WBA fact sheet

BIOFUELS FOR TRANSPORT

SUMMARY

Biofuels for transport are part of important strategies to improve fuel security, mitigate climate change and support rural development. In 2010 some 84 millions tonnes of conventional biofuels based on crops containing starch, sugar or vegetable oil were delivered, that represents some 104 billion litres of fuels that address 2.7% of the global demand for transportation fuels.

Conventional biofuel production not only delivers ethanol and biodiesel but also protein feed, with the quantities of these both being produced on a similar scale. In 2010, the protein production associated with conventional biofuels based on corn, cereals, canola and soybeans delivered 79 million tonnes of protein feed corresponding to the protein production of 29 million ha soybeans, that is more than a quarter of the global demand for soybean cake. Hence, conventional biofuel production chains are a vital part of both global fuel and protein supplies.

Advanced biofuels based on cellulosic feedstocks, various waste streams and algae have a large potential in the future. However, some of these are in early commercial phase in the market at present but most of these new technologies remain in a pre-commercial phase. Investors need reliable long-term framework conditions to be created by governments to offset the huge capital expenditures required to start large-scale production and to offset the initially high production cost of these new fuels.

In order to achieve compliance with emission targets set to slow global warming and to improve the security of energy supply, an increased contribution from both conventional and advanced biofuels will be needed in the coming years. The protein production has to be seen as an important part of the social, economic and environmental aspects of the biofuel industry.

Many studies have shown there is enough land available to produce more food, more feed and more biofuels. However, the available land has to be used in a better way. In recent years more than 200 Mha land has been set aside around the globe and not used at all! Therefore a priority for all governments and international organizations must be to improve agricultural and forestry production methods worldwide in a sustainable and socially acceptable way.

In addition, conventional biofuel production could become part of a global strategy to compensate for the strong variations of harvests coming along with climate change.

INTRODUCTION

The aim of this Fact Sheet from the WBA is to improve the understanding of the biofuels issues by presenting economic and natural science based facts and commenting on these facts.

In recent years, several major challenges have become a focus of public interest. Key issues in this context are: worries about energy security, the need to mitigate climate change, efforts to stimulate economic development including the creation of jobs in agriculture and the renewable energy industry. As a consequence biofuels as renewable fuels for transport became part of a new energy strategy in many countries.

In this Fact Sheet we refer to biofuels as any liquid or gaseous fuels derived from organic material.


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Sugar cane and sugar beet, grain such as corn and wheat and oilseeds are biomass sources for conventional biofuel production – they are often called first generation biofuels. Cellulosic biomass, organic waste and algae have the potential to become an important basis for advanced biofuels – they are also called second generation biofuels.

In this Fact sheet the terms “conventional” and “advanced” are used for the classification of biofuels instead of the terms first and second generation fuels.

FACTS ON BIOFUELS

Conventional biofuels

The raw materials used to produce ethanol or vegetable oil-sourced fuels such as biodiesel contain large portions of sugars, starch or oils but they also include considerable quantities of proteins. The protein production and the biofuel production are of similar importance.

Bioethanol

Ethanol (C_2H_5OH) is an alcohol made by fermenting sugars by adding yeast.

The basic chemical equation for the fermentation of sugars (glucose, fructose) to alcohol is $C_6H_{12}O_6$ " $2C_2H_5OH + 2CO_2$. One kg glucose delivers 511 g C_2H_5OH, 498 g CO_2 and 867 kJ heat [1].

Raw materials are crops with high sugar content such as sugar cane, sugar beet, sweet sorghum or crops with high starch content such as cassava or cereals grains including corn, sorghum, wheat and millet. In the latter case starch must first be converted to sugars by enzymes and then the sugar is fermented to ethanol with release of CO_2.

After fermentation the liquid mixture containing water, ethanol, proteins, and other nutrients has to be distilled to separate the ethanol from the other parts of the liquid. The CO_2 can be captured for industrial purposes. The remaining solids are dried and deliver a protein feed called Dried Distillers Grains with Soluble (DDGS) with typically 30% protein in the dry matter.

Biodiesel

Biodiesel is a fuel produced from vegetable oils that have been extracted from the seeds or fruit kernels of plants including canola (rapeseed), soybean, oil palm, sunflower, jatropha. Oil-rich and fatty wastes such as used kitchen oil collected from restaurants, collective kitchens and animal fats are also important feedstock resources. The oil in the feedstock is transformed to an ester by adding methanol and a catalyst. This process is called esterification. The esters have properties very similar to ordinary diesel and are collectively termed biodiesel.

The energy content and weight of one litre ethanol, biodiesel, gasoline and fossil diesel are not the same. The different properties of these fuels are presented in Table 1.

Pure vegetable oil

Pure vegetable oil (PVO) known also as straight vegetable oil (SVO) is an alternative fuel for modified diesel engines. Decentralised small-scale production of PVO occurs in some European countries. This is used for example in tractors on farms, in private vehicles or in municipal vehicle fleets. [3]

Biogas

Biogas is gas produced from the breakdown of organic matter by microorganisms under anaerobic conditions. Under technically controlled conditions, this process takes place in airtight digesters at a temperature between 30 and 40 degrees and in some cases in higher temperatures around 55-65 degrees. The Raw materials include sewage sludge, animal manure, organic waste, municipal putrescible waste and green or ensilaged biomass from energy crops such as corn or sorghum. The biogas produced is actually a mixture of gases, with methane making up 60 to 65% of the total: the majority of the reminder is CO_2. Biogas can be upgraded to CH4 (methane) through a process that remove other gases. It is then called biomethane and is in essence compatible with fossil “natural gas” system. Biogas has a wide variety of applications, from cogeneration to produce electricity and heat, to industrial processes, and when compressed and upgraded for use as a renewable transportation fuel.

Advanced biofuels

There are several chemical-based, biological and thermochemical technologies for producing advanced biofuels. They are under research and development (R&D) or in the pilot-plant phases or just entering the commercial phase as illustrated in Table 2.

Cellulosic ethanol

Cellulosic ethanol can be produced from lignocellulosic feedstocks through the biochemical conversion of the cellulose and hemicellulose components into fermentable sugar and then this is followed by the alcoholic fermentation. Agricultural and forest sources have great potential to provide cellulosic feedstock, for example: agricultural crop residues such as straw and corn-stover, energy crops, forestry harvest residues and forest processing by-products such as pulping (black) liquor from paper mills and wood processing mill residues.

Hydrotreated vegetable oil (HVO)

Hydrotreated vegetable oil (HVO) is a modern alternative process to esterification and a way to produce very high-quality bio based substitute diesel or aviation fuels. Feedstocks for the HVO process are the same as for biodiesel, vegetable oils or waste animal fats. HVO is known as Renewable Diesel (RD) in the United States. [4]

TABLE 1: AVERAGE NET CALORIFIC VALUE (NCV), DENSITY & ENERGY CONTENT TOE [2]

	GJ/m³NCV	t/m³ Density	GJ/t NCV	1m³=x toe	1t= x toe
Diesel	35.4	0.83	42.7	0.85	1.02
Biodiesel	32.65	0.892	36.6	0.78	0.87
Petrol	31.9	0.748	42.7	0.76	1.02
Ethanol	21.2	0.794	26.7	0.51	0.64

THE UNITS USED IN THIS FACT SHEET:

one tonne = 1 000 kg =1t; one million tonne = 1Mt

one hectare = 10 000 m² = 1 ha

one million hectare = 1 Mha

one litre = 1 litre

one billion litre = 1bn litre

one tonne oil-equivalent = 1toe = 41.686 gigajoule (GJ)

one million tonne oil-equivalent = 1Mtoe = 41.868 petajoule (PJ)

TABLE 2: BIOFUELS, THE DIFFERENT PHASES OF DEVELOPMENT [14]

	ADVANCED BIOFUELS				CONVENTIONAL BIOFUELS
Fuel types	**R&D**	**DEMONSTRATION**	**EARLY COMMERCIAL**	**COMMERCIAL**	**COMMERCIAL**
Bioethanol			Cellulosic ethanol		Ethanol from sugar and starch
Diesel-type biofuels	Biodiesel from algae	BtL diesel		Hydrotreated vegetable oil (HVO)	Biodiesel Pure vegetable oil (PVO, SVO)
Biomethane		BioSNG			Biogas (Biomethane)
Other fuels		Biobutanol, DME	Biomethanol Bio-oil		

Conventional biofuel production is in commercial use, the advanced biofuels are in different phases towards commercial application.
Some of these fuels like HVO are called drop-in-fuels that are being produced in refineries together with their fossil equivalents and are chemically identical with petrol or diesel. By contrast the fuels like ethanol, fatty acid methyl ester (biodiesel), butanol are produced in separate facilities and may be blended with the fossil component. Drop-in-fuels and blendable fuels use the existing infrastructure.
The third types are those renewable fuels that need their own infrastructure or will need special handling, storage and filling systems like biomethane or DME.

Biomass to Liquids (BtL) diesel

Biomass to Liquids (BtL) diesel is the product of a two-step process that produces synthetic diesel from renewable feedstock. The first step requires that any type of biomass is first gasified to produce a synthesis gas (Syngas). The syngas contains varying amounts of carbon monoxide and hydrogen. The syngas is then treated further to clean it from impurities such as tars, particulates and other trace gaseous contaminants. After cleaning it is put through a Fischer-Tropsch (FT) or Mobil process [3] in which the syngas is catalytically converted into various hydrocarbon liquids, for example synthetic diesel.

Synthetic Natural Gas (BioSNG)

Bio-SNG is produced by gasification of cellulosic materials (e.g. forestry residues, energy crops) followed by gas conditioning, SNG synthesis and gas upgrading. Bio-SNG can be used in a similar way to biomethane upgraded from biogas.

Bio-based dimethylether (BioDME)

BioDME or bio-based dimethyl ether is a fuel with similar energy content and handling requirements to LPG (liquified petroleum gas), which is produced in two steps. The first step is methanol production from gasified biomass feedstock and the second step is conversion of methanol to BioDME. DME is a gas at room temperature and pressure and burned like natural gas. BioDME production from black liquor has been demonstrated in a trial.

Biobutanol

Butanol is an energy dense pure alcohol formed by fermentation from biomass by using specific microorganisms. It has a greater energy density with four carbon atoms per molecule by comparison with ethanol with two carbon atoms. Biobutanol can be burned without modifications in an existing gasoline engine and has been demonstrated to be less corrosive than ethanol.

Algal Biofuel

Algae are highly diverse single- or multicelled organisms containing lipids, protein, and carbohydrates, which may be used to produce a wide variety of biofuels. [5] Algal biofuel is an advanced biofuel candidate, which eventually could replace petroleum-based fuel due to several advantages including high oil content, high production per unit of land, etc. Some types of microalgae contain a large percentage of dry matter as oil, with the remaining parts consisting of proteins, carbohydrates and other nutrients. [6] While producing biofuel from algae is in R&D phase, however some pilot-scale demonstration facilities have been developed.

Chemical composition and yields of biofuel feedstock

Information about the composition of the biomass feedstock and the yields per hectare are essential to better understand the complex issues of biofuel and protein production.

Table 3 shows that the dry matter of corn consists mainly of starch, sugar cane consists mainly of sugar and fiber; the plantseeds suitable for biodiesel production have either a high content of vegetable oil such as palm seed (55%) and canola (48%) or a lower oil content but a high content of protein (40%) such as soybeans.

In ethanol production starch and sugar go to ethanol, proteins to the feed production; in the biodiesel production the oil

TABLE 3: CHEMICAL COMPONENTS OF CROPS IN % OF DRY MATTER [1,7]

Composition	Corn	Sugar cane	Canola Rape seed	Soybean seed	Oil palm
Starch	73.3	-			
Sugar	3	52.0		7.3	
Fiber	2.4	33.0	6.4	9.3	6.0
Other carbon hydrates		-	19.4	18.4	28.0
Total carbohydrates	84.0	85.0	25.8	35.0	34
Protein	10.0	7.0	21.1	40.0	9.0
Oil/fat	4.3	2.0	48.5	20.0	55
Ash	1.7	6.0	4.6	5.0	2.0
Total	100.0	100.0	100.0	100.0	100.0
Moisture content before processing %	14	72	8	8	66

goes to biodiesel, the protein to cake/meal for protein feed.

Not only the chemical composition of the crops differs strongly but also the yields/ha.

Average yields of crops per ha

Table 4 shows the average yields in 2010 in those countries that are leading in the production of the specific crop for transport fuels.

These differences in yields – see column crop yield/ha - can partly be explained: in the case of corn, rapeseed and soybean only the seeds are harvested with a low moisture content whereas in the case of sugar cane the whole stalk and in the case of oil palm the total fresh fruit bunches with their higher fibre and moisture content are harvested.

Small parts of these above mentioned crops are also grown for biofuels in regions with lower or higher yields than in these main growing regions. Therefore the yields assumed for the global production model are slightly different from the yields in Table 4.

Biofuels and protein feed per ha

On the basis of the assumed yields for biofuel production and the composition of the dry matter the conversion rates for the output of biofuels and protein per ton can be defined and the output of biofuels in litre per hectare and of protein feed in kg per hectare calculated. The results are presented in Table 5.

As can be seen in Table 5 tropical plants like sugar cane for ethanol or oil palms for biodiesel deliver the highest yields in terms of transport fuels per hectare – 6100 litre ethanol and 5500 litre biodiesel respectively. In the moderate zones corn is the plant with highest biofuel yield at about 3800litre ethanol/ha, while wheat as feedstock for ethanol produced 2500 l/ha. The biofuel output of rapeseed is in average 1280 litre biodiesel whereas soybean delivers an even smaller quantity of biofuels per hectare – 550 litre.

Corn, cereals, rapeseed and soy beans used as a feedstock for biofuels also produce protein feed. These protein feeds like DDGS or rapeseed cake contain different quantities of protein per tonne. To make the yields better comparable they are expressed for the fuel in energy units (toe) and for the protein in of soya cake equivalent with 44% protein.

As can be seen in Table 6 oil palms bring the highest output of transport fuel in terms of toe followed by sugar cane and corn. Soybean brings the highest output in protein feed followed by corn. Hence the fuel production is closely linked with the vegetable protein production. Less ethanol and biodiesel from the crops cultivated on the Northern hemisphere means less protein supply and more pressure for land for soybeans with possibly additional CO_2 emissions.

TABLE 4: AVERAGE YIELDS OF IMPORTANT CROPS FOR BIOFUELS IN MAIN GROWING REGIONS; [8]

Crop	Crop Yield t/ha	Moisture content	Dry matter t/ha
Sugar cane; Brazil, 2010	74	72	20.7
Oil palm; Malaysia, 2010	25	32	17
Corn, USA, 2010	9.6	14	8.3
Wheat, EU15, 2010	6,6	14	5,7
Rapeseed; European Union 2010	2,97	8	2,73
Soybean; USA	2.7	8	2.5

TABLE 5: PRODUCTION OF BIOFUELS AND PROTEIN FEED PER HECTARE IN 2010 [9,10,20,21]

Crop	t/ha	Conversion l biofuel/t biomass	Biofuel yields l/ha	Conversion t Protein feed/t biomass	Protein feed t/ha
Corn	9.57	396	3790	0.3	2.87
Wheat	6.25	400	2500	0.327	2.04
Sugar cane, B	74	82	6100	-1)	-
Soy bean	2.7	205	550	0.790	2.13
Rape seed	2.97	430	1280	0.6	1.78
Oil palm	25	220	5500	-	-

1) Sugar cane also contains protein and minerals; in many plants this fraction of the liquid after distillation is not recaptured but pumped back to the fields as mineral and N fertilizer. Therefore no protein output is mentioned above. This is possible in Brazil where the ethanol plants are surrounded by the sugarcane fields.

TABLE 6: COMPARABLE FUEL & PROTEIN PRODUCTION FOR DIFFERENT CROPS PER HA; UNIT TOE FOR FUEL AND TONS SOYBEAN EQUIVALENT FOR PROTEIN FEED [11]

Crop	Fuel toe/ha	Protein feed Soybean cake equiv. t/ha
	ETHANOL	
Corn	1,9	1,9
Wheat	1,3	1,4
Sugar Cane	3,1	-
	BIODIESEL	
Soybean	0,4	2.1
Rapeseed	1.0	1.3
Oil palm	4,3	--

> “In order to achieve compliance with emission targets set to slow global warming and to improve the security of energy supply, an increased contribution from both conventional and advanced biofuels will be needed in the coming years.”

GLOBAL PRODUCTION

An analysis of the production of biofuels and protein feed in 2010

Biofuel production

Global biofuel production grew from 16 bn litre in 2000 to 104bn litre in 2010, split into 85 bn litres ethanol and 19bn litres biodiesel. In 2010, biofuels provided 2.7% of total road transport fuel [3, 12].

In 2010, the leading country in ethanol production was the USA with 49 bn litres, followed by Brazil with 28bn litres. The European Union was leading in the biodiesel production.

The global biofuel production 2010 in terms of tonnes and tonnes of oil-equivalent is demonstrated in Table 7.

An analysis of the global biofuel/protein production 2010 including land use is now presented. Note that data on land use and protein production are calculated based on published yields, coefficients and fuel production data per region and that crops with a share below 1% of the global production are not included [12, 13, 14, 21].

Land for fuels and protein

The land needed, as illustrated in Table 8, for the ethanol production in 2010 is calculated as 20.3 Mha, comprising 13.2 Mha corn, 2.0 Mha cereals, 4.6 Mha for sugar cane and 0.5 Mha other crops, hereof almost 0.3 Mha sugarbeets.

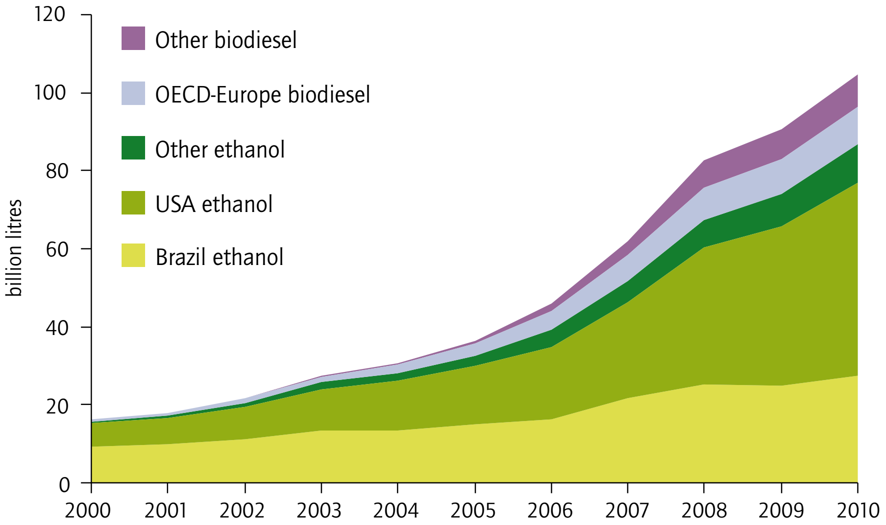
Biodiesel production was based on 19.2 Mha, hereof 7.8 Mha rapeseed, 10.9 Mha soybeans and 0.5 Mha oil palm and others. Together this makes 39.5 Mha.

Protein production

The ethanol production based on corn and cereals delivered 42.0 Mt of brewers grain or DDGS and the biodiesel production based on rapeseed delivered 13.9 Mt canola meal. This sums up to 55.9 Mt protein feed.

In addition, the oil of 10.9 Mha of soybeans was used for biodiesel. These soybeans delivered 23.2 Mt of soybean meal so that in 2010 the total protein production related to biofuels reached 79.1 Mt protein feed. Table 9 gives an overview:

Hence in 2010 the 23.0 Mha needed for corn, cereals and rapeseed not only delivered the feedstock for 43.67 Mt ethanol and 8.9 Mt biodiesel, but also for 55.9 Mt protein feed -18.3 Mha land would have been needed to produce the same quantity of protein on the basis of soybeans. It can be concluded: one hectare for biofuels based on grains/canola delivers as much protein as 0.8 hectare soybeans!



Global Biofuel Production (billion liters) from 2000-2010 [14].

TABLE 7: BIOFUEL PRODUCTION IN 2010 IN BN LITRES, TONNES, TOE AND PJ

	bn litres	Mt	Mtoe	PJ
Ethanol	85	67,49	43.35	1815
Biodiesel	19	16.72	14.82	620
TOTAL	**104**	**84,21**	**58.17**	**2435**

TABLE 8: LAND FOR BIOFUELS AND PROTEIN, MHA

crop	corn/ cereal	rape	soybean	sugar cane	oil palm / sugarbeets/ others	TOTAL
Mha	15,2	7.8	10,9	4.6	1.0	39.5

TABLE 9: PROTEIN PRODUCTION IN MT PROTEIN FEED AND MT SOYBEAN CAKE-EQUIV.

crop	kind of feed	protein feed Mt	soybean-equ. Mt	Biofuel bn litres	Biofuel Mt
corn/cereal	DDGS	42,0	28,6	55	43,67
rapeseed	rape cake	13.9	10.4	10	8.92
sum		55.9	39.0	65	52,59
soybean	soybean cake	23,2	23,2	6	5,28
TOTAL		**79.1**	**62.2**	**71**	**57,87**

The allocation of land between biofuels and protein

As the above analysis demonstrates, there are two groups of crops for biofuels:

Crops A: deliver feedstock for biofuels and protein feed for the market such as corn, cereals, rape and soybean (non tropical).

Crops B: deliver feedstock for biofuels without a protein production for the market such as sugar cane and oil palm (tropical).

Crops A: These crops planted 2010 on 33.9Mha delivered an output of:

- 57.9 Mt transport fuels
- 79.1 Mt protein feed

Hence biofuels constitute 42% of the total output in terms of mass units and protein feed 58%. Per hectare these plants produced in average 1.7 fuels and 2.3t protein cake. An allocation of the land based on this relationship means that out of the 33.9Mha the net use of land for biofuels was 14.2Mha and the use of land for protein production was 19,7 Mha.

Crops B: These crops like sugar cane, oil palm and minor other crops, planted together on 5.6Mha land delivered 26.4 Mt biofuels. The biofuel production per hectare was 4.7 t, that is 2.5 times as high as in group A.

To summarize: from the 39.5 Mha land commonly attributed to the production of biofuels in reality only 19.8Mha served to produce the feedstock for biofuels and 19.7 Mha to produce protein feed. There is a clear difference between non-tropical plants – group A – and tropical plants – group B. For group A plants, as a whole, the main output is protein and biofuels are a by-product, this is especially the case for soybeans and canola though not so much for corn. On the other hand tropical plants deliver a much higher output of biofuels per hectare than non-tropical plants.

Land requirements and the food/fuel issue

The land needed in 2010 for the simultaneous production of biofuels and protein has to be set in relation to the global land use pattern as an orientation for the further development.

At present only 11,8% of the total land area is used as cropland and this with greatly varying yields from continent to continent. It is estimated that additional 893 million ha land can be used for rain-fed agriculture, part of this land is now not used, or is used as range grazing land for livestock. [15]

In a recent study [16] referring to the period 2006 – 2009 Zeddies points out that globally 226 Mha land were set aside and not used at all. That is ten times as much as the net use of land for first generation biofuels!

The future availability of land will be determined:

- By the growing population and changing eating habits.
- By the ability to better use the available land
- By the technological progress in achieving higher yields.

Over recent years global agricultural yields increased by 1% per year [16]; this alone corresponds to 150Mha more cropland potentially available within ten years.

TABLE 10: AVAILABLE LANDS FOR ENERGY CROPS [15, 16]

	Billion hectares
Total global land mass without Antarctica	13.20
Forests	4.0 (30,3%)
Land for livestock	3.92 (29,7%)
Current crop land	1.56 (11,8%)
Additional potential for rain fed agriculture (Includes partly land for livestock)	0.89 (6,8%)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Ethanol plant by corn field.

> " Conventional biofuels such as ethanol, biodiesel, biogas are the only commercially available low emission option to replace fossil fuels at present. For many years these will be needed – bedding the path for advanced biofuels. "

Taking these different drivers into account Zeddies estimates additional 150.000 to 195.000 Mha will be available for energy crops, or an average of 170 Mha, by 2020. This land can be used to produce more biomass for liquid, gaseous or solid biofuels.

It should be mentioned in this context that, assuming a production of 8t dry matter biomass per ha per year, an area of 100 Mha land planted with energy crops (short rotation forests, sweet sorghum, corn etc.) delivers 344Mtoe = 14,4 exajoule (EJ) of primary energy.

As a conclusion: there is enough land available to produce more food and more biomass for energy, but it has to be used more properly!

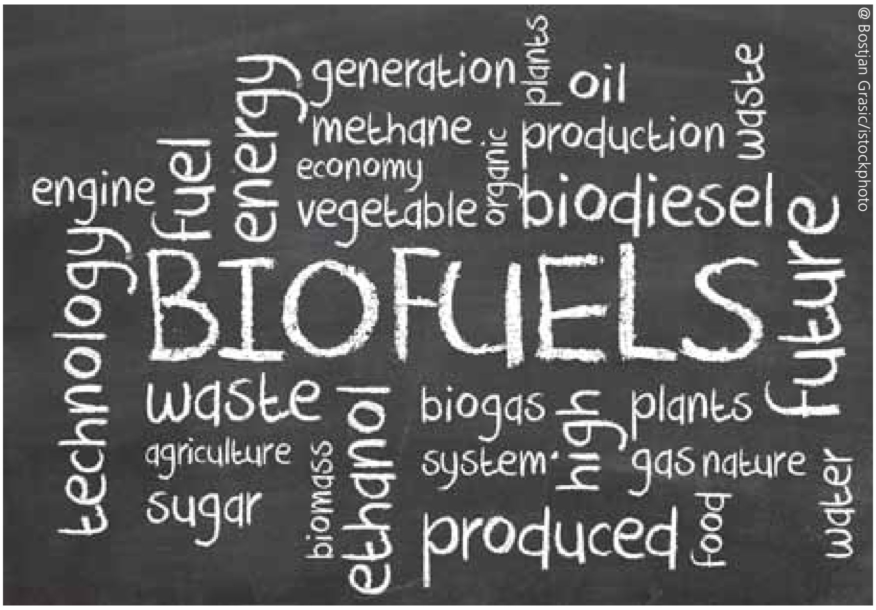
Global grain and oilseed production in relation to biofuels

The global grain production averaged 2250 Mt/year over the years 2007 – 2011. The annual variations of the grain harvest between 2007 and 2011, mainly due to changing weather conditions, amounted to 250Mt; the smallest harvest in this period was 2.100Mt, the biggest reached 2350Mt.

How does this relate to the biofuel production? In 2010 a quantity of 137Mt grain (corn and cereal) was needed to produce 43.7 Mt biofuels and 42.0 Mt protein feed, hence a net share of 3.1% of the total grain production was used for biofuels, much less than the annual variations of the grain harvest. About 37% of the global grain production is used directly for food, almost 50% as feed for meat production, 6.1% for protein/biofuels and the rest as seed for new planting and for industrial purposes. [17]

In an OECD/FAO outlook study the global oil seed production for the period 2009 -2011 is presented with 470 Mt and an increase until 2021 to 523 Mt is forecast. In 2010 around 53 Mt of oil seeds (canola, soybean) were used to produce 14.3Mt biodiesel and 37.1Mt protein feed, hence almost three quarters of this 53Mt oilseeds went to the protein feed and only 30% to the fuel production – about 3% of the total oilseed production.

BIOFUELS IN THE PUBLIC DISCUSSION



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The global context

Several global developments influence the discussion on biofuels:

- The world population is growing annually by 70 million people;
- In 2011 CO_2 emissions reached a maximum of 34 billion tonnes; far above the limit to comply with the 2°C target!
- Global warming and the growing frequency of extreme weather events are becoming a threat for a secure food production in the future.
- A reduction of GHG emissions can only be achieved, if also the transport sector reduces its emissions.

These facts demonstrate some of the challenges the global society is facing.

Commodity prices and biofuels

Agricultural commodity prices have been fluctuating over the past decade and were particularly high in 2007/08. A number of different factors are influencing them such as: increasing fossil oil prices, bad harvests (as a consequence of extreme weather situations), growing demand of food for an increasing population with changing eating habits, slower improvements in productivity gains due to low investments in agriculture and finally the production of biofuels.

According to several studies, among these different factors biofuels have a minor impact on the level of global food prices. Importantly these studies have also shown that the higher commodity prices have many positive effects in the global agricultural commodities market. They provide strong incentives for increased returns for farmers for example in developing countries, thus offering important development benefits.

Malnutrition and biofuels

It is regrettable that still hundreds of million of the world's people don't get enough to eat. This problem has existed for many decades but thankfully the situation is slowly improving. 40 years ago one quarter of mankind suffered hunger, in 2012 it was less than 15'%, while these levels of hunger and malnutrition are unacceptable, the improvement continues. There is no scientific evidence that global malnutrition has increased as the production of biofuels commenced and ramped up. On the other hand if fallow land remains unused instead of producing crops for biofuels, opportunities to increase global vegetable protein production will be passed up and the global food supply will become tighter. Biofuels are not the cause for the unsolved problem of the food supply for the poor.

ILUC discussion and biofuels

The discussion of indirect land use change (ILUC) caused by biofuels started a few years ago. The core of the discussion can be illustrated using an example: Based on studies it was calculated that one hectare of canola used for biofuel production causes a change in land use somewhere on the globe that releases 1,5 t CO_2/ha annually (55 g CO_2 eqv./MJ; 1310 l oil/ha) because land with high carbon value is converted to land with a lower carbon value [18]. An explanation for this high value is the assumption that peat land is converted to oil palm plantations. Adding these ILUC-related CO_2 emissions to the emissions that occur in producing, transporting and processing canola results in higher total emissions than the reference value of fossil fuels. Hence it is concluded use of fossil diesel is less damaging to the climate than biodiesel from oil crops and the latter should be banned.

This example has to be seen in a broader context: Globally the use of land is changing permanently: the population grows, deserts are expanding due to the loss of protection for fertile land, forests are expanding in one part of the world and declining in other parts, urban settlements are getting bigger, more land is used for roads and other infrastructure, and large tracts of potentially productive agricultural land is just left idle due to market failure, poor incentives, or lack of technology or capacity. Furher, a growing consumption of meat requires more land.

Just to develop this example: The increased demand for meat over the last 15 years has required more additional land for feed production for animals than used for any expansion of biofuel production. If in one part of the world such as in Europe biofuel production is reduced on the basis of ILUC calculations and the other trends continue unchanged, the shift of carbon to the atmosphere cannot be prevented. To the contrary, CO_2 emission will increase due to higher consumption of fossil fuels.

Conventional and advanced biofuels

In the transformation of the transport sector conventional biofuels cannot be replaced. They are one essential pillar of this transformation. The second pillar in the form of production of advanced biofuels has to be built upon the foundation that they provide. The volumes of possible feedstock for the production of advanced biofuels are vast: by-products from agriculture such as straw, bagasse, rice husks, oil palm empty fruit bunches, MSW, by-products of the forest-and-wood industry, woody harvest residues, dedicated cellulosic energy crops like grasses, short rotation woody coppices and algal biomass.

One big advantage of these fuels is that there is no direct competition with the food market. While there can be competition with other energy pathways such as biomass for heat or potentially for land use in case of growing dedicated crops there is in essence no competition as long as waste or unutilized cellulosic by-products serve as biofuels feedstock. There are vast

> “ Many studies have shown there is enough land available to produce more food, more feed and more biofuels.”

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Sugar cane plantation.

amounts of such feedstock worldwide.

In general the conversion of cellulose to liquids is complex and rather expensive as is the production of algae for producing biofuels. Intensive research is required to improve the technologies for production and their economies. This research has been going on now for many years. As a result different technologies are under development and several pilot- and an increasing number of demonstration plants are under construction or entering production.

Now the time is ripe to start commercial plants to gain experience in large-scale operation. The production cost will be high due to a combination of the very high capital investment requirements for plant, a lack of experience, the complexity of the conversion technology and the need to build up logistic chains that can supply sufficient feed stock volumes for large-capacity plants at reasonable costs. Only commercial plants can bring the needed experience for further development and a quantity of fuel production that will make significant impacts on the market.

Conventional biofuels and food security

Climate change is becoming more and more a threat to global food security, largely because more extreme weather events, and shifting rainfall patterns are predicted to cause bad harvests more frequently.

The difference in global crop harvests between good and bad years typically oscillates around 10 per cent – more extreme weather poses a risk that these ‘oscillations’ can become larger. In this context conventional biofuels can be seen as an insurance; in years with good or normal harvests the biofuel production capacity can be fully used whereas in years with bad global harvests fuel production is reduced. Such effects are driven by the market as in times of cereal and oilseed shortage, price shifts drive biofuel production down while more elastic food markets increase their share of the harvest.

The feedstock is used for food and feed and more fossil fuels are temporarily used instead for transport. Such a concept, including remuneration payments for plants shut down for a period of time, would better secure the food supply than set-aside programs. These set-aside programs imply no production on the concerned land and it might take one or two years to get a crop harvest from this land, whereas a global food shortage might be urgent immediately. Hence it makes sense to use several per cent of the cropland for biofuels also from the standpoint of food security.

Global trade, land grabbing and biofuels

The expansion of biofuels has to be supported within a global policy to decrease the dependence on fossil fuels and mitigate climate change – not only in Europe but worldwide. There should be a strong imperative for all countries to start the process of replacing fossil fuels by renewables in their transport sector. The build up of a biofuel production for export while continuing the use of fossil fuels at home is not a sustainable concept, it only favours trade. In countries with no adequate land policy it might increase the demand for land that is already strong for many other reasons and cause land grabbing to the detriment of the indigenous or rural population.

This should be avoided and therefore each region should primarily develop for there own resources for food and biomass production. Only those countries should export feedstock for biofuels that have already a successful national and genuinely sustainable biofuels policy that prevents land grabbing within its boundaries. ■

POSITION OF WBA

WBA sees the future position of biofuels within the broader scope of the global transformation of the energy system from fossil-based to renewable energy-based sources. A main driver for an accelerated transformation is the struggle for better fuel security. A second driver is the threat of a global warming up to 6 ° C in this century as it is predicted by IEA officials on the basis of the "business as usual" development. (References: Fatih Birol, presentation ADIREC conference Abu Dhabi, January 2013) According to WBA calculations the CO_2 emissions from fossil fuels need to be reduced by 50% until 2035 to keep on track towards the "under 2°C temperature rise" target. Based on this background and on the facts presented in this paper WBA's position on biofuels is summarized below:

Improved fuel security: the WBA reminds the public that 40 years ago, during the winter 1973/74 an oil crisis severely hampered the supply of transport fuels. The transport sector and the agriculture were severely affected. In some regions even the planting of new crops in spring 1974 was compromised. Nobody can rule out the development of a similar situation within the next two decades. Therefore, WBA supports a consistent, far sighted further deployment of biofuels for transport as an important strategy to improve fuel security worldwide.

Conventional biofuels can grow: the WBA believes that conventional biofuel production can grow to cover 5-7% of the global transport demand by 2035 without compromising social, economic and environmental conditions – and in many instances improving such. The WBA holds that work is required to ensure that the public perception of these fuels produced from corn, cereals, canola/rapeseed, and soybean is improved. Among other things this should ensure that these crops are recognized as being an important basis for the global protein supply as well as for transport fuel. In many instances biofuels should be seen as a co-product with protein production and as an important contribution to the global supply of protein for feed and food.

Advanced biofuels are vital but need commercialisation: the WBA is convinced that advanced biofuels are vital for the future but they are yet to enter the market on the basis of commercial production units. As production costs are currently higher than the market price this can only happen if government set up reliable and long-lasting framework conditions for investors to offset the initial higher cost. This must be achieved in the near future otherwise advanced biofuels will not gain momentum within the next decade. If these commercial plants develop successfully advanced biofuels could cover 5 -10% of the transport sector by 2035, with biomethane for transport included. The deployment should be intensified especially on the basis of waste materials and by-products such as straw, bagasse, and organic waste.

On agriculture: The WBA holds that much more emphasis is needed to improve the agricultural productivity world-wide by a set of measures such as education, training, supply with modern inputs, improved facilities for the storage of the harvests to avoid losses, improved access to markets, better extension services, more research to increase the production per hectare and also to increase surface of arable land by a new land policy such as fighting desertification, regaining degraded land for production.

On land availability: WBA emphasizes there is enough land available to feed a growing population and for the production of biofuels. We advocate the use of several per cent of the agricultural land for the production of biomass for fuels. Not only is better use of the available land an imperative for all countries, this will also help to improve the security of food supply of the local population, stimulate endogenous economic growth, reduce poverty in many regions. Well managed integration of biofuels production to national agricultural portfolios can both: reduce GHG emissions and fuel import dependency.

On European discussion: The European discussion on biofuels and ILUC factors appears exaggerated. It only can be understood under the assumption that one

1. ignores the issue of energy security and rural development
2. takes for granted that fossil fuels are always available
3. believes that economic models completely portray the complex relations between land use, socio-economic development, protein supply, meat production, elasticity of commodity markets etc.

But all these assumptions are questionable. It is also not clear how ILUC gains by displaced soybeans as a consequence of the protein production based on corn and canola are taken into account. ILUC models are a blunt tool and don't portray the complex reality. WBA is against the application of ILUC factors and favours targeted regional strategies to minimize emissions by land use change. In addition the CO_2 emissions by land use changes are declining and are not the big cause of a growing CO_2 concentration in the atmosphere [19]; this increase of the CO_2 concentration is mainly caused by the use of fossil fuels.

The proposed change of the rules for biofuels only a few years after they have been decided upon by the European Authorities undermines the confidence of investors, reduces jobs and will hamper future investments. The submitted proposals reduce the market for biofuels, serve the fossil fuels and will increase the CO_2 emissions. WBA sees a pragmatic solution of the present discussion in sticking to the 10% target but adding subtargets for 8% ethanol, 8% biodiesel and 2% advanced biofuels including biomethane without referring to a higher counting of specific technologies.

On CO_2 emission and biofuels: The WBA stresses that there is an urgent need to reduce the CO_2 emissions across all sectors - the transportation sector is particularly important and biofuels are central to such efforts. Conventional biofuels such as ethanol, biodiesel, biogas are the only commercially available low emission option to replace fossil fuels at present. For many years these will be needed – bedding the path for advanced biofuels. Biofuels are only one portion of the suite of transportation solutions required, other renewable technologies for transport must be promoted as well.

Finally, the use of land for energy is nothing new. Before entering the fossil age mankind used 20 – 30% of the land to produce feed for animals used for traction and transport. Leaving the fossil age means that again a few per cent of the land will be needed to produce energy for transport and traction! ■

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