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POTENTIAL AND RISK OF SLOVAK AGRICULTURE IN SECOND GENERATION BIOFUELS CROPS PRODUCTION

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For centuries, humans have been using the Earth's surface to produce food through agricultural activities. Few decades ago, this main role of agriculture is altering with new roles including bio-energy and biofuel production. This paper presents the situation and potential of Slovak agricultural regarding the first and second generation biofuel production. The paper summarises how such production can affect the economy, food security and availability of soils. General assessment on impact of biofuel production to the environment and agricultural structure is done.

Key words: biofuels, agricultural production, agricultural crops, perennial grass, impact on environment.

ПЕРСПЕКТИВИ ТА РИЗИКИ ДЛЯ СІЛЬСЬКОГО ГОСПОДАРСТВА СЛОВАЧЧИНИ У ЗВ'ЯЗКУ З ВИРОБНИЦТВОМ БІОПАЛИВА ДРУГОГО ПОКОЛІННЯ З ПРОДУКТІВ РОСЛИННИЦТВА

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Протягом сторіч людство використовувало земельні ресурси для виробництва продуктів харчування та сільськогосподарської діяльності. Декілька десятиріч тому цю основну роль сільського господарства було доповнено такою новою галуззю як виробництво біопалива. Описано сучасний стан та потенціал сільського господарства Словаччини щодо виробництва біопалива першого та другого покоління із сільгоспкультур. З'ясовано, що процес виробництва біопалива може впливати на економіку, харчову безпеку та доступність земельних ресурсів. Наведено оцінку впливу виробництва біопалива на довкілля та структуру сільського господарства.

Ключові слова: біопаливо, сільськогосподарська продукція, сільськогосподарські культури, багаторічні трави, вплив на довкілля.

PROBLEM STATEMENT. For centuries, humans have been using the earth´s surface to produce food through agricultural activities. Few decades ago, this main role of agriculture is altering with new roles including bio-energy and fuel production. Production of liquid biofuels has rapidly increased around the world in recent years. Such production can affect the economy, agricultural structure and environment.

Europe is increasingly dependent on imported fossil energy. According to "business as usual" scenarios, the EU's energy import dependence will jump from 50 % of total EU energy consumption today to 65% in 2030. Reliance on gas imports is expected to increase from 57% to 84 % by 2030, and reliance on oil imports will rise from 82 % [1]. The replacement of fossil fuels with renewable energy sources is acknowledged to be beneficial from both environmental and economic points of view and with respect to global climate change [2]. The point of departure for a European energy policy is threefold: combating climate change, limiting the EU's external vulnerability to providers of imported fossil energy, and promoting growth and jobs, thereby providing secure and affordable energy to consumers [1]. Increasing biomass energetic utilisation can be one of the tools for restructuring the energy system of the EU to a low carbon model; this is one of the critical challenges of the 21st Century [3]. But, the market with biomass for energy purposes is insufficient in OECD countries [4], EU countries [5], as well as in Slovakia [6].

Liquid biomass fuels can be produced from two major resources: food/feed crops and cellulosic material. Currently, the biofuels industry relies mainly on food/feed crops such as corn, soybeans, rapeseed, and sugarcane. Technologies for deriving biofuels from crops are well developed, and their use has been expanded substantially in the past two decades. The major producers of biomass fuels from food/feed crops are the U.S., Brazil, and the European Union. They mainly produce ethanol from corn and sugarcane, and biodiesel from rapeseed (or Canola) and soybeans [7]. Liquid and gaseous fuels derived from biomass have been growing steadily over the last decades from 16 billion litres in 2000 to more than 100 billion litres in 2011. Today, biofuels provide around 3% of total road transport fuel globally [8].

Over the next 10 to 15 years, it is expected that lower cost residue and waste sources of cellulosic biomass such as wood, tall grasses, and forestry and crop residues, will provide the first influx of next-generation feedstock. Does potential in the second generation biofuel crop production exist in Slovakia? How high is it and how are advantages and risks of such agricultural products utilisation? This paper presents the situation and calculates potential of Slovak agricultural in the first and second generation biofuel crop production.

The paper summarises how such production can affect the economy, food security and asses the impact of biofuel production on the environment and agricultural structure.

EXPERIMENTAL PART AND RESULTS OBTAINED. The primary crop harvest is only a fraction of the total plant biomass. The residual biomass, such as straw is often subject to further economic use. Crop residues are used as feed or bedding material in livestock production. But still there exist so called unused biomass residues which are left in the field or burned and could be used for other utilisation. The quantity of used and unused residues from cereals was calculated from statistical data on yields by the method of EUROSTAT [9] and coefficients according to Jölli and Giljum [10]. The data

were retrieved from official publications and databases of Statistical Office of the Slovak Republic [11].

The extraction of fossil fuels is quite low in Slovakia and the fuels extracted are mostly crude oil and natural gas [12]. Slovakia is almost fully dependent on fossil fuels import and thus one of the highest priorities in the energy policy of the Slovak republic is to increase the share of renewable energy sources.

Concerning to the overall domestic raw materials extraction in Slovakia, non-metallic construction minerals dominate by 44 % share. Important part at this extraction, 30% share in 2007, was represented by biomass in Slovakia [13].

The first generation biofuels industry relies in Slovakia mainly on oilseeds with dominance of rapeseed, and starch crops with dominance of maize. Since 1990, there was observed rising trend in these crop production and harvested areas in Slovakia. Rapeseed and maize areas and production during the period of 1990–2011 show figures 1–4. Demand for rapeseed and maize was increasing also in response to growing demand for biofuels.

Figure 1 – Trend in rapeseed production (t) and hectare yield (t/ha) in Slovakia
Data source: Statistical Office of the Slovak republic, www.statistics.sk, own processing

Figure 2 – Trend in rapeseed harvested area (ha) in Slovakia
Data source: Statistical Office of the Slovak republic, www.statistics.sk, own processing

Figure 3 – Trend in maize production (t) and hectare yield (t/ha) in Slovakia
Source: Statistical Office of the Slovak republic, www.statistics.sk, own processing

Figure 4 – Trend in maize harvested areas (ha) in Slovakia
Source: Statistical Office of the Slovak republic, www.statistics.sk, own processing

Market with oilseeds crop is also developing. In market year 2010/11, rapeseed imports to Slovakia jumped to 76 thousand tons, up from market year 2009/10 volume of 26 thousand tons [14].

Second generation feedstock is presented by cellulosic biomass from crop residues and grasses. In Slovakia, harvest residues from cereals, economically unused at present, create potential for biofuels production. Further potential source are yields from at present unmanaged permanent grasslands. In Slovakia from the permanent grasslands area of 800 000 ha is approximately 500 000 ha under regular management. Almost 300 000 ha are unmanaged and thus create potential for second generation biofuels production.

Trend in unused harvest residues production in Slovakia calculated from statistical data on yields by the method of EUROSTAT [9] and coefficients according to Jölli and Giljum [10] shows Figure 5. Situation in permanent grasslands utilisation shows Table 1.

In Slovakia in 2007, according to our calculation it would have been possible to use 1 383 kt (773 kt of cereal crop residues and 610 kt of permanent grasslands biomass) of unused biomass. Such biomass can be transformed into energy by several processes and can serve for heating or biofuel production.

Table 1 – Permanent grasslands (PG) area and their biomass production in 2007 in Slovakia [13]

Total PG area (ha)	880 920
Used PG area (ha)	582 502
Unused PG area (ha)	277 398
Afforested PG area (ha)	74 820
Total PG biomass production	2 162
Grazed biomass and harvested hay from used PG areas (kt/yr)	1 403
Potential biomass from unused PG areas (kt/yr)	610
Potential biomass production from afforested PG areas (kt/yr)	150

Figure 5 – Trend in total cereal production in Slovakia (t) Source: Own calculation from statistical data on yields by the method of EUROSTAT [9] and coefficients according to Jölli and Giljum [10]

Because many factors affect these outcomes, it is not possible to give exact values for the amount of produced biofuels. For this reason we used for the calculation of bioethanol production, 460 l yield of bioethanol from 1 t of cereal crop residues [15] and 150 l yield of bioethanol from 1 t of hay from permanent grasslands [16]. Thus the total unused biomass in 2007 could have produced 355 672 thousand litres of bioethanol what is equivalent to 171 193 toe and 7,17 PJ. In 2010 in Slovakia, the total biofuel production was equal to 4,47 PJ [17] what is of 2,70 PJ less than calculated potential.

Second generation of biofuels and the environment. The environment consequences of biofuel production depend on what crops or materials are used, where and how these feed stocks are grown, how the biofuel is produced and used, and how much is produced and consumed. The opinions on the production and use of first and second generation biofuels differ across the world and scientific communities.

First generation biofuels have only a limited potential to provide sustainable fuels. Globally, the liquid biofuel production has contributed and is in the near future likely to continue to weaken the access of vulnerable people to adequate food. Biofuel production has caused the increase in food prices [18].

First generation biofuels can also affect food security. Nowadays food security of Slovakia is 45–50 %. Compared to 1990, when food security of Slovakia was 80–100 %, 30 % decrease during 20 years period is the biggest in the EU.

But if second generation biofuels are produced from agricultural or forestry residues, the problems related to first generation biofuel production can be avoided [19].

There are a variety of reasons why cellulosic biomass is considered an attractive option. The use of waste biomass offers a way of creating value for society, displacing fossil fuel with material that typically would otherwise decompose, with no additional land use required for its production.

By the other hand, biofuel crop growing and biofuel utilisation can affect all components of the environment, air, water, soil and biota in positive or negative way.

New liquid hydrocarbon fuels produced from cellulosic biomass seem likely to offer several advantages over producing ethanol from cellulose in terms of more efficient yields and less environmental impact.

The important role of second generation biofuels is mainly in CO_2 emissions reduction in the transport sector. Global carbon dioxide emissions from fossil fuel combustion reached a record high of 31,6 Gt in 2011, according to preliminary estimates from the International Energy Agency. This represents an increase of 1,0 Gt on 2010, or 3,2 %. Coal accounted for 45% of total energy related CO_2 emissions in 2011, followed by oil (35 %) and natural gas (20 %) [19]. However, current biofuels production processes do not always meet expected net life–cycle greenhouse gas emission. In addition, ethanol and biodiesel can reduce the emissions of some pollutants from vehicle exhaust (e.g. fine particles and carbon monoxide), but tend to increase other pollutant emissions such as nitrogen gases. Biofuel crops offer their greatest promise for GHG benefits if grown on abandoned, degraded or marginal lands. On these lands, carbon losses from conversion to biofuels are often small.

The conversion of land to certain types of biofuel crop production leads to intensification in terms of fertilizer and pesticide use, increased pollution load and further biodiversity loss. Much depends on where the conversion takes place, and the extent to which European production contributes to reaching the biofuel target. The available information suggests that the trend towards concentration of agriculture in the most productive areas, as well as to further intensity and productivity increases, is likely to continue [20].

Impact on water is caused by using irrigation to grow biofuel crops what aggravate the shortages of water resources. The procession of biofuels can also consume substantial quantities of water. Water pollution can result from runoff from agricultural fields and from wastes created during the production of biofuels. Nutrient losses from fields and permanent grasslands pose particular problems in terms of eutrophication.

CONCLUSIONS. The results show that unused biomass from second generation biofuel crop sources constitute a remarkable potential in Slovakia that could be used for energy purposes, for heating or biofuels

production. But still the role that second generation biofuels will play for agriculture and food security is uncertain. Further research is needed also in connection to ecosystems and the environment.

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ПЕРСПЕКТИВЫ И РИСКИ ДЛЯ СЕЛЬСКОГО ХОЗЯЙСТВА СЛОВАКИИ ПРИ ПРОИЗВОДСТВЕ БИОТОПЛИВА ВТОРОГО ПОКОЛЕНИЯ ИЗ ПРОДУКТОВ РАСТЕНИЕВОДСТВА

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На протяжении веков человечество использовало верхний слой почвы для выращивания продуктов питания и сельскохозяйственной деятельности. Несколько десятилетий назад к основной функции сельского хозяйства добавились такие новые отрасли, как производство биологической энергии и топлива. В последние годы во всем мире наблюдается рост производства жидкого биотоплива. Рассматривается ситуация и перспективы для сельского хозяйства Словакии при производстве биотоплива первого и второго поколения на сегодняшний день. Представлены результаты исследований влияния такого производства на экономику, продовольственную безопасность, а также возможность использования биотоплива. Проведена оценка последствий биотопливного производства для окружающей среды и сельского хозяйства.

Ключевые слова: биотопливо, сельскохозяйственное производство, сельскохозяйственные культуры, многолетние травы, воздействие на окружающую среду.

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