

Situation and Development Potential for the Production of Biodiesel – an International Study

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Summary

The production of biodiesel has made a substantial leap in the past years, particularly in the European Union. From 1996 to 2002, the biodiesel production capacity was increased by a factor of four to a total of 2 million tonnes. A further extension of the production capacity must be anticipated due to the initiative of the EU commission to promote biological fuels and the associated national amendments to the mineral oil tax laws. The prospective candidates to EU membership are also requested to implement the corresponding EU rulings in their national legislation. Urgency is created by the minimum target quantities laid down in the action plan of the EU commission, by which the market share of biological fuels is to be increased step by step from 2% in the year 2005 to 5.75% in the year 2010. This results in new production and sales opportunities for farming, as a producer of raw materials, which will be highly significant, particularly to the countries gaining membership.

With regard to marketing, differences exist between the member states which market biodiesel as an additive to conventional diesel fuel and the member states (Germany and Austria) which market pure biodiesel. Biodiesel is a type of product generally known to consumers in the latter named countries.

The supply of raw materials is the limiting factor for the further development of the biodiesel economy. Given the existing production facilities, it cannot be anticipated that over 10 % of diesel fuel consumption can be replaced by biodiesel.

1 Introduction

The commercial marketing of rapeseed oil methyl ester as a fuel for use in diesel vehicles began about ten years ago. With regard to the produced qualities and sales, the beginnings were initially very modest. Particularly in countries where the marketing of pure biodiesel was intended from the beginning, this development was borne initially by a few idealists, who preserved their courage despite setbacks. The entry to the market was extremely difficult due to lacking approvals and a price relatively high in comparison with diesel fuel. Two factors have significantly determined the further penetration of the market:

With the introduction of the Farming Reform in the year 1992 and the connected fallow land obligations, an enormous potential area became available for the production of regenerative raw materials for employment as materials and for energy.

With the creation of the preliminary standard for biodiesel V DIN 51606, obligatory quality parameters were specified for the production of biodiesel and the first approvals were issued on the basis of the preliminary standard.

In contrast to France and Italy, Germany had not fully exploited the possibilities of the mineral oil tax structure directive (92/81/EWG) [1] to create a mineral oil taxation preference for biodiesel in the course of pilot projects, but has adopted the opinion that the Council and the EU commission had agreed to allow the member states to retain the more favourable tax rulings valid until the mineral oil tax structure directive came into force (1st January 1993) until the resolution of the proposal of the EU commission on uniform consumption tax rates on

fuels derived from agricultural raw materials (KOM (92) 36 final, Der. EG No. C 73, 24.03.92). UFOP therefore supported the introduction of pure biodiesel to the market within the limits of its public relations work from the very beginning and sought co-operation with the biodiesel economy and the automotive industry. In view of the price development for oilseed, the fundamental objective of involving farming in the value gain by the pure marketing of biodiesel was and is the pursued objective. In the meantime, numerous production communities have arisen which have specialised in the production of rapeseed for the manufacture of food and non-food products, some of which operate their own oil mills to supply biodiesel production plants and/or are involved in biodiesel production plants.

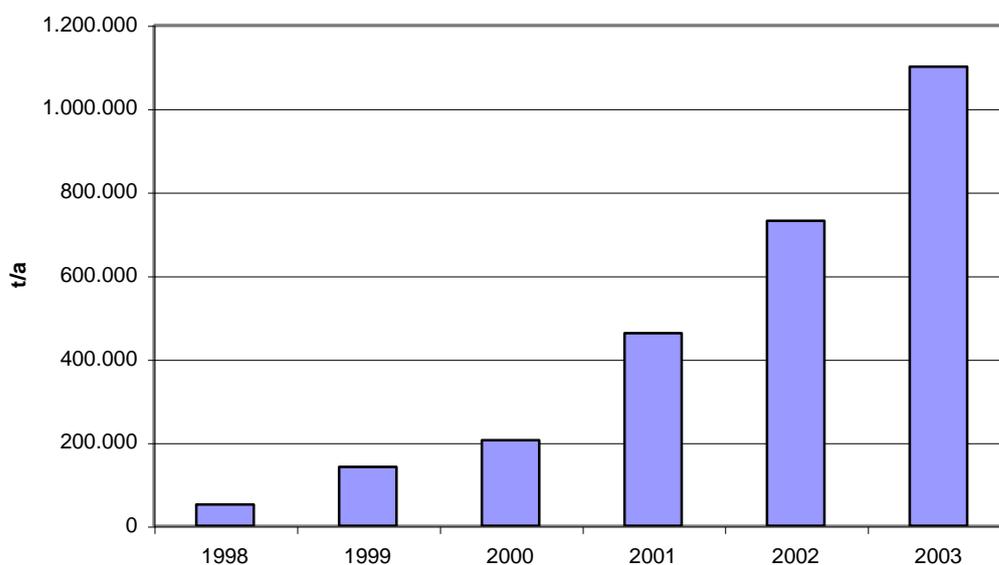
2 Situation

2.1 Biodiesel production

Measured by the situation in 1998, the biodiesel economy has grown substantially, particularly in Fig. 1 Biodiesel production capacity in Germany, 1998 - 2003

Germany. With an anticipated biodiesel production capacity of around 1.1 million tonnes, the total capacity in the specified period will have increased more than tenfold (Fig.1). The ester interchange capacity fluctuates heavily between the individual plants due to the given investment facilities (Fig.2). This does not take account of the existing ester interchange capacities of the oleochemical industry, which has also produced for the biodiesel fuel market in the past, such as SISAS AG (now BASF), 60,000 tonnes, Veluy, Belgium. Regardless of the plant size, the quality requirements for biodiesel as stipulated by the fuel standard E DIN 51606 and the future European DIN EN 14214 must be fulfilled. In an international comparison, Germany has taken a leading position in the development of capacities (Fig.3). The reasons for the "production difference" to France and Italy lie in tax legislation. The produced quantity in the stated countries is tied to quantitative contingents which are determined annually by the respective parliaments. In Germany, there is still no upper limit for the production of biological fuels.

Biodiesel production capacity in Germany, 1998 - 2003



Source: UFOP

Fig. 2 Biodiesel plants in Germany, 2003 (in operation/under construction)

| <i>In production:</i> | | | |
|--|----------------------------------|-----------------------|--------------------------------|
| Operator | Place / state | Capacity (t/a) | Beginning of production |
| Oelmühle Hamburg AG | Hamburg | 120,000 | 09/2001 |
| Oelmühle Leer Connemann GmbH & Co. KG | Leer / Niedersachsen | 100,000 | 09/1996 |
| Mitteldeutsche Umesterungswerke Bitterfeld | Bitterfeld / Sachsen-Anhalt | 100,000 | 09/2001 |
| Natur Energie West | Marl / Nordrhein-Westfalen | 100,000 | 04/2002 |
| NEVEST AG | Schwarzheide / Brandenburg | 100,000 | 10/2002 |
| Rheinische Bioester GmbH | Neuss / Nordrhein-Westfalen | 100,000 | 12/2002 |
| Campa Biodiesel GmbH | Ochsenfurt / Bayern | 75,000 | 01/2000 |
| Biodiesel Wittenberge GmbH | Wittenberge / Brandenburg | 60,000 | 08/1999 |
| Bio-Ölwerke Magdeburg | Magdeburg / Sachsen-Anhalt | 50,000 | 03/2003 |
| Thüringer-Methylesterwerke GmbH & Co. KG | Harth-Pöllnitz / Thüringen | 45,000 | 01/2002 |
| Petrotec GmbH | Südlohn / NRW | 35,000 | 05/2002 |
| SARIA Bio-Industries GmbH & Co. Verw. KG | Malchin / Mecklenburg Vorpommern | 12,000 | 10/2001 |
| Biodiese Bokel GmbH | Bokel / Niedersachsen | 10,000 | 09/2002 |
| Hallertauer Hopfen-Verwertungsgesellschaft | Mainburg / Bayern | 8,000 | 04/1995 |
| Landwirtschaftliche Produkt-Verarbeitungs GmbH | Henningsleben / Thüringen | 5,000 | 04/1998 |
| PPM Umwelttechnik GmbH & Co.KG | Oranienburg / Brandenburg | 5,000 | 11/2001 |
| BioWerk Sohland GmbH | Sohland / Sachsen | 5,000 | 07/ 2002 |
| BKK Biodiesel GmbH | Rudolstadt / Thüringen | 4,000 | 12/2001 |
| Verwertungsgenossenschaft Biokraftstoffe | Großfriesen / Sachsen | 2,000 | 04/1996 |
| Sum | | 936,000 | |
| <i>Plants under construction:</i> | | | |
| Operator | Place/state | | |
| Marina Biodiesel GmbH & Co. KG | Brunsbüttel / Schleswig-Holstein | 100,000 | |
| EOP Elbe Oel AG | Falkenhagen / Brandenburg | 30,000 | |
| Biodiesel Kyritz GmbH | Kyritz / Brandenburg | 28,000 | |
| Kartoffelverwertungsgesellschaft Cordes & Stoltenburg GmbH & Co. | Schleswig / Schleswig-Holstein | 10,000 | |
| BioWerk Kleisthöhe GmbH | Uckerland / Brandenburg | 5,000 | |
| Sum | | 173,000 | |

Fig. 3 Biodiesel capacities in the individual European countries

| Country | Capacity in t/a |
|----------------|------------------|
| Germany | 1,109,000 |
| France | 440,000 |
| Italy | 350,000 |
| Czech Republic | 60,000 |
| Denmark | 60,000 |
| Austria | 45,000 |
| Sweden | 30,000 |
| Great Britain | 30,000 |
| <i>Sum</i> | <i>2,124,000</i> |

Source: own research

2.2 Action plan of the European Union

The proposals of the EU commission to promote biological fuels will give the biological fuel production in the expanding European Union a long-term impulse. The EU commission, the responsible EU councils and the European Parliament have agreed in principle to the amendment of the mineral oil tax structure directive and the action plan [2] of the EU commission to introduce minimum contingents of biological fuels to the consumption of conventional fuels (Fig.4, 5).

Fig. 4 Fuel consumption (in thousand t crude oil derivatives) in the European Union in the transport sector, 1998

| Country | Petrol consumption | Diesel consumption | Total |
|-----------------|--------------------|--------------------|---------|
| Austria | 2,130 | 3,224 | 5,354 |
| Belgium | 2,514 | 4,852 | 7,366 |
| Denmark | 2,016 | 1,711 | 3,727 |
| Finland | 1,846 | 1,776 | 3,622 |
| France | 14,554 | 26,603 | 41,157 |
| Germany | 30,080 | 24,834 | 54,914 |
| Greece | 3,106 | 2,245 | 5,351 |
| Ireland | 1,307 | 1,429 | 2,736 |
| Italy | 17,880 | 16,138 | 34,018 |
| Luxembourg | 541 | 685 | 1,226 |
| The Netherlands | 4,112 | 5,067 | 9,179 |
| Portugal | 2,030 | 2,863 | 4,893 |
| Spain | 9,018 | 16,215 | 25,233 |
| Sweden | 4,021 | 2,374 | 6,395 |
| Great Britain | 2,1882 | 16,597 | 38,479 |
| Total | 117,037 | 12,6613 | 24,3650 |

Source: EU commission (KOM (2001) 547 final

Fig. 5 Biological fuel production in the European Union

| Year/minimum contingent (based on 1998) | Petrol consumption | Diesel consumption | Total |
|---|--------------------|--------------------|--------|
| 2005/2.00% | 2,341 | 2,532 | 4,873 |
| 2006/2.75% | 3,219 | 3,482 | 6,701 |
| 2007/3.50% | 4,096 | 4,431 | 8,527 |
| 2008/4.25% | 4,974 | 5,381 | 10,355 |
| 2009/5.00% | 5,852 | 6,331 | 12,183 |
| 2010/5.75% | 6,730 | 7,280 | 14,010 |

Source: D. Bockey, UFOP, according to information from the EU commission (KOM (2001) 547 final

In the course of the first reading, the European Parliament had approved the proposed directive of the Commission with 58 suggested amendments. The most important amendments are:

- Retention of the specified quantity contingents as obligatory quantity contingents of biological fuels of the total quantity of sold fuels.
- Refusal of enforced admixture of biological fuels.
- Member states which have special difficulties with compliance with the specified target quantities can be freed of obligations for two years upon application.
- Biodiesel as a fuel must fulfil the DIN EN 14214 standard for fatty acid methyl ester.
- Biological fuels sold pure or as admixtures of over 5 % must be marked as such.
- The employment of biological fuels in public transport and taxis is given special priority.
- The member states will report annually to the Commission – for the first time on 1st July 2004 – on the measures which they have taken to achieve the quantities specified in Appendix B.
- The Commission will produce an assessment report by 31.12.2006 and subsequently every two years on the progress in the employment of biological fuels.

Happily, the Danish council presidency has also exerted pressure to resolve the proposed directive during this year and to enforce its implementation in the member states. By the amendment to the mineral oil tax act before the parliamentary summer break, the German federal government created the legal prerequisites with regard to the mineral oil tax to exempt biological fuels from the mineral oil tax until the year 2008. This period can be extended by application to the EU Commission.

2.3 Sales development

Many discussions have been held on the marketing of pure biodiesel or as an additive to diesel fuel. However, the success achieved in the marketing of pure biodiesel in Germany and Austria is uncontended. In these countries, biodiesel is no longer a “no-name product”, the alternative fuel is now generally known to the public.

The marketing of the pure product opens a series of positive arguments to improve the acceptance of this fuel by the consumer, but also by politicians, such as: biodegradability, reduction of exhaust emission, biodiesel is not a hazardous substance etc. Biodiesel is now on sale in Germany at over 1,500 public filling stations and over 100 in Austria (Fig.6). The marketing of biodiesel through the public filling station network will be further extended in the future. For the so-called “free stations”, biodiesel has now become an important supplementary product for survival in the ruinous competition between filling stations. In 2003, over 1700 filling stations and

Development of the biodiesel filling station network in Germany, 1994-2002

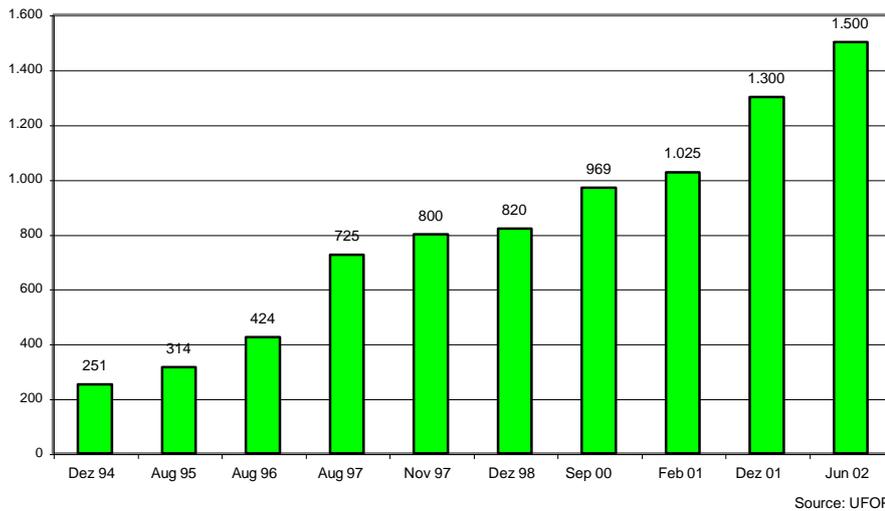


Fig. 6 Development of the biodiesel filling station network in Germany, 1994 - 2002

thereby every 10th public filling station in Germany will supply biodiesel.

According to a study by the “Arbeitsgemeinschaft Qualitätsmanagement Biodiesel e.V.”, (Working Association Qualitymanagement Biodiesel reg. Ass.) around 30 % of the biodiesel is distributed through the public filling station network and 70 % through major customers, or the operators of public transport fleets, taxi companies etc.

In total, approx. 450.000 tonnes of biodiesel will be sold in 2001, a further increase by 100,000 tonnes is anticipated for this year. However, the indicated sales development (Fig.7) shows that the development of the demand is not keeping step with the growth of capacity. Despite the growth of the entrepreneurs marketing biodiesel, particularly at the wholesale level, the surplus demand is leading to a competition which results in a price advantage for vehicle keepers in comparison with diesel fuel.

Biodiesel - Sales in Germany

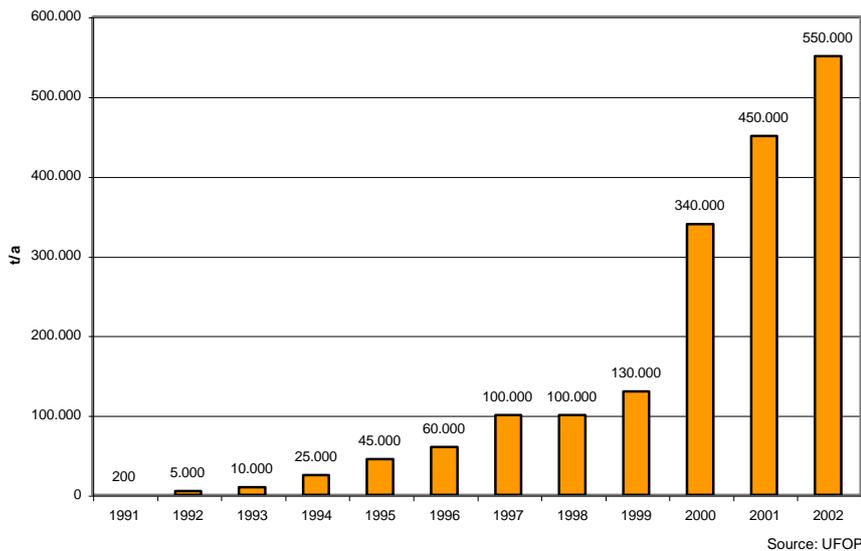


Fig. 7 Biodiesel – Sales in Germany

Due to the described capacity development, it cannot be anticipated that the market will relax. However, these price advantages are only available to vehicle keepers with a vehicle or fleet of vehicles duly approved for biodiesel. The described sales and overall developments would have been impossible without the approvals issued by the leading German automotive manufacturers. An estimated 2.5 – 3 million vehicles approved for biodiesel represent the “potential clientele” for the biodiesel economy. The biodiesel economy therefore is and will be interested in continuing the issue of approvals and co-operating in creating the technical prerequisites for this as far as possible.

It also cannot be disregarded that German biodiesel manufacturers and wholesalers will act as biodiesel exporters, as the internal market rules for unrestricted trading are applicable in the EU. National contingent rulings contradict these rules.

2.4 *Developments outside Europe*

The production and marketing of biodiesel is also advancing, particularly in the USA. The sales of biodiesel in the year 2001 is estimated at around 54,000 tonnes according to the American Soybean Association (ASA). In the USA, biodiesel is supplied in mixtures to improve the lubricating capacity and also as so-called B-20 biodiesel. The proportion of biodiesel in the mixture is 20 %. An agreement on a fuel specification (D 6751) for pure biodiesel (B 100) [3] has been declined. Diesel fuel can be mixed with biodiesel to this standard up to 20 % (B 20).

In the meantime, biodiesel is receiving substantial political support in the USA from the Congress and the Senate in the creation and improvement of the general taxation and administrative conditions. The energy ministry has recognised biodiesel as an alternative fuel for vehicle fleets as specified by the “Energy Policy Act”. This is connected with advantages when procuring vehicles driven by biodiesel.

Biodiesel is also the only alternative fuel recognised by the Environment Protection Agency with regard to the more favourably assessed effects of the exhaust emission on human health in comparison with diesel fuel. The marketing of biodiesel in the USA therefore concentrates particularly on environmentally sensitive sectors such as its employment in large urban areas and also pure biodiesel in shipping.

Beyond this, the State of Minnesota has issued a mandate to mix 2 % of biodiesel to diesel fuel.

2.5 *Raw material supply*

The world consumption of oils and fats rose from 81.8 million t in 1991/92 to 120.6 million t in the year 2001/2002. A comparison of the figures shows that, on one hand, the demand for oils and fats has increased, but on the other hand that the production could follow the increased demand without difficulty (Fig.8,9). Not least due to the surplus situation on the world market for cereals, substantial reserve areas remain for the production of oilseed. The global production of oilseed was approx. 320 million t in 2001/2002. The most important oilseed world-wide is soy, followed by rape (Fig.10). Oilseeds are cultivated world-wide on an area of over 200 million ha, in which the productivity has increased more sharply since the beginning of the nineties than the cultivated area (Fig.11). The development of productivity is even clearer for cereals. The average growth in yield for cereals is approximately 1.3 % per annum. Measured against the cereal production in Germany of approx. 44 million t, a cereal yield growth of 1 % is equivalent to a growth in area of approx. 70,000 ha. The target quantities stipulated in the action plan can be fulfilled without difficulty due to the given potential production (Fig.12). At the current fallow rate of 10 %, over 1 million ha have been put to fallow in Germany and approx. 7 million ha throughout the EU. The potential area for the production of regenerative raw materials is determined by technical progress (increased productivity) and will increase substantially due to the impending extension of the European Union (Fig.13). Understandably, the membership candidates therefore have a very high interest in obtaining new sales channels for these freed areas. This is connected with the simultaneous advantage that these areas, employed in crop rotation, can be employed at any time for food production in dependency on the supply and market circumstances. Measured by the production potential of the total arable area, structural surpluses must be anticipated particularly in cereals regardless of the fallow rate, the cultivation of regenerative raw materials for the production of biodiesel or bioethanol therefore relieves the surplus markets and contributes thereby to stabilising incomes in farming and in rural areas in general.

3 **Conclusions**

The production of biodiesel has taken an upward course in the past years which even experts did not expect. With the anticipated resolution of the directive to promote biological fuels, uniform general conditions will be created throughout the EU for the first time. The member states which have not yet

developed initiatives in this field will also develop such initiatives and begin production. Particularly attentive interest can be seen in the eastern European EU aspiring countries, e.g. Poland and Estonia, as far as capacities do not already exist there. In Australia, work is currently in progress to produce a biodiesel standard on the European pattern; it will be possible to produce approx. 40,000 tonnes of biodiesel by the end of 2003.

However, it was also found in the course of research conducted for this article that co-operation at the international level between the manufacturers of biodiesel must be significantly improved in view of the described developments. This also includes the production of the corresponding fundamental data on the cultivation and exploitation, marketing strategies, capacity development and co-ordination and execution of the necessary (predictive) research. It is also necessary to improve the know-how transfer. In

view of the increasing technical requirements of engines, action is particularly required to improve the co-ordination of the necessary research activities by the biodiesel manufacturers as a prerequisite for their further survival in and access to the market. This also means a general improvement in know-how transfer. It is therefore extremely pleasing that the International Energy Agency (IEA) has initiated a study to determine the current state of developments world-wide by direct inquiry from the biodiesel manufacturers.

The potential raw materials are available world-wide to develop biodiesel not only in Europe, but also in North and South America and in Asia to a notable alternative fuel. Biodiesel will therefore also help to conserve resources and to reduce greenhouse gases – the EU commission has drawn particular attention to this aspect in the justification of its proposals.

Literature:

[1] Directive 92/81 EEC of the Council on 19th October 1992 on the harmonisation of the structure of consumption taxes on mineral oil, Der. L 316 dated 31.10.1992

[2] Memorandum of the Commission to the Council, the European Parliament, the Economic and Social Committee and the Regional Committee on alternative fuels for road transport and a series of measures to promote the employment of biological fuels

Proposal for a directive of the European Parliament and the Council for the Promotion of Biological Fuels

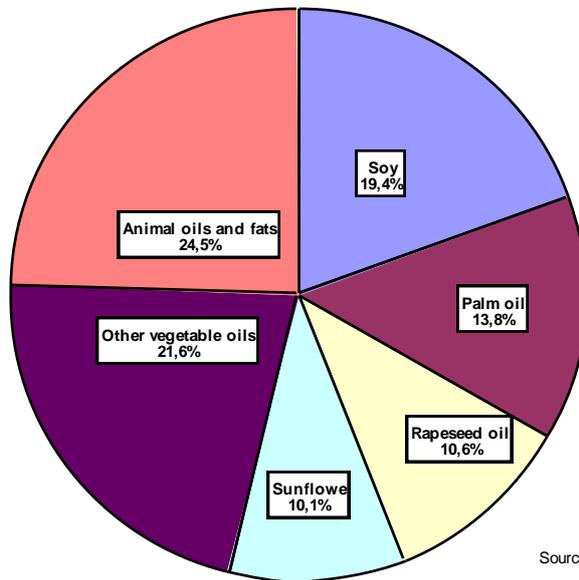
Proposal for a directive of the Council on the amendment of directive 92/81/EEC with regard to the possibility of applying a reduced consumption tax rate to specific mineral oils containing biological fuels, KOM (2001) 547 final, 2001

[3] NEWS National Biodiesel Board, ASTM Issues Biodiesel Fuel Standard [online], USA, to be found at <http://www.biodiesel.org/pdf_files/ASTM_Spec_02.pdf> [quoted on 22.07.2002]

[4] Mark Snyder Electric, Biodiesel: Fuel Fact Sheet. The clean, domestically produced, alternative to petroleum [online], USA to be found at <<http://www.marksniderelectric.com/biodiesel.htm>> [quoted on 22.07.2002]

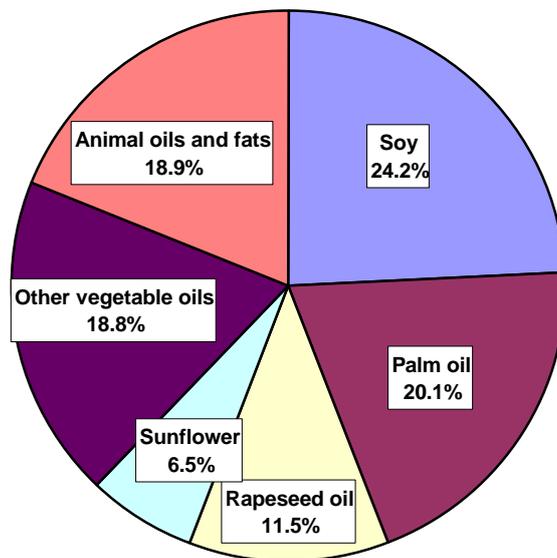
Fig. 8 + 9

World consumption oil/fats 1991/1992 (81,8 Mio t)



Source: Oil World, Hamburg

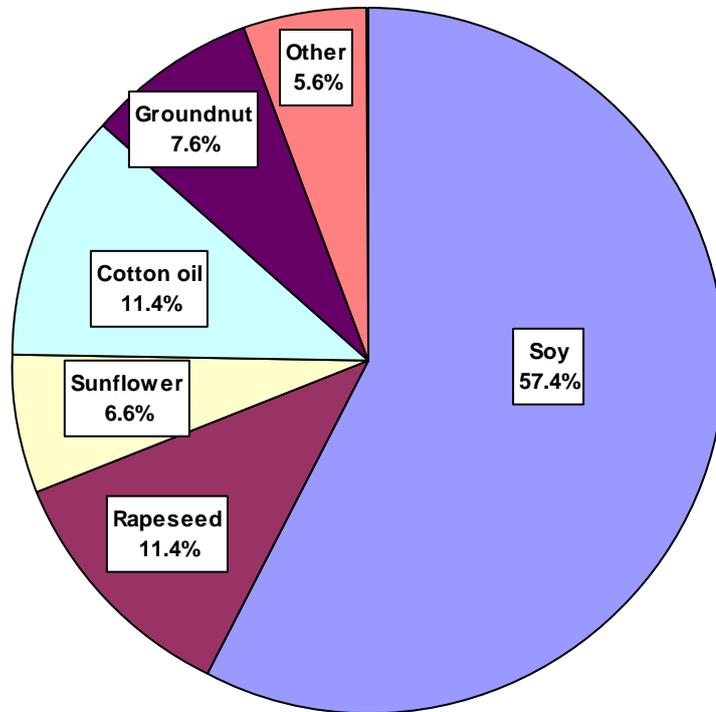
World consumption of oils/fats, 2001/2002 (120.6 million t)



Source: Oil World, Hamburg

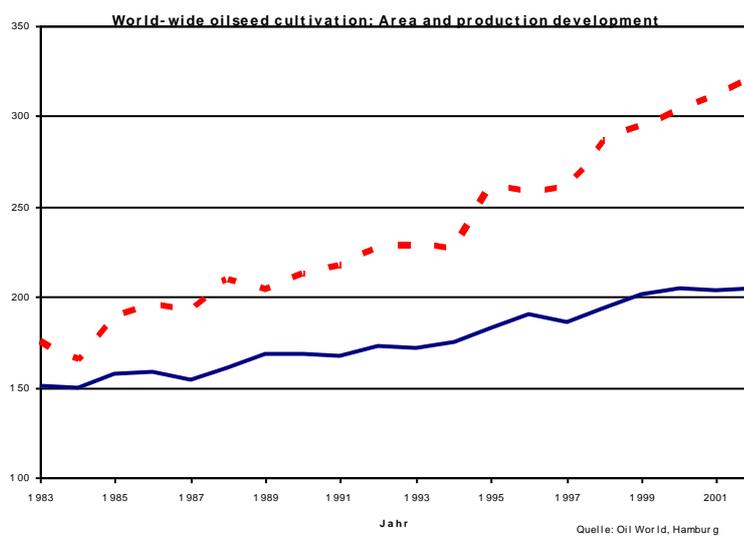
Fig. 10

World production of oilseed, 2001/2002 (320.72 million t)



Source: Oil World, Hamburg

Fig. 11



----- Production (million t)
 _____ Cultivated area (million ha)

Quelle: Oil World, Hamburg

Fig. 12

Action plan for biological fuels of the EU commission

2005 – 2010 Development of the biofuel production in Germany

| Year | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|----------------------------|-------|-------|-------|-------|-------|-------|
| Target quantities | 2% | 2.75% | 3.5% | 4.25% | 5% | 5.75% |
| Petrol fuels | 26.9 | 26.3 | 25.7 | 25.1 | 24.5 | 23.9 |
| Ethanol/ETBE | 0.538 | 0.723 | 0.899 | 1.066 | 1.225 | 1.37 |
| Hectare equivalent | 0.269 | 0.362 | 0.45 | 0.533 | 0.613 | 0.685 |
| Diesel fuel | 31.3 | 31.3 | 31.3 | 31.2 | 31.2 | 31.2 |
| Biodiesel/rape-seed oil | 0.63 | 0.861 | 1.01 | 1.32 | 1.55 | 1.79 |
| Hectare equivalent | 0.45 | 0.615 | 0.721 | 0.943 | 1.11 | 1.30 |
| Sum: | | | | | | |
| Biological fuel production | 1.168 | 1.584 | 1.909 | 2.386 | 2.775 | 3.168 |
| Hectare equivalent | 0.719 | 0.977 | 1.171 | 1.426 | 1.723 | 1.985 |

Average rapeseed oil yield: 1.4 t/ha; bioethanol yield of wheat: 2 t/ha; all figures in million t or ha.

Source: D. Bockey, UFOP; on information from the EU commission, MWV, own estimates

Fig. 13

Regenerative raw materials as an option to the implementation of fallowing

| Fallowing of 10 % of the arable area | | | | | | |
|---|----------------------------|--|-------------------------------------|--|-----------------------|-----------------------------------|
| Specific data on the ration arable area/population | | | | | | |
| In Germany: approx. 1,200,000 ha; in the EU (15): approx. 7,000,000 ha; in the EU (27): approx. 12,000,000 ha | | | | | | |
| | Arable area in 1,000 ha | Arable area/ capita in m ² | Agricultural area in 1,000 ha | Agricultural area/ capita in m ² | Land area 1,000 ha | Population in million citizens |
| D | 11,084 | 1,437 | 17,067 | 2,077 | 34,099 | 82.2 |
| EU (15) | 76,087 | 2,024 | 136,249 | 3,624 | 313,169 | 376.0 |
| EU (27) | 118,707 | 2,464 | 196,644 | 4,082 | 419,350 | 481.7 |
| World | 1,376,437 | 2,294 | 4,926,805 | 8,211 | 13,048,407 | 6000.0 |

Source: Bavarian Ministry of Agriculture and Forestry