ? What are the priorities of various components in terms of operational implementation?
- Is there the need of an environmental certification system of biofuels or a sustainability certification system covering not only environmental issues but also social ones ? How to ensure active participation of farmers in a biofuels certification system ?
- Is there the need of international systems or are national compatible systems sufficient ?
- Considering the great uncertainties related to GHGs emissions assessment, how can GHGs emissions assessment be inserted into an operational certification scheme based on scientific evidence or consensus ?
- Should only certified biofuels or also non-certified biofuels have access to EU markets ? Should there be a performance rewarding system (green biofuels for example more supported

than lesser green biofuels) and through which mechanisms ?

- How would the future EU system would fit with the Common Agriculture Policy, especially the agro-environment activities, the cross compliance requirements and the reporting needs ?
- How to avoid the risk of a double standard policy between fuel and food ("green" sugar in car tanks and non certified sugar for food or green palm oil in car tanks and non certified palm oil for cooking ?) Do we need sustainable biofuels coming from agriculture or do we need sustainable agriculture independanly of the 4Fs output: Food, Fuel, Fodder, Fiber ?
- How are sustainability certification schemes treated during WTO negotiations and how can we ensure that these certification schemes will not become an instrument preventing international trade or the growth of a biofuels sector ?

6. Conclusion and recommendations

- The success of the Brazilian experience with ethanol from sugar cane is based on the achievements of a programme started more than 30 years ago, initially with public support, then progressively liberalized. In our view, the economic comparisons between oil derived fuels on one hand, European, US and tropical biofuels on the other hand are only valid if they take into account externalities, financial fluxes and the difference in maturity between several technology options.
- Biofuels certification is an opportunity both for exporters from tropical countries and for importers, for example from the European Union. Extreme care must be taken in order to make sure that biofuels certification will provide a fair treatment both to European and tropical biofuels feedstock productions, and will be acceptable for WTO standards. Biofuels certification should allow the development of international trade, not make it difficult or impossible by being based on criteria so detailed their verification will be too complex or costly to check. The issue of the possible links between CAP rules, cross-compliance and biofuels certification should be clarified. It is proposed to support and develop European participation in initiatives such as the Round Table on Sustainable Palm Oil, the Better Sugar Initiative, the Global Roundtable on Sustainable Soy and the International Energy Agency Bioenergy Tasks.
- More research is needed on GHG emissions quantification in relation to biofuels, especially considering N_2O emissions, the contribution of peat soils to emissions in case of land use change, indirect effects on tropical deforestation, the price interactions between food and biofuel prices. Life Cycle Analysis of biofuels is a useful tool of analysis as long as it is transparent but the results are associated to a high level of uncertainty. The indirect effect (displacement, leakage…) of EU and US policies on land use/land cover in tropical countries is a complex issue which requires more research using among others global macro-economic and land use/land cover models.
- Crops must be grown in a sustainable way whatever their final use. Do we need green sugar in car tanks and any sugar in coffee cups ? All crops have advantages/disadvantages and it is our responsibility that the biofuels development based on tropical feedstock takes into account How (i.e. farming practices) and nor What (i.e. this crop is "good" and this one is "bad").
- The final decision for a country or group of countries to implement biofuel policies should be based on the combination of policies such as: transport, environment, energy, climate change, agriculture, rural development, employment, security of supply, development and aid… part of the confusion presently observed in the biofuels debate is in our view linked to scientific uncertainty mixed with policy drivers confusion and commercial interests.

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