Studies in Agricultural Economics No. 106. p. 105-124. (2007)

Hungary's Biofuel Market

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Abstract

In 2005 the Hungarian Exise Tax Act was amended regarding the sale of biofuels. The amendment stipulated that from July 1, 2007 fuels with a 4.4 volume percentage bioethanol content will be sold in Hungary. It equally stipulated that from January 1, 2008 fuels with a 4.4 volume percentage biodiesel content will also be sold. Hungary's stated 2010 biofuel objective is 5.75%, which is calculated in relation to energy content. Blending requirements for this transition are 144 thousand tonnes of bioethanol (or 106 thousand tonnes of ETBE, due to its higher energy content) and 183 thousand tonnes of biodiesel. Hungary's planned biofuel production capacities are approximately 3 million tonnes of bioethanol and 400 thousand tonnes of biodiesel, which seems farfetched both from a raw material and market point of view. Generous long-term estimates predict bioethanol production will utilise 40-50% of Hungary's maize production, (3-4 million tonnes) and 1.2 million tonnes of wheat. And from this would come 1.4-1.7 million tonnes of bioethanol. Hungarian rape and sunflower seed total approximately 850 thousand tonnes, and from this approximately 255 thousand tonnes of biodiesel could be produced. Hungarian domestic demand does not require this much product, and these quantities would entail major exports, especially for bioethanol (1.2-1.5 M tonnes).

Key words

Production, consumption and export of bioethanol and biodiesel, raw material supply and handling of by-products

Introduction

Global energy demand is continually increasing. Pessimistic forecasts state that in the coming decades this demand can only be met by fossil fuels. The 1973 oil crisis made developed countries recongise that fossil fuel reserves are limited, and that crude oil production has peaked, meaning that already excavated and economically extractable energy sources are about to be depleted. Morever, **environmental pollution,** caused by increased use of crude-oil derivatives, poses a significant problem. And of course there is **climate change**.

Beyond environemtnal protection and the replacement of fossil energy resources, utilising biomass has other advantages. These include job creation and preventing rural depopulation, as well as securing energy supply and decreasing political dependence on energy rich countries.

Moreover, utilising agricultural biomass for energy production could help alleviate problems caused by agricultural overproduction. In most developed countries agricultural output exceeds internal consumption, and thus several sectors struggle to market surplus products. By utilising surplus production and mitigating social tensions generated by loss of income and unemployment, agriculture can go beyond producing food for animals and humans, and start to produce energy.

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In developed countries world climate change is a hot topic and it has drawn attention to the use of renewable resources. The European Union has declared that it is ready to unilaterally reduce its carbon dioxide emissions and thus to increase renewable energy use. The new target is for renewable energy to constitute 20% of total energy consumption. Of this 20%, 10% would come from biofuel, and this target is to be reached by 2020. [European Comission, 2007]. The European Council's Action Plan for Energy Policy [March, 2007]. has already established a 20% binding target rate for renewable energy and a minimum mandatory 10% blending rate for biofulels by 2020. However, the target is set for the whole Union, while the Member States are required to increase their utilisation of alternative energy resources at a pace and rate consisent with their capabilities. Within the 20% target rate, the member states have to set their own target according to their country's means and their present utilisation rate for renwable energy sources. On the other hand, the minimal 10% blending rate for biofuels will apply to every member state.

Also growing biofuel production may cause serious problems. There is fierce competition for cereal grains among ethanol production companies, the food industry, and the animal feed and husbandry sector. In the EU and USA increasing ethanol production using today's technology may cause dependence on biofuels or food instead of oil.

The EU and USA apply a significantly high tariff rate for biofuels produced using the most environmentally friendly technology and for their raw materials, meaning Brazilian sugar cane bioethanol and to a lesser degree palm oil from the tropics. Regarding the more expensive biofuels from developed countries, current rhetoric tends to focus on environmental protection and energy security. However, the nature of agriculture policy is becoming increasingly obvious, meaning that biofuel production is aimed at ensuring subsidies for farmers. Agricultural producers strongly resist any reduction of current tariff rates. It will be difficult to cease subsidies for first generation biofuel production if second generation biofuel technology is viable. [Popp, 2007].

This study's primary focus is on Hungary's present situation and future potential. After providing an introduction to the Hungarian biofuel market, the paper surveys the current and future status of processing capacities, plus the domestic and export outlook as well as the legal framework governing Hungarian biofuels. This paper also examines the scope for biofuel production and utilisation in relation to those products potentially suitable as biofuels.

1. Hungary's biofuel market: birth and surrounding conditions

Hungarian Government Decree No. 2233/2004. (IX. 22.) set the 2005 national objective for replacing traditional fuels at 0.4-0.6% of total energy content, while a 2% rate was set for 2010. Later this was modified by Parliamentary Resolution No. 63/2005. (VI. 28.), aiming for 2% in 2007 and 4% in 2010.

Later Government Decree No. 2058/2006. (III. 27.) stipulated that **Hungary must entirely conform to the EU Directive on Biofuels**[2] used in transportation. A large number of

[2] Directive 2003/30/EC of the European Parliament and of the Council, OJ L 123, 17/052003. The Directive on Biofuels set a reference value for the national indicative targets at 2%, calculated on the basis of energy content, of all fuels for transport purposes placed on their markets by 2005, while the market share of biofuels is set at 5.75% for 2010. In 2007 the European Commission recommends a minimum share of 10% for biofuels by 2020 in its schedule regarding renewable energy.

measures have been taken to reach, by 2010, a minimum 5.75% biofuel ratio per total energy fuel content for the Hungarian transportation sector:

- providing tax incentives for trade in biofuels;
- making E85 fuel a national standard;
- potential introduction of used cooking oil in public transport coupled with a tax exemption or with reduced excise tax;
- developing biofuel raw material production and processing capacities to a level exceeding domestic demand so to supply the European market;
- subsidising raw material production and processing within the framework of National Development Plan II;
- creating small biofuel production capacities, while still considering regional development aspects within the framework of regional development projects;
- researching production technology and applications for biofuels' application, providing special support to technical and scientific endeavours creating second-generation organic waste biofuels.

In order to promote the sale of biofuels conforming to the Directive on Taxation of Energy Products[3], on January 1, 2005 Hungary introduced an excise tax exemption in the form of a tax refund on blended **biodiesel** fuels, as well as on **ETBE**[4] fuels produced from bioethanol. Since both types of fuels are blended in mineral oil derivatives, the excise tax exemption only covers the blends' biofuel portion. The excise tax exemption only covers a maximum of 5 volume percentage of the final blend for biodiesel and a maximum of 15 volume percentage for ETBE. The tax on bioethanol can only be reclaimed if it is a ETBE constituent, i.e. it only falls on 47% of the ETBE found in the blend, the equivalent of its biofuel content. The tax exemption refers to any fuel, regardless of national origin.

The tax paid on biofuels can be reclaimed by the entity marketing the fuel-blend. Due to 2005 budget restrictions, the maximum tax refund limit was 2% of the total fuel amount produced or imported by the given entity, which will increase by 0.5% yearly until 2010[5]. The refund amount is HUF 85 per liter for the marketed biodiesel (which amounts to a maximum HUF 4.30 per liter for 5% blends), while it is HUF 103.5 per liter for bioethanol (limited to the ETBE in the blend at a maximum HUF 7.30 per liter).

Before introduction of the new tax laws, **Hungary** did not produce a commercially significant **amount of biofuels**. The measure aimed to create commercial biofuel production capacities and to launch biofuels blended with traditional fuels. As a result, in 2005 Hungary planned to reach a 0.4-0.6% ratio of biofuels to total fuel.

In Hungary during the second half of 2005 ETBE production began. In January 2005 MOL Plc. launched an international tender to purchase 11 thousand tonnes of bioethanol for 2005, 47 thousand for 2006, 67 thousand for 2007 and 75 thousand for 2008. Of the 10 thousand tonnes of bioethanol produced in Hungary during 2005, 4 thousand were used in Hungary while the rest remained in stock or were sold in Austria and Slovakia. For biodiesel the incentive was ineffective as the tax allowance did not ensure biodiesel production competitiveness.

[3] Council Directive 2003/96/EC, OJ L283, 31.10.2003

[4] Bioethanol may be blended into petrol directly or by adding isobutylene, which is a by-product that comes while refining crude oil. This is how ethyl-tertio-butyl-ether (ETBE) is created which, due to its significant bioethanol content, can be considered biofuel. ETBE is used for replacing MTBE (methyl-terctio-butyl-ether), most frequently used in Hungary to increase the octane number (it is produced from isobuthylene, as a reaction with methanol).

[5] Exemption may last for six years dependent on European Commission approval.

During 2005 slightly more than 3 thousand tonnes of bioethanol were blended into fossil fuels in the form of ETBE, while in 2006 approximately 17 thousand tonnes were intended for this purpose.. When calculated on the basis of energy content, this meant **0.07% for 2005**, but ETBE production and blending only started in the second half of the year. When calculated on the basis of energy content, the estimated **2006 r**atio for ethanol use was **0,35%,** which **reflected a petrol ratio of 0.95%** (Table 1).

Table 1

Fossil fuels and biofuels used in Hungary

Name	2005		2006*	
	thousand tonnes	PJ	thousand tonnes	PJ
Motor petrol	1,462	61	1,500	63
Motor diesel	2,475	104	2,550	107
Total	3,937	165	4,050	170
In which 47% of ETBE	3.30	0.12	17.10	0.60
Biofuel ratio, %	0.08	0.07	0.42	0.35
Biofuel ratio to petrol, %	0.23	0.20	1.14	0.95

* based on estimation
Source: Energy Centre Public Interest Co. and MOL Plc. data

Late 2005 Excise Tax Act amendments heralded a change in excise tax exemptions. For **bioethanol** this change comes into effect **on July 1, 2007**, and for **biodiesel on January 1, 2008**. If the fuel-blend biocomponent (as biodiesel, directly blended bioethanol or ETBE) **reaches a 4.4 volume percentage**, the **excise tax duty will decrease**; and, failing that, it will increase. For fuels containing a 4.4 bioethanol volume percentage (through direct blending or as ETBE) the difference will be HUF 8.30 per liter, while for fuels containing biodiesel the difference will come to HUF 8. This regulation means the tax refund is replaced by an **excise tax differentiation**, simlar to the Austrian model, which imposes a "penalty" tax on fuels not containing environmentally friendly components. Tax differentiation does not provide **tax reduction** for the more environmentally friendly fuels: tax exemption for biological origin fuels ceases and therefore the excise tax on almost all types of fuel, including fuels with biocomponents, will grow. The regulation was made so as not to put extra strain on the national budget.

In response to the revamped regulations, in early January 2006 MOL Plc put out a tender for the purchase of **biodiesel-components** (fatty acid – methyl-esther) and vegetable oils (*SVO: Straight Vegetable Oils*). For the period 2008-2012 a purchase contract was concluded for **220 thousand tonnes of biodiesel** and **40 thousand tonnes of vegetable oil. From January 1, 2008 MOL Plc will be selling diesel with 4.4% biocomponents**, but the sale of these products will not be restricted to Hungary, but will also occur in Slovakia, Croatia and Austria. The sales proportion will entail a 30:70% benefit for the Hungarian market.

In order to reach **the 4.4 volume percentage blending rate, in 2008 the Hungarian market's blending requirement will reach 71 thousand tonnes of bioethanol.** 2008 is the first full year that Hungary will use the 4.4. volume percentage biofuel ratio derived from bioethanol. The EU Directive and the Government Decree stipulate a **5.75%** target, which is calculated on the basis of energy content, which is supposed to be achieved by **2010**. If Hungary does manage to reach the year 2010 **5.75%** target, **144 thousand tonnes of bioethanol components** will be blended. **If blending** continues in the form of **ETBE**, the required quantity of bioethanol will have to be modified due to ETBE's different energy content and density. If this happens, in the year **2008 67 thousand tonnes** of bioethanol is projected to be blended in the form of ETBE, while in **2010 it will reach 106 thousand tonnes** (Table 2).

Table 2

Quantity of bioethanol needed to reach the 4.4 volume percentage or the 5.75 percentage blending ratio (based on energy content)

Name	2008			2010		
	thousand tonnes	thousand hl	PJ	thousand tonnes	thousand hl	PJ
Motor petrol	1,560	20,526	65	1,608	21,158	67
Bioethanol	***71***	903	1.9	***144***	1,822	3.9
Bioethanol ratio, %	4.57	**4.4**	2.94	8.95	8.61	**5.75**
Motor petrol	1,560	20,526	65	1,608	21,158	67
47% of ETBE	***67***	903	2.4	***106***	1,426	3.9
Biofuel ratio, %	4.31	**4.4**	3.75	6.6	6.74	**5.75**

Source: calculation made at the Agricultural Policy Department of Agricultural Economics Research Institute (AKI) on the basis of data from Energia Központ Kht. and MOL Plc.

In order to make it possible by 2010 to blend 5.75% bioethanol (based on energy content), the currently effective fuel regulations will have to be amended. This means that a maximum 5 volume percentage bioethanol can be blended into petrol, while using 5.75% bioethanol (based on energy content) as the blending component actually entails a 8.6 volume percentage. According to experts, the **fuel standard modification may happen within 2-3 years**, which makes it possible to use a higher percentage of bioethanol from 2010 on. However, the EU's longe-range plans require even higher blending rates, and to reach them Hungarian cars will have to undergo a major transformation. MOL Plc. is busy developing its ETBE production blending component. For this reason Mol has transformed its Százhalombatta operation plus its Bratislava MTBE production facility. Mol has also established an ETBE production capacity in Tiszaújváros where the total output is about 160-170 thousand tonnes. Since this quantity in itself is not enough to meet the EU reference value, **joint blending of bioethanol and ETBE components is the most probable outcome.**.

Current fuel standards prohibit a higher biocomponent ratio mainly because car manufacturers are reluctant to provide guarantees. In order to eliminate this problem, special spare parts and new engine types are needed, which in turn will increase manufacturing costs and make such cars more expensive. However, in Hungary real incomes are expected to stagnate so new, more expensive cars are unlikely to suddenly become popular and modernizing older cars.is improbable Without the cooperation and acceptance of car manufacturers and consumer groups, it is not possible to change automobile standards. . Even if the various interest groups did accept such measures, changing the standards would require about three years. Thus, one **cannot expect Hungarian domestic demand for ethanol to suddenly shoot up**.

For biodiesel , a blending rate of **4.4 volume percentage** means using **124 thousand tonnes** of biodiesel for fuels, but the stated **2010** target would require **183 thousand tonnes of biodiesel** for blending (Table 3). Although biodiesel and traditional diesel's energy content differs less than that of petrol and bioethanol, the 5.75% blending ratio to energy content means blending a 6.21 volume percentage of biodiesel. Therefore one also has to change the fuel standard for biodiesel, but experts say this is less problematic than for bioethanol.

Table 3

Quantity of bioethanol needed to reach the 4.4 volume percentage or 5.75 percent blending rate (based on energy content)

Name	2008			2010		
	thousand tonnes	thousand hl	PJ	thousand tonnes	thousand hl	PJ
Motor diesel	2,681	31,917	113	2,816	33,524	118
Biodiesel	***124***	1,404	4.6	***183***	2,083	6.8
Biodiesel ratio, %	4.61	**4.4**	4.07	6.51	6.21	**5.75**

Source: calculation made at the Agricultural Policy Department of the Agricultural Economics Research Institute (AKI) on the basis of data from Energy Centre Public Interest Co. and MOL Plc.

2. Existing and planned processing capacities

2.1. Bioethanol

Hungary's current **bioethanol-production capacity** is approximately 80 thousand tonnes, and is located in **Szabadegyháza** and **Győr**. These facilities mainly serve the food and drink industry, plus the pharmaceutical and chemical industries. Recently both plants made significant capital investments, especially Hungrana in Szabadegyháza where a major technological improvement and capacity enlargement project is being carried out to go from dry processing technology to wet. From 2008 the plant will annually be able to process 1 million tonnes of maize. There 40-45% of the raw material will become bioethanol, while 55-60% will become isoglucose, the company's main product. This is because preliminary calculations indicate that the capital investments will only achieve a return with the previous production percentages. Owing to capacity enlargement, the Hungarian market's **2007-2010 bioethanol demand could be safely satisfied by the existing two producers.**

Despite this, up until autumn 2006 various investor groups were announcing the establishment of plants in more than 20 locations, capable of processing about 7.8 million tonnes of maize and 1 million tonnes of wheat.

The planned and announced investments are associated with four large investor groups. Swedish **SEKAB**, majority owner of SEKAB Bioenergy Hungary Zrt., wishes to invest EUR 380 million in Hungary to build **four bioethanol plants**. The four planned locations are **Mohács, Marcali, Gönyű and Kaba**. The investment process is expected to start in spring or summer of 2007, depending on how fast the company can obtain authorisation after which production will start in late 2008 or in early 2009. The planned four plants are expected to process about 1.5 million tonnes of maize per year, as well as approximately 600 thousand tonnes of biomass and 60 thousand tonnes of organic waste. Consequently the planned plants will produce 124-125 gigawatthours of electric energy and about 500 thousand tonnes of bioethanol. They will also produce 460 thousand tonnes of DDGS, 423 thousand tonnes of liquid carbon dioxyde and 3 thousand tonnes of active carbon.

So far the largest bioethanol project in Hungary has been announced by Swiss ***United BioFuels*** **Holding**. In its 6 plants the company would process 2 million tonnes of maize. **The planned locations are: Martfű, Mohács, Csurgó, Orosháza, Szeghalom and Almásfüzítő.**

The third largest investor, the American **CSLM Holding,** wishes to establish a bio-ethanol plant in **Hajdúsámson**, and aims to process 1 million tonnes of wheat per year.

The Hungarian-owned **Hungarian Bioenergetic (Mabio) Zrt.** hopes to transform 1.75 million tonnes of maize to bioethanol in five different locations. Three processing plants are projected for **Bácsalmás**, **Csabacsűd** and **Dunaalmás**, while sites for the other two plants have yet to be selected.

Two additional investors (Rodeport Kft., BIO-MA Zrt.) have more modest and less developed plans related to three locations: Fadd, Sarkad, Mezőhegyes.

Beyond the large investment projects that fall within the framework of the New Hungary Regional Development Programme (Új Magyarország Vidékfejlesztési Program) in 2007-2008 the Ministry of Agriculture and Rural Development is planning to back 40 producer-owned bioethanol plants to the tune of HUF 200 million per plant, each with a grain processing capacity of 15 thousand tonnes.

In October 2006 because of lower EU sugar prices, *Eastern Sugar* announced that it would close down its factories in the Czech Republic, Slovakia and Hungary . In ***Eastern Sugar's*** **Kaba location** a bioethanol plant suitable for processing 300 thousand tonnes of maize annually will be built. The new plant's investment costs will be financed with EU subsidies provided to the producers to compensate for losses due to the sugar plant's closure.

The new capacities are mostly scheduled to be started in 2008-2009, but their completion will depend on whether they get EU subsidies from 2007 on. Given the limitations of the Hungarian market, the planned bioethanol plants are mainly geared toward European export demand for biofuels. According to the our calculations, if **all the planned investments occurred, Hungarian grain processing's total volume would exceed 9 million tonnes. And from this 3 million bioethanol tonnes could be produced.**

As we will see later, the demand for grain exceeds the amount that can be safely produced from domestic production. However sufficient current stocks are, in the medium run a raw material shortage may occur, especially if weather conditions become poor which could in turn cause a need for grain imports! This would cause prices to shoot up, which would not only endanger Hungarian bioethanol production profitability as higher **feed prices** would also harm Hungarian animal husbandry. Another problem is finding a market for the finished and by-products. In the above mentioned plants the quantity of bioethanol projected to be produced surpasses expected domestic demand several times over. Therefore **we think that the announced capacities are excessive. Even if one is totally optimistic, it still remains that feasibility and profitability for bioethanol producition are limited to 3-4 million tonnes of maize and 0.8-1.2 million tonnes of wheat.**

2.2. Biodiesel

Hungary lacks an operating biodiesel plant. However, there is now a a half-completed one, and by the autumn of 2006 amendments to excise tax regulations had sparked development in Hungarian biodiesel projects. In fact, 14 plants had reached either the planning or construction phase.

In Hungary there are **two biodiesel plants currently under construction One of them is the Kunhegyes plant [Bánhalma] which is owned by Közép-Tisza MG Rt. The other is the Intertram Kft. Mátészalka plant. Toghether they have a 10 thousand tonne capacity**. In November 2005 the Kunhegyes plant started test production, and the biodiesel produced is currently transported abroad. However, they took part in MOL Plc's tender for biodiesel suppliers. The Mátészalka investment began at the turn of the century, and in August 2006 began test production by processing sunflower seed.

Right now the most important plant under construction has **a capacity of 150 thousand biodiesel tonnes. It is being constructed at MOL's Komáron site**, and produces diesel from rape seed, sunflower seed, used cooking oil and – in case of a raw material shortage – animal fat. For security of supply reasons MOL Plc. has decided to work with *Rossi Beteiligungs GmbH* and establishe a plant equipped with efficient technology capable of producing biocomponents of uniform quality. The company will supply MOL with 120 thousand tonnes of biodiesel per year for five years, while selling 30 thousand tonnes abroad.

Tempora Bioenergia Zrt., with a production rate of 100 thousand tonnes of biodiesel, will also produce for export. The company intends to locate plants in **Günyű and Polgár**. One third of the processed raw material will come from Hungarian sources, the rest from abroad. Biodiesel production by-products (sleet, glycerine) will be used in the company's biogas plant.

Though not presently operational**,** two biodiesel plants have been located in **Baja** and **Gyöngyös** with a total capacity of 30-40 thousand tonnes, while in four other locations (**Bábolna, Tab, Szerencs, Pacsa**) other biodiesel plants with a total capacity of 50 thousand tonnes have been established, though they are presently not operating.

The total biodiesel production capacity **of plants under planning is a little over 400 thousand tonnes**, which would require processing approximately 1.3 million tonnes of oil seeds. **But even if all the rape and sunflower seed beyond that necessary for domestic consuption were processed for biofuel, the amount of raw material would not be sufficient. In addition, the planned capacities exceed Hungary's expected 2010 biodiesel demand by 120%.**

3. Issues regarding the establishment of processing plants, supplier relations and by-products

For biofuel processing plant long-term profitability, several factors should be considered before capital investment. The most important factors are **suitable markets (for both the end-product and the by-products) and securing raw materials for continous operation**.

From the biofuel producers currently operating in Hungary, we opted to scrutinize Hungrana and how it purchases raw material. The plant currently purchases 500 thousand tonnes of maize per year. **The suppliers are located within a radius of 100 km, the average distance being approximately 50 km.**

Although vendor relations are long-term, contracts are renewed annually, which is explained by purchase price insecurity. The main problem is the absence of a reference price related to the purchase, and therefore the parties cannot conclude longer contracts. Thus securing raw material for continuous plant operation requires a serious organisational effort and a lot of man hours. The fact that most of the suppliers are wholesalers makes the job somewhat easier. This is because only wholesalers have long-term storage and drying facilities. Also dealing with wholesalers limits the number of operators the company needs to interact with.

The arrival of large volume bioethanol production will make securing raw material supply vitally important. If all the planned capacities swing into operation, theoretically Hungary may come to need grain imports, and this will be especially true in years of poor weather and poor crop yields.

For both types of biofuel absence of long-term contractcs coupled with competition for raw materials may boost the prices, which may in turn accelerate biofuel production costs. If fewer capacities are established, the raw material producers might then suffer, and this would be particularly true for grain producers if the grounds for state intervention narrow or if state intervention disappears altogether. It is therefore apparent that both parties would benefit from long-term contracts with fixed prices, or at least prices tied to a reference price.

If subsidies for energy crop production were associated with a long-term contract with a bioethanol producing plant, vendor relations would be more stable and long-term contractual relations made easier. On the other hand, tenders directed at investors could also require long-term contracts with the suppliers, which would also help avoid the danger of plants' relying on the same source of raw materials.

A vital part of investing in biofuel production plants is selecting a suitable location.. It therefore makes sense to locate bioethanol and biodiesel plants near the raw material producer and the end-product consumer since long distance deliveries (in both cases) may significantly reduce profitability. When transporting the end-product and marketing the by-products, potential transport methods should be examined, be they river, rail, or road. In Hungary river transport remains cheapest and thus it is best to locate bioethanol and biodiesel plants near the Danube.

The question of **managing by-products** is also very important. Biodiesel production by-products (rape seed and sunflower meal) are not suitable for animal feed, and thus there is limited potential for using them (combustion, biogas production). If an investor is not well-informed and clever regarding by-product utilisation, then by-product disposal can entail further costs.

Bioethanol production by-products can be used as animal feed, therefore close proximity to animal husbandry facilities offers a distinct advantage. This is even more valid for dry grind technology, where a large volume of by-products means expensive transport costs. It is no coincidence that most of the currently planned investments are located along the Danube in the principal grain growing and animal breeding regions.

Most of WDGS (wet distillers grains with solubles) or DDGS (distillers dried grains with solubles) which are created during dry grind bioethanol production can be utilised as animal feed. For every **100 kg of maize used in bioethanol production, 30-32 kg of ethanol is created, as well as 30 kg of carbon dioxide and 29 kg of DDGS** [Butzen et al, 2003]. DDGS is an effective, easily digestable form of animal feed. It is rich in protein and energy, and also contains vitamins and minerals. It is a good food source for beef and milk cows, but can also be fed to poultry and swine.

When it comes to food for animals and humans, bioethanol by-products produced during wet milling are even more valuable and marketable than DDGS. In WDGS for every **100 kg of maize, one can produce 29 kg of ethanol, 20 kg of gluten, 5kg of corn husk and 3 kg of corn steep** [Butzen – Hobbs, 2002]. By using extrusion from corn steep one can create corn steep oil, a valuable vegetable oil with a high vitamin content. Gluten constitutes a high protein basis for animal feed, but corn husk is also highly marketable (especially for companies producing animal feed for pets).

So far animal feed producers in Hungary have primarily used DDGS for feeding milk cows. In cow feed mix and concentrates DDGS can constitute up to 20% of the conent. **DDGS’s** raw protein and fat content is relatively high, but **can also be used to partially replace fat and protein** carriers while increasing the cows’ feed intake. This is because of DDGS’s favourable price/value ratio. Chicken and swine feed can contain up to 10% DDGS.

Gluten offers slightly more opportunities for utilisation. To a limited extent it **can partially replace expensive imported soybean.** However, Gluten has a lower protein content and lacks certain essential amino acids, and therefore corn glutein may only replace 10-15% of the soybean used.

In 2005 the Hungarian animal feed industry purchased DDGS for HUF 22 per kg Today animal breeders and animal feed producers still require DDGS and are willing to pay a slightly higher price. In fact, in 2006 in the town of Szabadegyháza, the Hungarana Maize Startch and Isoglucose Manufacturing and Trading Ltd. (Hungrana Keményítő és Izocukorgyártó és Forgalmazó Kft.) transformed its operation to apply wet milling technology. Nonetheless, currently in Hungary there is no domestic DDGS available for purchase.Wet milling process by-products (corn steep and gluten) can be sold at a much higher price than DDGS. In 2005 gluten was sold by Hungrana at HUF 140 per kg, corn steep at HUF 52 Ft per kg, and corn husk at HUF 20 per kg.

On the basis of foreign trade statistics it is difficult to estimate the quantity and value of Hungarian DDGS and gluten imports. According to HS codes, the two products cannot be separated, as both are imported under the code HS 2303101100 (starch waste from maize with a minimum of 40% protein content). Statistics indicate that the imports of this product group increased from 1.1 thousand tonnes per year in 2000 to 20 thousand tonnes per year in 2004, the import price fluctuating between HUF 109 and HUF 117 per kg. Based on this, current usage is still negligible.

If one views data available on Hungarian animal feed usage and considers the distribution of DDGS usage in the US animal breeding sectors, **in the medium-run DDGS usage in Hungary will likely reach 300-350 thousand tonnes. These figures are based on our own projections for livestock numbers and projections by current animal feeding systems**. We estimate the quantity of DDGS used by the individual sectors as follows:

- milk processing: 87 thousand tonnes;
- cattle : 87 thousand tonnes;
- pork : 56 thousand tonnes;
- poultry: 105 thousand tonnes.

If one calculates current soybean usage in Hungary, which is about 700 thousand tonnes annually, Hungarian usage of gluten may fall between between 70 and 100 thousand tonnes. However, one has to recall that DDGS and gluten may partly replace each other. The actual usage proportion will probably depend on how much is produced and their price. Currently it is not known what percentage of the planned investments will be using wet milling or dry grind production.

If one takes DDGS and gluten usage as a starting point, the Hungarian market may be able to absorb approximately 1-1.15 million tonnes of maize processing by-products, meaning the rest will have to be exported. Delivery costs dictate that primarily EU Member States will be the target markets [Potori et al, 2006].

On Table 4, one sees that during the past five years the EU imported only 700-800 thousand tonnes of DDGS annually and this was mainly from the USA.. In terms of planned capacities this equals less than expected Hungarian production. The low import volume is because DDGS is difficult and expensive to transport, and thus bioethanol producers seek nearby markets.

Regarding import potential, the gluten situation is more promising but it is noteworthy that imports dropped to half between 2000 and 2005! This drop, however, wasn't because of a decline in in EU demand, but to increased domestic use in the USA, which is the principal exporter. This fact was also confirmed by soaring prices linked to a decrease in supply. In 2006 there was also the B10 GM maize scandal which caused a steep decline in imports from the US. B10 GM maize was prohibited within the EU and this further constrained gluten supply.

The above data indicate that out of all the by-products coming from Hungarian bioethanol production gluten has strong external market outlook, but demand is still limited. Likely there will be a surplus amount of these by-products, which could be used for energy production (combustion, gasification).

Table 4

EU import of protein animal feed and by-products of bioethanol production, 2000-2005

Thousand tonnes	2000	2001	2002	2003	2004	2005
Corn gluten	4,863	4,183	4,140	3,570	3,301	2,548
DDGS	723	690	825	773	670	722
Soybeen	27,820	29,244	29,479	30,818	30,666	31,467
Total protein animal feed	**36,960**	**37,443**	**36,593**	**37,606**	**38,368**	**36,281**

Forrás: Toepfer International [2006]

4. Foreign market prospects for biofuels produced in Hungary

In the previous sections we stated that if planned biofuel production capacities actually do start operation in Hungary, in 2009-2010 bioethanol and biodiesel production will significantly exceed Hungarian demand, meaning a huge volume of excess products will have to be placed on foreign markets. **Due to factors linked to transportation, the potential export market should be the EU Member States**. The EU Directive on Biofuels has set a 5.75% reference value. If this 5.75% reference value is to be achieved, then given the expected 2010 petrol and gas consumption structure, **12.6 million tonnes of bioethanol and 11.5 million tonnes of biodiesel will have to be used in the EU-25**. Compared to the 2005 production level (721 thousand tonnes of bioethanol and 3,184 thousand tonnes of biodiesel), this will mean a market expansion of 11.9 million tonnes for bioethanol and 8.3 million tonnes tonnes for biodiesel. **In 2010 the quantity of Hungarian bioethanol available for export (1.2-1.5 million tonnes) will constitute about 10-13% of the expected additional European , while for biodiesel (70 thousand tonnes) this will be less than 1%.**

In 2005 the EU issued a Directive on Biofuels, stipulating a 2% reference value. This directive was also complemented by targets set by individual member sates. However, according to 2006 reports on the EU-25, neither the year 2005 2% reference value nor the stated 2005 national targets were ever met. On the contrary, in most of the Member States the biofuel usage rate didn't come close to target values. Estimates show that in 2005 EU-25 biofuel usage was only 1% of total fuel consumption. Serious tax incentives or the obligatory application of the stipulated target values will be needed to meet the 2010 target in the EU-25 Member States. Unofficial information suggests that the Commission will recommend obligatory blending.

If mandatory biofuel blending to total fuel stock was required **at a 5.75% level** (starting from the current fuel consumption and biofuel production figures), **this would result in a significant shortage in each Member State.** Therefore the Member States could try to meet EU requirements in the following ways:

- competitive production of biofuels;
- tax allowances or subsidies (although in this case the former would no comply with the Directive on the Taxation of Energy Products);
- usage of import biofuels.

Given the scarcity of agricultural land, unfavourable climate and soil conditions for raw material production, and high intervention prices for grain, the EU Member States have few options for competitive biofuel production. Between 2010 and 2020 the advent of second generation biofuels is expected to bring about much more efficient biofuel production in Europe.

France has a EU high grain self-sufficiency rate iof more than 200%, which is mainly due to its barley and maize production. Hungary is the only other Member State with a similarly high maize and wheat ratio, which places it in a good position. In Germany rye and wheat production exceeds the internal usage volume by approximately 20-40%. Surprisingly, Spain's self-sufficiency rate is only 70%, but in 2005 the country was still was the largest bioethanol producer and user in Europe. This was due to importing raw material such as wheat for animal feed and barley. In some Member States grain production falls well short of meeting current demand. The self-sufficiency ratio of Belgium, Holland and Portugal falls between 25-50%. In Estonia, Greece, Italy and Ireland the ratio does not exceed 80%. Belgium, France, Germany and Poland have stong and competitive sugar production.

The most suitable land for growing **rape seed is** in Germany, France, the United Kingdom, Poland, Hungary, Lithuania and Denmark**.** Germany, France, Italy and the Czech Republic use a significant amount of rape seed for fuel production. Even today Germany and Italy have to rely on imported rape seed, which limits opportunities for further expansion. Due to tax allowances for biofuels Germany[6] and some other countries are biodiesel importers, and are thus able to absorb other countries' production such as the Czech Republic's and Austria's.

The best places for **growing sunflowers** are France, Hungary, Spain, Slovakia and the newly joined Romania. In the other countries there is only a limited area for production or production simply isn't possible.

If the EU Directive on Biofuels becomes mandatory, bioethanol and biodiesel production will ignite increasing competition for both raw material and end-products. This would prove lucrative for Hungary regarding the sale of biofuels, but for Hungarian producers (and for other European producer countries) several questions remain :

- it is not known how the world market price for oil will change;
- it is not known what technological and self-sufficiency level non-EU countries will attain;
- it is not known how large consumers outside Europe (e.g. USA, Brazil, China) will influence demand;
- Even though wheat and other grains currently provide cheaper animal feed than wheat, Hungary enjoys a huge competitive advantage due to its low-cost maize production. However, world trade liberalisation means other Member States will be able to obtain cheap raw material from South America and from other developing countries. It is difficult to forecast how this will effect EU bioethanol production;
- after securing the biodiesel standard, it will be possible to blend biodiesel produced from imported vegetable oils. These imported vegetable oils will be primarily soybean and palm oils, and blending them will be possible at a higher ratio into biodiesel produced from rape seed;

[6] As of 1 August 2006 the tax exemption of biofuels was cancelled in Germany and from 2007 on a certain percentage of all fuels will have to be biofuel (4.4% biodiesel, 2% bioethanol).

- as for bioethanol, in Europe one will have to be ready for competition from Brazil, the USA and developing countries, especially after WTO negotiations end and if a bilateral agreement with MERCOSUR states is reached.

It is difficult to forecast which Member States will have more intensive biofuel production and which will import from third countries or other Member States. This certainly depends on their own raw material supply (although the Spanish example seems to refute this!), but subsidies, taxation policies and the entire economic environment may also have a large influence.

The media mainly mention Germany and Sweden as potential external markets forHungarian bioethanol. This assumption is well-founded, because presently there are only three EU countries where bioethanol usage exceeds internal production: Sweden, Germany and Great Britain. The latter doesn't constitute a target market for Hungary, because it is too faraway and its Atlantic ports provide easy access for cheap overseas imports.

Sweden and Germany are much more realistic alternatives. Both Member States are leading biofuel consumers and their stated national targets are much more ambitious than the EU average. Sweden already has a high green energy usage rate as biomass energy entails 17% of total energy consumption. In Sweden biomass energy is a major source for heating and the country would also like to blend bioethanol produced from wood (cellulose) into petrol.

With a biofuel consumption rate of 90% Sweden is the largest regional biofuel consumer. In Sweden various automobile types were launched with flex engines (Volvo, Saab, Ford), but blending stimulated by tax incentives has also created a large bioethanol market. Starting in 2005 the Swedish government set a 3% blending rate target and Sweden (jointly with Spain) initiated the fuel standard modification at the European Commission, increasing the 5% bioethanol ratio to 10%.

Thanks to generous incentives, in recent years Swedish bioethanol consumption has shot up and analysts expectfuture growth. This projection is based on a considerable increase in car sales with flex engines (in 2006 15% of cars sold in Sweden had flex engines).

At the moment approximately 80% of Swedish ethanol consumption is served by Brazilian imports. Importing Brazilian ethanol was facilitated by the decision not to apply an ethanol specific tariff, but rather a tariff for "other chemical materials" of only EUR 2.5 per hl. However, this has been somewhat offset because as of **January 1, 2006 there hasn't been an excise tax differentiation for bioethanol imported with the favourable tariff.** This should lead to a price increase, because presently Brazil offers the cheapest source for ethanol.

Continued dependence on imports is expected, particularly in the short run. This is because to meet projected 2010 consumption levels internal production would have to grow twelvefold, but in the coming 10-15 years this appears unlikely. In Sweden bioethanol is presently made from wheat, barley, and rye, but research is being conducted on making bioethanol from wood, and second generation bioethanol production may provide a breakthough in this field. Consequently, **Swedes are taking interest in EU produced bioethanol, and this interest includes Hungary.**

A vibrant and growing demand promises future market opportunities. However, Brazilian bioethanol's strong share of the Swedish market is worrisome because it exists despite a tariff, albeit a reduced one. If tariffs are further reduced, this may well lead to a greater influx of Brazilian bioethanol. However, it is uncertain when and by how much tarriffs will be reduced so Sweden may long remain a market for Hungarian bioethanol. Moreover, Swedish investors are showing interest in investing in Hungarian bioethanol production. A drawback is that high transport costs from Hungary mean that only cheap bioethanol can be competitive on the Swedish market.

Sweden consumes more bioethanol than biodiesel, although the 2% blending ratio also encourages biodiesel use. Presently about half of Swedish demand is met by biodiesel from Swedish rape seed, and the remainder met by EU imports, mostly from Germany and Denmark.

On the other hand, German biodiesel consumption and production is highly developed. In 2004 German biodiesel production had already reached 1.04 million tonnes, while 2005 production is estimated at approximately 1.67 million tonnes. As a result, the area devoted to rape seed almost doubled between 1990 and 2005. In Germany in 1990 an area of 722 thousand hectares was devoted to colza while in 2005 this attained 1.3 million hectares.

In recent years consumption has also shot up with biodiesel consumption reaching almost 1.8 million tonnes in 2005.

Bioethanol production lags far behind that of biodiesel. In 2005 approximately 200 thousand tonnes were produced and for 2006 500 thousand tonnes are projected. However, Germany still relies on imports.

Biodiesel production is limited in scope as oil seed growing areas are not that extensive. In Europe **blending rate targets can only be reached by far greater bioethanol consumption**. And this also holds true for Germany because for 2007-2009 the stated German national blending rate target **is 4.4% for biodiesel and 2% for bioethanol, but by 2010 this will rise to 3%.** In Germany there is less raw material for bioethanol production, and therefore the country's expected bioethanol demand exceeds its domestic production. Germany is a lot closer to Hungary than Great Britain so **Germany may comprise a potential market for Hungarian bioethanol producers**.

In Hungary there will be excess biodiesel. In the short run it will be harder to find a significant biodiesel market, especially considering that the main biodiesel consumers are also producers. However, over time the rising blending rate means that Hungary will be able to sell the excess quantity to its neighbours.

5. Hungarian raw material production

The future for Hungarian sunflower seed and rape seed is bright. The two crops are already attracting keen interest and the entire quantity is used either internally or abroad. Therefore, due to a national shortage of these grains, biodiesel production will not be a major factor in Hungary. Otherwise, Hungarian biodiesel production will have to be partially built on imported raw material. However, Hungary's neighbours also suffer from a shortage of oil plants.

Biofuel production provides an alternative use for **surplus crop production.** In the short and medium term using crops for human consumption or animal feed is not predicted to increase. This is because only modest growth is expected in consumption by humans and livestock numbers are likely to stagnate. Moreover, high transport costs and scarce transport links make it difficult to expedite crop surpluses abroad. Also bolstering the use of crops for energy sources is the argument that it renders unnecessary. the payment of intervention prices and storage subsidies as well as selling intervention volumes and paying export subsidies [Potori – Udovecz, 2006].

5.1. Grains

Maize and wheat constitute the principal raw material required for bioethanol production. **During good weather years 11-12 million tonnes** of the two crops are harvested. If one then assumes food and animal consumption to be **6.6-7.3 million** tonnes, then there remains an annual surplus of **3.7-5.4 million tonnes.**

Wheat is grown on 24-26% of the country's ploughland and is Hungary's major crop. However, dry weather greatly impacts on the extent of the harvest. For example, at less than **3 million tonnes,** 2003 represented the lowest wheat yield within the 2000-2006 period. However, in 2004 more than **6 million tonnes** were harvested. Apart from erratic yields, sales opportunities are curtailed because crop ares are highly dispersed which means too many different types of wheat are grown.

In recent years wheat for human consumption or animal feed amounted to approximately **2.6-2.8 million tonnes, and i**n future years these consmption numbers are not forecasted to radically change. After exports, in average years there is an annual surplus of about 800 thousand tonnes. However, anticipated growth in bioethanol production may boost demand for wheat and thus some of the wheat currently exported could be used in bioethanol production. We estimate this quantity at a maximum of 400 thousand tonnes, because it is improbable that good quality high protein edible wheat will be used for biofuel production. An annual average maximum of **1.2 million tonnes of wheat** should be available for bioethanol production. This equals the biodiesel industry's requirements, because some of the plants intend to utilise only 10% wheat as an emergency reserve in case of a maize shortage.

The planned facilities would primarily rely on maize. Similar to wheat and other crops, getting alcohol from maize is determined by its sugar and starch content. Although making bioethanol from maize is less efficient than from sugar beet, maize is still more suitable than wheat. According to the pertinent literature, one needs **3.14 tonnes of wheat** to produce one tonne of bioethanol, while with maize **one needs only 2.72 tonnes.** Maize also offers a higher per hectare yield and thus provides **one and a half times more** bioethanol from the same area.

In Hungary maize is grown on 24-26% of the ploughland. However, the yield for maize is volatile, which makes it similar to wheat. One reason for this is that the maize plant mainly needs moisture in May, July and August, months where drought is often a problem. In the past five years an average of **7.2 million tonnes of maize was harvested.** During the observed period the yield was lowest in the drought year 2003 and highest in 2005.

In recent years maize for industrial purposes and for animal feed was between **4-4.5 million tonnes**. In 2002 exports were over 2.1 million tonnes, but the average volume was 1.5 million tonnes. If one assumes that the exported maize also went for ethanol production, and takes into account the remaining 1.5 million tonnes, then an annual average of 3 million tonnes of maize is available.

If one assumes growth in average yield, stagnation in livestock numbers, and bioethanol by-products used as animal feed, a positive scenario is that up to **40-50%** of domestic maize production (3-4 million tonnes) could be used for bioethanol production. This entails potential bioethanol production of **1.2-1.4 million tonnes. Most of this amount would have to be sold in the EU.** To meet the 5.75% blending rate to total energy content, **144 thousand tonnes** of bioethanol would be needed, and this could come from a maize yield of **55-70 thousand hectares**. It is noteworthy that in the medium term a demand for bioethanol is not anticipated in the Hungarian market because **MOL Plc**. **only wishes to purchase the quantity needed to meet the tax friendly blending rate.**

Wheat and maize stocks that are available as raw material equal a maximum 4.2-5.2 million tonnes and from that 1.4-1.7 million tonnes of bioethanol can be produced. This comes to only about half of the annuounced planned processing capacities. In fact, approximately 1.3-1.6 million tonnes less.

5.2. Oil plants

In Hungary oil plants follow grain as the second major group of cultivated plants. Among Hungarian oil plants rape and sunflower seed stand out when it comes to biodiesel production. In 2005 663 thousand hectares were devoted to rape and sunflower crops.

Sunflowers are grown on 10-12% of Hungary's arable land. In 2005 1.1 million tonnes of sunflower seed were harvested, 7% less than the 2004 record volume,which amounted for a third of the EU-25's production. **Over the past seven years the average yield was 0.9 million tonnes.** The Hungarian per hectare yield is generally higher than that of the EU-15 average, but lower than in France. The Hungarian per hectare yield for 2004 was 2.47 tonnes, in 2005 2.17, and in 2006 2.23.

Thanks to its high oil content Hungarian sunflower seed is popular, and when favourable weather conditions prevail it is harvested earlier than in neighbouring countries. Approximately 70% of the sunflower harvest is processed by the Hungarian vegetable oil industry, and the remaining 30% is exported. Hungary's total sunflower seed yield is one million tonnes. It is estimated that from the total yield **50 thousand tonnes could, in the medium term, be used for fuel** production, but this excludes exports. However, if fuel production were to replace export, annually **400 thousand tonnes of sunflower seed would be available**.

In Hungary rape seed is the second most oil plant grown, but so far the area consecreated to rape seed has only amounted to 2-3% of plouged land. In pre-EU accession Hungary the average rape seed yield fluctuated between 1-1.9 t/ha. This fluctuation was partially caused by adverse weather, meaning frequent frost damage, or drought. Another reason for the fluctuation was the limited use of fertilisers and pesticides. During the past three years the average yield has exceeded 2 t/ha and in 2004 it was 2.78 t/ha, but this still falls short of the EU-25 average of 3.4 t/ha. In 2006, thanks to good weather and an enlarged sowing area, **329 thousand tonnes of rape seed were produced**, which exceeded the 2004 record yield by 13%.

There are multiple ways of using rape seed and its cultivation offers numerous advantages. For example, it is an excellent fore-crop for winter wheat and meshes well with apiculture areas, but only since the last decade has its relevance been recognised in Hungary But rape seed is a sensitive plant, requiring expertise to nuture it. In Hungary areas suitable for rape seed really only amount to 240 thousand hectares. In 2006 a record 232 thousand hectares were sown and this was one and a half times more than in 2005. If agrometeorological aspects are also taken into account, only 150 thousand hectares are prime rape seed growing areas.

In the future the demand for rape seed is expected to continue to grow. This is because the number of European biodiesel facilities is also increasing and their demand for raw material has to be met. Processing plants in Hungary and abroad are keenly interested in Hungarian rape seed. In fact, Hungarian rape seed has always enjoyed a market, though the purchase price has been volatile.

Due to the great interest in rape seed, **even doubling the sowing area would not entail a major commerical risk,** but crop rotation and climatic factors only allow a limited growth in area. Moreover, devoting more crop land to oil seed plants would only be to the detriment of grains.

In Hungary rape seed processing is currently insignicant. This is because Bunge Zrt, the dominant player in vegetable oil production, dismantled its operation and moved it abroad. Hungary's current annual diesel consumption is approximately 2.5 million tonnes, which by 2010 will grow to 2.8 million tonnes. In 2010 anticipated domestic biodiesel demand will be about **183 thousand tonnes**. To produce this volume, approximately **555 thousand tonnes of rape seed** will have to be processed. Under average weather conditions, the total annual rape seed yield of 240-250 thousand tonnes could produce 80 thousand tonnes of biodiesel. This quantity would only allow a 2.5% blending rate to total energy content. Even if one processed the total Hungarian rape seed yield and sunflower seed surplus, it would still be impossible to meet the blending rate of 5.75% to total energy content.

It would be possible to expand rape seed production by **increasing the average yield**, but to accomplish this proper agrotechnology needs to be applied. Based on a minimum yield of 3t/ha[7], the 150 thousand hectares optimal for rape seed could produce 450 thousand tonnes of rape seed. These 450 thousand rape seed tonnes plus the 400 thousand sunflower seed tonnes left after domestic use could yield **255 thousand tonnes of biodiesel** . This means that approximately 60% of projected biodiesel production capacity(410 thousand tonnes) could be satisfied by domestic raw material.

[7] The average rape seed yield of 3 t/ha has not been reached yet, despite the fact that on the basis of the results of the experiments of OMMI (National Institute for Agricultural Quality Control - NIAQC) the types and hybrids of rape seed recognised by the government are potentially able to provide much higher yields.

References

1. **Bai**, A. [2005]: Domestic Prospects of Biomass Production (in Hungarian). Study. Debrecen University, Department of Agricultural Management.
2. **Butzen**, S. and **Hobbs**, T. [2002]: Corn Processing III: Wet milling. *Crop Insights*, Vol. 12, No. 12, pp. 1.
3. **Butzen**, S.; **Haefele**, D. and **Hilliard**, P. [2003]: Corn Processing II: Dry-grind Ethanol Production. *Crop Insights*, Vol. 13, No. 3, pp. 1.
4. **Council of the European Union** [2007]: European Council Action Plan (2007-2009) Energy Policy for Europe (EPE) Brussels, 9 March 2007. www.consilium.europa.eu/ueDocs/cms_Data/docs/pressData/en/ec/93135.pdf
5. **Dorgai**, L. et al. [1997]: Agroecological and Economic Regionalisation (in Hungarian). Manuscript. Report prepared within the PHARE IPP programme.
6. **Emőd**, I. et al. [2005]: Technological, Economic and Environmental Conditions of Launching Bioethanol in Hungary (in Hungarian). *(Magyar Tudomány)*, Vol. 165, No. 3, pp. 278.
7. **Commission of the European Communities** [2006]: *Communication from the Commission. An EU Strategy for Biofuels.* http://ec.europa.eu/agriculture/biomass/biofuel/com2006_34_hu.pdf
8. **Commission of the European Communities** [2007]: *Schedule on renewable energy sources: further pusuits in order to achieve 20% rate of renewable energy within the energy-mix*. Bussels. 10. January, 2007. http://ec.europa.eu/rapid/pressReleasesAction.do?reference"MEMO/07/13
9. **Ministry of Agriculture and Regional Development** [2006]: *New Hungarian Strategic Plan for Regional Development (2007-201)* (in Hungarian). www.fvm.hu
10. **Gőgös**, Z. [2005]: Biomass Potential and its Utilisation in Hungary). „Biomass energy from agriculture" (in Hungarian). Three-border conference. Nyitra, Maz 3-4, 2005.
11. **Hajdú**, J. [2006]: Opportunities for Production and Utilisation of Biofuel in Hungary. (in Hungarian). *Agro Napló*, Vol. 10, No. 10.
12. **Heszky**, L. [2006]:]: Biological Grounds of Biodiesel and Bioalcohol Production and their Development in Hungary (in Hungarian). *Agroinform,* Vol. 15, No. 2. (special volume).
13. **Hingyi**, H. and **Radóczné Kocsis**, T. [2006]: Structural Tensions in Hungarian Agriculture: Competitiveness of Hungarian Plant Growing (in Hungarian). *Magyar Mezőgazdaság*, Vol. 61, No. 13, pp. 8-10.
14. **Kacz**, K.; **Neményi**, M.; **Némethné Varga**, M. and **Stépán**, Zs. [2006]: Potentials of Using Vegetable Oils as Fuels (in Hungarian). *Agroinform,* Vol. 15, No. 2. (special edition).
15. **Nagy**, J. and **Dobos**, A. [2006]: Production Characteristics of Raw Material for Biodiesel (in Hungarian). *Agroinform*, Vol. 15, No. 2. (special edition).

16. **Nemes**, F. [2006]: Hungary. Grain and Feed. Biofuels Situation and Policy. USDA Foreign Agricultural Service. www.fas.usda.gov

17. **Popp**, J. [2007]: *International connections of biofuel and agricultural production*. (in Hungarian) Agricultural Economy, Rural Development, Agricultural Informatics. International Conference, Debrecen, 21-22. March, 2007.

18. **Popp**, J. [2006]: Dependence on Energy or Food? (in Hungarian). *Magyar Mezőgazdaság*, Vol. 61, No. 32, pp. 6-7.

19. **Popp**, J. [2006]: Dependence on Energy or Food?' (in Hungarian). *Magyar Mezőgazdaság*, Vol. 61, No. 33, pp. 8-9.

20. **Potori**, N. and **Vőneki**, É. (eds.) [2006]: International Comparison of the Production Price of Some Important Agricultural Products (in Hungarian). *Studies in Agricultural Economics,* No. 1. Budapest: Agricultural Economics Research Institute.

21. **Potori**, N.; **Hingyi**, H.; **Kürthy**, Gy.; **Nyárs**, L.; **Papp**, G. and **Vőneki**, É. [2006]: Grain Strategy (in Hungarian). Manuscript.

22. **Potori**, N. and **Udovecz**, G. [2006]: Structural Tensions in Hungarian Agriculture: SPS (II) instead of SAPS (in Hungarian). *Magyar Mezőgazdaság*, Vol. 61, No. 12, pp. 6-7.

23. **Sági**, F. [2005]: Gaining Energy from Carbohydrate and Oil Plants (in Hungarian). *Mag Kutatás, Fejlesztés és Környezet*, Vol. 19, No. 6, pp. 7-10.