ENERGY POTENTIAL OF THE AGRICULTURAL SUGARY AND STARCHY CROPS IN THE SPECIFIC CONDITIONS OF TRANSYLVANIAN PLAIN

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Abstract. *This article aims to present a comparative study of the energy potential of agricultural sugary (sugar beet) and starchy (corn) crops, in the specific conditions of Transylvanian Plain, for extending the energy crop surface in this area, in order to produce bioethanol. The carried-out study concluded that the cultivation of sugar beet in order to obtain bioethanol, depending on the sugar content, can reach an extraction efficiency of 10 – 14%, while for the corn crop, it is about 44l alcohol from 100 kg corn grains.*

Keywords: bioethanol, sugar beet, sugar content.

INTRODUCTION

The development of a society is directly dependent on its energy consumption. Its provision to reasonable costs influences the economic competiveness, the internal output capacity and, moreover, the political force of a state. Therefore, the essential problem of any energy policy is represented by its cost.

The diversification of the utilized energy sources, as well as the necessary research and investments should be performed under economically efficient and environmental protection circumstances.

The limited character of the natural energy sources, in conditions of continuous increasing demands, associated with their price evolution, raises the problem of the future energy options.

Studies performed **worldwide** regarding the energy tender and demand for the following 50 years have shown that this period of energy crisis will be overcome with the price of an intense effort, going through two difficult stages, namely: the transition from the natural liquid hydrocarbons to synthetic liquid fuels and, simultaneous, the development of energy extraction technologies from renewable sources.

In Europe, the increasingly dependence on the energy resources is more and more visible, enforcing thus the need to find new energy sources in order to satisfy demand and safety requirements. Nowadays, Europe owns the seventh part of the world energy consumption and depends on imports for more than half of its energy needs. Therefore, in order to deal with the energy needs and to provide energy safety at European level, it is necessary to establish clear future strategies and to elaborate

new measures in perspective of the next strategic revision of the energy strategic policy adopted by the European Council

The mutual Action Plan of the European Union in the field of energy/climate changes, which regards, on the one hand, the reduction of green gas emissions and, on the other one, the increase of the renewable energy percentage, with a low carbon dioxide content, includes two key objectives

- Reduction with at least 20% of the greenhouse gas emissions, at the level of the entire European Union, until 2020, as compared to 1990, and with 30% if an international agreement would be reached after 2012;
- Increase at 20%, until 2020, of the renewable energies quota in the final energy consumption of the European Union, including the 10% biofuel target in the overall of the biofuels consumption used in transports.

In Romania, the optimum large-scale production and use of renewable energy sources represents more than a priority, but a necessity in order to align our country to European Union requirements, taking also in consideration the geographical and geopolitical situation of our country, position which provides a series of opportunities. After having analyzed the competitiveness indicators, it has been underlined the fact that our country has a delay as compared to the EU countries, which is the reason for one of our most important objectives, namely to reduce Romania's dependence on the energy resources imports. At present, among the priorities of our country's energy strategy, the most important of them should be to limit climate changes, their costs and negative effects on society and environment, by using renewable energies.

One of the general action trends is the integration of Romania within the European concept of promoting the use of biofuels and biomass. Therefore, the followings become necessary:

- the identification of the best practices in promoting the use of biofuels in transportation, as well as in specific areas of agricultural mechanization;
- the identification of mechanisms for stimulating the production of raw materials for biofuels production;
- the identification and improvement of specific technologies in the production of biofuels (the establishment of energy crops, implementation of modern technologies for biofuel production).

Nowadays, the most frequently used biofuels (which can be obtained from organic materials as well) nowadays are represented by biodiesel (extracted of vegetal oils) and bioethanol (extracted of plants with a high content of sugar and starch).

The statistical data show that, in Romania, *approx.* 5 million tons of gasoline are consumed annually, which means that in the first stage, at national level, the necessary quantity of bioethanol would be of about 350 million liters/ year, namely a daily production of 1 million liters. In addition, both the Romanian agriculture organization and the establishment, in the latest years, of bioetahnol plants, suggest that the initiative of extending areas planted with sugar beet and corn for bioethanol production would be very well received by the Romanian market. For all those reasons and even more than this, due to EU requirements to introduce on the market only gasoline containing 4,5 up to 5 % bioethanol (mixtures with bioethanol in a

percent below 5 do not imply any changes in the existing car engines) followed by each year raise up to 20% in 2020, carrying out studies on this matter is fully justified.

Bioethanol

The bioethanol is an ecological fuel, with the same chemical formula as the ethylic alcohol, being used as an alternative to gasoline, in various ratio mixtures or even in pure form

The use of bioethanol in mixtures with gasoline for fuel-burning engines has a series of positive consequences, such as the reduction of smog, which can be performed by:

-the decrease, with 8-30 %, of the carbon dioxide emissions when using an E10 mixture. Due to its oxygen content, bioethanol makes combustion more efficient.

-the reduction, with 5-15 %, of toxic emissions (sulphur, olefin, aromatic components such as: benzene, toluene etc.) without influencing fuel performances. Therefore, the ethanol presents good properties related to its use as fuel in spark-ignition engines, as it has a high octane value and, in the presence of the oxygen, it determines different combustion features as compared to gasoline (lower flame temperature, lower combustion heat, lower air volume and different gas emissions characteristics).

The bioethanol is the most important biofuel in the alcohol class and, presently, it is obtained predominantly from starchy or sugar renewable raw materials, through fermentation processes. The fermentation in the presence of yeast stalks generates ethylic alcohol. The ethylic alcohol extracted (bioethanol) is then separated by distillation. In order to obtain bioethanol with a similar quality as gasoline, the alcohol should be first dehydrated, until the bioethanol concentration increases up to more than 99%.

Generally, the bioethanol production involves three phases:

1. Enzymatic destruction / dissolution of glucidic compounds with high molecular mass (cellulose) into simple sugars (glucose);
2. Conversion of sugar into alcohol and CO_2, by using the alcoholic fermentation process;
3. Purification of alcohol: distillation and elimination of water

In the fermentation process, the chemical reaction of decomposition of sugar (glucose) into alcohol and CO_2, in the presence of yeast enzymes, is the following:

$$C_6H_{12}O_6 \Rightarrow 2\ C_2H_5OH + 2\ CO_2$$

The carbon dioxide resulted from combustion is used by plants in the photosynthesis process, for the regeneration of biomass. Therefore, one should underline the fact that the use of bioethanol takes place according to a closed circuit, while the use of fossil fuels takes place according to an open cycle, which leads in the end to the exhaustion of oil deposits.

Today, the bioethanol is the most used biofuel. Thus, every year, *approx.* 25 billiard liters are used worldwide. The ethanol percentage used in gasoline mixtures is between 5-20 % or even up to 80 %, according to each country. The use of ethanol as fuel is continuously growing worldwide, because it decreases the fossil fuels import dependency, it reduces air pollution and change of global climate,

caused by the greenhouse effect (as compared to gasoline, ethanol is an oxygenated fuel, with a 35 % oxygen content, which reduces both the toxic emissions in the air and the NOx emissions resulted from combustion) and, not the least, it generates new jobs.

Agricultural sugary (sugar beet) and starchy (corn) crops

The overall objective of the present study was to analyze the effective use of the energy crops: sugary and starchy crops, namely sugar beet and, respectively, corn in Transylania's plain conditions, in order to obtain bioetahnol and to evaluate its extraction efficiency.

The raw materials used in ethanol extraction are:

- glucidic raw materials: sugar cane, sugar beet, sugar sorghum, some fruits etc.;
-starchy raw materials: maize, wheat, potato, manioc;
- wood-cellulose raw materials: wood and other materials of fibrous plants.

The bioethanol production cycle depends on the raw materials chosen. For bioethanol extraction, sugar beet and corn are the most suitable energy plants which fully answer the technological conditions and requirements specific to the Transylvanian Plain. Therefore, bioethanol can be easily obtained from sugar and there is a vast experience in this direction, and for obtaining starch, the existing technologies may be used. The raw material production costs are generally high, taking into account the fact that, for its extraction, a series of expenses referring to crop formation and maintenance are needed (fertilizers, pesticides etc.). But, on long term, the cultivation of these two energy crops has benefic effects upon the environment. Taking into consideration the fact that the European standard for ethanol as fuel is continuously changing, researches on the optimization of the ethanol extraction process from sugar and starch agricultural crops are performed, having the final purpose of determining the necessary energy consumption for its extraction.

Table 1.

Sugar beet production, 2001-2011

Specification	Unit	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Surface	thousand ha	39,0	41,6	45,2	20,8	25,2	39,8	28,7	20,4	21,3	22,0
Average gross production	Kg/ha	22432	22930	16916	32290	28932	28942	26065	34564	38296	38036
Total production	thousand t	875,5	954,6	764,5	672,7	729,7	1152,2	748,8	706,7	816,8	837,9

Source:
INS data – Statistical yearbook of Romania, 2010 (2001 – 2009);
INS data – Main crops production – June 2011(2010)

Sugar beet (*Beta vulgaris* L.) has a long tradition in Romania. From the point of view of its phytotechnical particularities, the sugar beet needs well structured, profound, fertile, humus rich soils, with a high capacity to retain water. The most recommended soils are the alluvial clay-sandy soils, brown-red forest soils, with 2-4

m deep water table and pH=6.5-8.0. The sugar beet crops provides conditions for crop rotation, water maintenance in soil, improvement of natural soil fertility and soil protective effects, by fixing CO_2 and releasing oxygen equivalent to one hectare of forest.

According to Bioethanol in Deutschland, Landwirschaftsverfag Munster, from one tone of sugar beet roots, *approx.* 107l bioethanol (or 66,2 hl bioethanol/ha) can be obtained.

Corn (*Zea mays* L.) is one of the most important crop plants, with multiple uses in human nutrition, industry or animal nutrition (according to FAO statistics, the distribution of consumption is: 21% human use, 72% animal use, 7% industry use). Corn grains are used in starch, alcohol, glucose and dextrin industry while its germs are used for oil extraction, utilised in dietetic nutrition.

As phytotechnical particularities, the followings can be mentioned: good resistance to drought and heat; relatively low number of diseases and pests; adaptability to various climate conditions; leaves the land clean of weeds; represents a good previous crop for many plants; good use of organic and mineral fertilizers; strong reaction to irrigations.

According to MADR, the extraction efficiency of corn is: 100 kg corn grains – 77 kg corn flour or 63 kg starch or 71 kg glucose or 44 l alcohol or 50-60 kg isomerase.

Table 2

Corn production, 2001-2010

Specification	Unit	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Surface	thousand ha	2980,2	2897,3	3206,5	3282,8	2630	2520,8	2525,8	2449,5	2344,9	2108,7
Average production	Kg/ha	3061	2900	2988	4438	3951	3565	1526	3213	3406	4297
Total production	thousand t	9124,8	8402,4	9582,0	14570,0	10390,4	8986,0	3855,1	7870,0	7987,7	9060,7

Source:
INS data – Statistical yearbook of Romania, 2010 (2001 – 2009);
INS data – Main crops production – June 2011(2010)

The sugar beet and corn crops are frequently cultivated in the Transylvanian Plain area, predominantly with a nutritional purpose. There are numerous differences regarding their crop technology and, implicitly, their cost. This is the reason why a special attention needs to be paid concerning the cultivation of sugar beet and corn for energy purposes, in order to more concisely render the advantages and disadvantages of these crops, for bioethanol extraction. The energy agricultural crops may have much higher efficiencies per unit of surface, comparatively to the natural vegetation in the respective area. These superior efficiencies improve the cost effectiveness as compared to conventional crops and minimize the requirements referring to soils, use of chemical substances and transportation. In order to develop these crops, the efficient use of land is necessary, by implementing solutions available for the entire crop and by using both fertile soils and poorer quality ones.

CONCLUSIONS

Recently occurred climate changes, development of new industries, population growth as well as continuously increasing energy consumption have directed world's attention on environment, noticeable being the fact that some materials are in danger of exhaustion. In this regard, it is necessary to find new sources of energy, cheaper and less polluting and accessible as possible to everyone. So, if resources for conventional energy are limited, the energy use from alternative sources - renewable energy – leads neither to any resource depletion and nor to an ecological imbalance.

Environment knowledge, interaction between natural and economic systems, as well as the consequences of these interactions on society are considered to be important, knowing that natural resources must be used rationally and economically. Prevention and control of the environmental degradation caused by man as well as harmonization, related to environmental factors, of the society's interests as a whole, or of the economic agents in particular, can be achieved by developing studies on renewable energies (in this case the energy crops), as a real opportunity. Moreover, the use of renewable and clean energy sources implies low costs, since the investments are relatively quickly amortized and the energy sources are inexhaustible.

The existence of a special potential for developing energy crops in the plain area of Transylvania and increased interest in the production of biofuels, in general, and bioethanol in particular, has revealed a great economic opportunity, namely the advantage of reducing the necessity of importing fuels.

The potential investments in the renewable energy field create opportunities for new jobs, income sources for the rural population, in the whole, opportunities for sustainable rural development and environmental protection.

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