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***Stanisław BIELSKI* [1]**

THE AGRICULTURAL PRODUCTION OF BIOMASS FOR ENERGY PURPOSES IN POLAND

SUMMARY

On the European markets, Poland is seen as a country with a high energy biomass potential. In the long run, gaseous biofuels, such as biogas and biomethane, will continue to be basic products obtained from energy agriculture. Biogas production in Poland should become one of the leading solutions for meeting the obligation of generating ‘green’ electricity and securing energy safety. It will be possible to increase the employment rate and wealth among farmers and in rural areas by producing biofules. However, for the future development of the biofuel production and use, it will be essential to solve the question of an optimal selection of raw materials that will ensure the maximum productivity, the lowest costs and the smallest emission of harmful substances to the atmosphere in all production processes. The aim of the study was to present possible to obtain raw materials from agricultural production used for energy purposes, as well as demonstrating the growing role and importance of renewable energy from agriculture in the energy balance of the country.

Keywords: renewable energy sources, biofuels, energy security, agriculture

INTRODUCTION

Constantly progressing industralization demands an increasing supply of fuels to meet the growing energy consumption (Chisti, 2008; Koh and Ghazoul, 2008). There are forecasts that by 2020 the energy use will have grown by 60% (Jasiulewicz, 2008). Higher energy consumption means higher GHG emission to the atmosphere, which causes undesirable changes in the climate. Analysts emphasize the high likelihood of an energy crisis, expected to break out within the next 15 to 25 years (Roszkowski, 2008).

Most renewable energy resources are local, independent of the availability of conventional sources of energy in the future, and their decentralized character alleviates the sensitivity of economy to fluctuating energy supplies. Doubtless, renewable energy is the key component of future sustainable energy (Directive 2009/28/EC). The objective of this paper is to present possible scenarios of generating raw materials in agricultural production to be used for energy

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[1] Stanisław BIELSKI, (corresponding author: stanislaw.bielski@uwm.edu.pl), University of Warmia and Mazury in Olsztyn, POLAND.
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generation. Another aim is to demonstrate the increasingly more important role of Renevable Energy Resources (RERs) derived from agriculture in the country's energy balance.

MATERIAL AND METHODS

The problem has been analyzed based on selected references, binding legal acts, statistical data and own calculations. The data from the Main Statistical Office and the National Indicator Set (NIS) for the years 2014-2020 were taken to estimate the demand for biocomponents, raw produce needed to obtain these components and the farmland required to grow the demanded amounts of energy crops. The data were set in tables and discussed.

RESULTS AND DISCUSSION

Biofuels have many technical and environmental advantages over conventional fossil fuels, which make them an attractive alternative in the transport sector (Pimentel and Patzek, 2005). The immediate advantages are reduced greenhouse gas emission, mainly carbon dioxide (CO2) and methane (CH4), diversification in the fuel sector, biodegradability, improved efficiency of vehicles, development of the market of agricultural products (Chisti, 2008, Koh and Ghazoul, 2008).

Sustainable energy management represents an important component in local development. This is of particular importance in agricultural regions where biomass resources are just inexhaustible (Kurowska et al., 2014). The economic results of the production and use of biofuels include: sustainable growth, diversity of fuels, more jobs in the countryside, higher income tax, more investment in the durable assets stimulating the development of agriculture, gaining an international competitive advantage (Sa´nchez and Cardona, 2008). Those who are in favour of biofuel production claim that energy crops contribute to the sustained growth of rural areas, where land can be cropped with plants grown for biomass (Chisti 2008; Koh and Ghazoul 2008; Jegannathan et al., 2009). Production of biofuels in rural areas offers many benefits, mainly through the social and economic activation of rural populations, opportunities of creating new work places, diversification of income sources, a chance to sell the overproduction of crops, more efficient use of the production potential (land, machines, labour), an opportunity to develop distributed energy systems, a chance to acquire external funds (EU funds, funds for protection the environment) (Gostomczyk, 2011). Another crucial aspect is the country's energy safety, i.e. securing energy supplies, reducing the use of fossil fuels, providing good access to the countrywide distribution system, renewability (Sa´nchez and Cardona, 2008).

The Directive 2003/30/EC of the European Parliament and of the Council of 8 May 2003 on the promotion of the use of biofuels or other renewable fuels for transport was the fundamental legal act on the basis of which the domestic acts securing its complete transposition into the Polish law i.e. the Acts of 25

August 2006 on biocomponents and liquid biofuels and on the system of fuels quality monitoring and control were drafted. Those acts introduced numerous changes into the Polish law that were focused on creating favourable and lasting conditions for development of the market of biocomponents and liquid biofuels. The most important changes concerned creating the possibilities for production by individual farmers of all liquid biofuels that were their own fuels for their own use, introduction as of the 1st of January 2008 of the requirement for assuring a specific share of biocomponents in the transport fuels' market while the implementation of the term of "chosen fleet" in the Polish law made use of a wide range of liquid biofuels other than allowed for general trading characterised by high contents of biocomponents in the vehicles and machines belonging to the "chosen fleets" possible (Bielski, 2011).

Alternative fuels that could totally or partly supplant fossil fuels are bioethanol or biodiesel produced on the basis of oil plants (Difiglio 1997; Chisti 2008; Koh and Ghazoul, 2008). Poland belongs to the biggest oilseed rape (OSR) producers in Europe (Europe in Figures 2010). After Poland's access to the European Union, production of OSR has become a nearly strategic branch in plant production. The reason is the large content of oil in rape seeds, which can be used as feedstock for production of OSR oil esters – a fuel used to run diesel engines. The highest productivity of biodiesel per 1 ha is achieved from plantations of oil palm trees. The lowest biodiesel production costs are obtained when the raw material is composed of waste products from the oil and fat industry or used oils (Zhang, 2003). The most popular raw product for making biodiesel in Europe is the seed of oilseed rape (canola). However, the direct use of rape seedoil, obtained by pressing rape seeds, as fuel for high-pressure engines involves several technical difficulties, due to some specific physicochemical properties of such raw oil, which cannot be used to power an unmodified diesel engine (Szlachta, 2002; Podkówka, 2004; Sitnik, 2004; Dzieniszewski and Piekarski 2006; Pasyniuk, 2009). Thus, it is necessary to adjust such fuel to the currently existing engines. A popular way of preparing rapeseed oil for combustion in high-pressure engines is transestrification (Demirbas, 2002; Tys et al., 2003, Demirbas, 2004; Demirbas, 2005; Bala, 2005; Balat, 2005). However, the profitability of making and using rape methyl ester (RME) is often dubious (Bielski, 2012).

Estimates of the acreage of farmland under energy crops are divergent (Bielski, 2005). Kuś and Faber (2009) claim that the total farmland in Poland which can be potentially cropped with energy plants is about 950,000 ha. Foreign sources (the European Environment Agency 2006) state that the area of agricultural land suitable for energy crops in Poland is much larger than in its EU neighbours. As of the year 2020, it is estimated to reach 4.3 million ha in Poland, 2.0 million ha in Germany, 2.6 million ha in Spain, 1.0 million ha in France and 1.1 million ha in the UK.

The predicted growth in the demand for esters of higher fatty acids and bioethanol as well as the acreage needed to supply enough raw products, presented in table 1, implies that over 1.3 m ha of agricultural land is needed in Poland in 2014 to supply sufficient plant material for production of esters. The domestic demand for rape seeds must also include the acreage cropped to supply the food industry (about 0.45 million ha). Over 0.50 million ha will be needed to produce the demanded volume of bioethanol. It is difficult to state precisely how much farmland will be needed because other species of cereal plants can be grown for the same purpose. Moreover, some bioethanol can be imported to Poland.

Table 1. Forecast demand for energetical oilseed and grains for bioethanol

Years	Biocomponents demand (ths. m^3)	Feedstock demand (ths. Mg)	Demand area under sowing (ths. ha)
oilseeds			
2014	1061	3077	1321
2020	1406	4077	1750
grains			
2014	615	2 029	538
2020	814	2 688	672

Source: own calculations based on the 2014-2020 the National Indicative Target; demand forecast takes into account consumption diesel fuel at 13 million m^3 and 5.4 million m^3 of gasoline consumption with the aim of maintaining the following years unchanged level

Another raw material which can be used for energy generation is straw. As Kuś and Faber (2009) have calculated, the Polish agriculture make about 9 million tons of surplus straw, of which at least 30-40% can be used for alternative purposes, including energy generation. When making an assessment of the amounts of straw potentially used elsewhere than in farming, we need to realize that its transport will be unprofitable in regions where fields are small and scattered. On the other hand, large quantities of straw for energy production can be obtained from regions where large farms are dominant, with as much as over 90% of acreage cropped with cereals and oilseed rape but relatively low livestock density. Realistically speaking, about 3-4 million of tons of straw can be used for energy generation.

One of the most prospective directions in the use of biomass for energy generation is thought to be the production of agricultural biogas. A biogas plant is an installation which serves the target production of biogas from plant biomass, animal waste or organic by-products (e.g. from the food industry). In line with the provisions of the document ‘Directions in the development of agricultural biogas plants in Poland in 2010-2020’, approved by the Council of Ministers, it is predicted that, on average, by the year 2020, there will be one biogas plant in each Polish commune, which will convert biomass from agricultural production to biogas, provided that a given commune has the right conditions to start such a venture. Unfortunately, this direction in the conversion of biomass is not pursued in Poland in a satisfying manner. A small share of agricultural biogas is a result of a small number of working agricultural biogas plants (according to the Register of enterprises dedicated to the production of agricultural biogas, there were 45 such biogas plants in February 2014). The reasons are two-fold: barriers to the construction of biogas plants (e.g. economic, legal and technological obstacles) and the supply of raw materials. Maize silage is now the major feedstock used to produce biogas in agricultural biogas plants (Fugol and Szlachta, 2010). However, the cost of acquiring raw substrate and the competitive advantage of using maize as food and feed forces us to look for alternative biomass as well as plant waste or by-products from the plant processing industry to be used for anaerobic fermentation in agricultural biogas plants (Rogulska et al., 2011). Biogas plants can make a good contribution to the domestic energy generation potential, especially as their theoretical output has been estimated to equal 5 thousand million m3 of biogas annually, while the actual potential based on by-products from agriculture and the food industry is about 1.7 thousand million a year. Such amount of refined biogas could cover about 10% of the demand for gas or completely satisfy the demand for gas by rural populations. Large-scale biogas production will also mean Poland's improved energy safety, lower gas deficit in the country and – in the long term – being independent from imported gas as well as satisfying the EU's expectations regarding energy generation from RERs (Borkowski, 2010). Among renewable energy resources, biogas plants are seen as most efficient installations. Provided they use generators with the same power, a biogas plant can generate thrice as much energy as a wind farm annually. Unlike other sources (e.g. wind farms depending on vertical air flows), biogas plants can produce energy all year round (Kołodziej, 2009).

Agricultural biogas plants enable farmers to satisfy own energy demands, while selling surplus energy to the power grid and re-using the digestate to fertilize soils. Agricultural biogas plants can stimulate the state's economy, support the efforts to ensure energy safety and create new opportunities for farmers, especially in the context of heralded reductions of payments under the Common Agricultural Policy (Czapiewska, 2010). Construction of biogas plants seems to be extremely important for attaining the diversification and increase of farmers' incomes. On the other hand, it will help to restrain environmental pollution (Podstawka, 2012).

The political and social support to biofuels has been challeneged regarding its impact on the environment protection and food safety. The claim that biofuels contribute to a large decrease in the emission of carbon dioxide has been questioned (Crutzen, 2007). There has also been some criticism of the influence of biofuels on the natural environment and costs incurred by their production, selection of an adquate technology and choice of raw materials. Production of biofuels may lead to a decreased biodiversity, substantial modification of the land use, higher food prices and competition for water resources. Considering in how many countries today people are starving, production of biofuels is seen as a threat to the prices of staple foods (Farrell et al., 2006; Ragauskas et al., 2006; Koh 2007; Field et al., 2008; James et al., 2008).

CONCLUSIONS

Investment in RERs could be a significant factor activating the regional and local economy. The fact that plants can be grown and delivered to be processed to energy is one of the elements involved in actions undertaken to enliven the Polish countryside, to look for additional types of entrepreneurship, to create work places and incomes outside farming.

The use of bioenergy derived from agricultural production is a chance to diversify and raise agricultural income, while improving the country's energy safety. However, when consumable products are used for this purpose, food safety is threatened. Thus, the second generation liquid biofuels should be introduced as soon as possible, where non-food substrates will be used (cellulose, lignin cellulose). Finally, the impact of renewable energy resources (including biomass) on the improvement of Poland's ecological and energy condition need not be overestimated.

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