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# Evaluation of the Possibilities of Selected Crops Production for Energy Production in the Selected Area

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**Abstract**: The current aim of the European Union is to increase share of energy from renewable sources (energy arises from alternative sources should represent min. 20 percent of final energy consumption in 2020). Biomass is one of the renewable energy source. There are areas where it is possible realized efficient crops production for energy production. The main aim of this article is to evaluate the possibilities of selected crops production for energy production in the Kapušany area.

**Keywords**: soil; crops; biomass; energy production;

**JEL Classification:** Q01; Q10; Q42

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## 1. Introduction

The aim of the paper was to identify possibilities of using alternative inputs (biomass) into biogas in terms of PD Kapušany in the context of their economic, environmental and energy efficiency. The main scope of the assessed company is the agricultural production (crop and livestock). One of the priorities of the company is to increase the use of alternative energy sources. For this purpose, it operates bio-co-generation unit with an annual output of 1,300 MW (electricity and heating), utilizing for their own needs and also provides for external customers. The company uses part of their own crop production as input to the biogas plant, which is located on the company property.

## 2. Literature review

This article builds on research realized earlier by the authors. This article draws knowledge from authors who long-term engages in issue of revitalization of soils (Vilček, J. 2011; 2013; Vilček, J. – A. Lisnyak, 2011; Hronec, O.- J. Hajduk, 1996; Vráblíková, J.- P. Vráblík 2002) in issues of energy crops (Porvaz, P. et al, 2009; Jamriška, P. 2007; Pekárová) and renewable energy sources (Bejda, J. et al., 2002; Demirbaş, A. 1999 etc).

## 3. Data and Methodology

Evaluation of selected area was realized based on suitability of selected crops growing of crops on that area and types of soil. The data used were obtained from VÚPOP and processed into soil maps (using the program PEDOP 2000). It was realized and field research in the Kapušany area.

## 4. Results and discussion

Company uses corn as the primary raw material in the biogas station. By its cultivation and burning the following problems were identified:

- Low yields, due to the fact that the crops do not change sufficiently on the fields.
- Corn, due to long-term growing (as monoculture), influences soil and leads to nutrient depletion and the deterioration of soil fertility.
- On the fields, the harvest is every year widely destructed by wild boars.

Based on the above issues we were looking for ways to eliminate such incurred costs and how to providing input into biogas more efficiently (while respecting the existing possibilities for company).
To meet this objective, it was necessary to carry out evaluation of the land on which plant production is grown. Assessment and determination of the optimal structure of crops is limited by soil characteristics and properties that were evaluated. In determining the appropriate crops structure, we focused on the assessment of soil conditions and production possibilities in Kapušany area, in which, besides others, the farm carries out its crop production.

We have evaluated the adequacy of the individual cultivation of crops which are useful in this area also for energy purposes. We took into account the availability of the crop, the production parameters and possible technical limitations of planting and harvesting.

The following crops were selected in order to assess the appropriateness and subsequent processing of map output of suitability of growing crops:

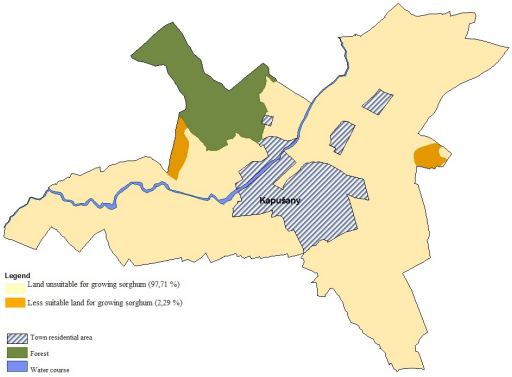
- sorghum,
- barley,
- wheat,
- rape,
- and in the last case, we also consider the growing willows (as fast-growing trees) for energy purposes.

Sorghum is a cereal crop, mostly grown for food, but often also for technical and feed purposes. In the non-food industry, 95% of produced sorghum is used for bioethanol and biogas production. For bioethanol production is used mainly grain and partially whole plants (Sweet Sorghum). For the purpose of biogas production is harvested the whole crop, which subsequently silage. Sorghum as an energy plant has become increasingly important.

Sugar can also easily produce ethanol. One ha of Sweet Sorghum is sufficient to produce about 3000 - 4000 litres of pure alcohol. As a substrate in a biogas plant 1 ha will supply about 4800 m3 of methane. This amount can produce approximately 18,500 kWh (which is the annual consumption of about four households). (Chobotová, www.kws.de)

Results of our evaluation of suitability for cultivation of sorghum (Map 1) in this area, however, showed that nearly 98% of assessed land is not suitable for this crop. Thus, despite the most appropriate energy characteristics of sorghum, it is not appropriate for a given location (even taking into account soil characteristics).

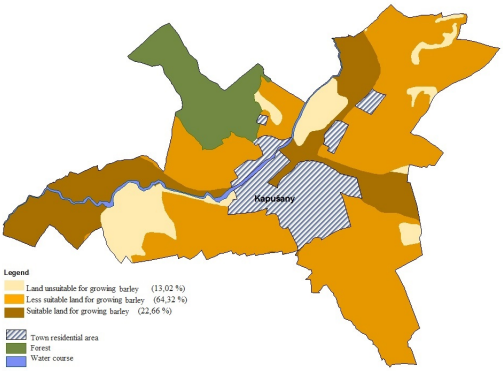
**Map 1 Evaluation of the suitability of sorghum cultivation in the Kapušany area**




Source: VUPOP, 2016

Barley (Hordeum distichon) is very productive crop that in a relatively short growing period (90-120 days) creates a rich biomass and can be grown on the territory of Slovakia, also in the site in question. Barley can be used also as an energy crop.

**Map 2 Evaluation of the suitability of barley (Hordeum distichon) cultivation in the Kapušany area**




Source: VUPOP, 2016

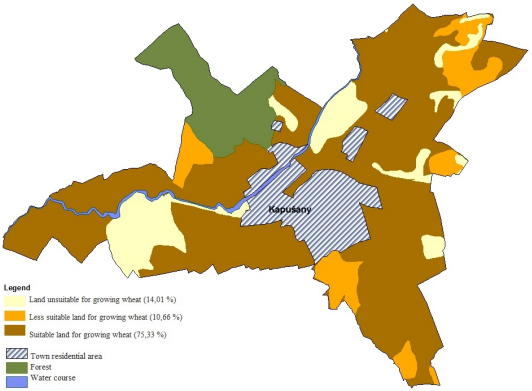
In the studied area soils were characterized in order to determine soil suitability for growing barley. Based on the results of evaluations (Map 2), it can be stated that most of the surveyed area represents less suitable soil for growing barley (64%) and 22% of land consists of soil suitable for its cultivation.
Production potential of barley on less adequate soil represents 3,0 to 3,8 tons per hectare, and soils suitable for its cultivation it is 3,81 to 4.6 tons per hectare. (Soil Science and Conservation Research Institute, Soil maps)

Winter wheat (Triticum aestivum) in terms of its production is very popular and widespread agricultural crop. It is grown throughout Slovakia and it creates nutritional base as one of the main inputs to the food industry. Use of wheat is broader and can be also used for energy purposes.

Results of realized evaluation of suitability for cultivation of wheat in this area, however, showed that more than 75% of soils are suitable for growing wheat and nearly 11% of soils are less suitable for growing wheat.

Based on the evaluations, it is possible to determine the value of the production potential in these areas. In case of suitable land for growing wheat, the production potential is 4.01 to 5.00 tons per hectare. Production potential of wheat on less adequate soil represents from 3.41 to 4.00 tons per hectare. (Soil Science and Conservation Research Institute, Soil maps).

**Map 3 Evaluation of the suitability of wheat (Triticum aestivum) cultivation in the Kapušany area**




Source: VUPOP, 2016

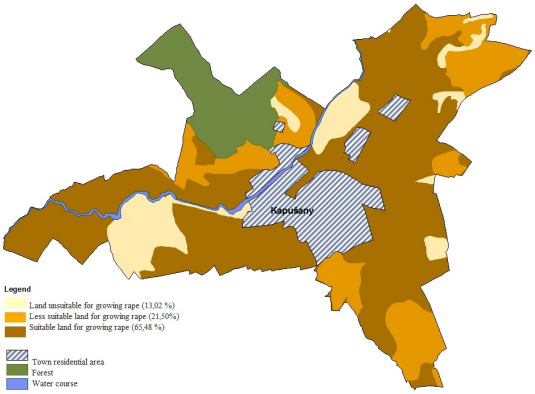
Rapeseed (Brassica napus) in the recent period is a widespread cultivation of crops such as for food and for energy purposes and also because it is relatively modest to land but also to agro technical practices. From rapeseed it is possible to produce biofuels (in different ways), for example its biomass can melt in ecological boilers. Great advantage is that its combustion does not create the greenhouse gas emissions. Biomass from rapeseed allows production of pellets. They are produced by compression in the pelletizing press and they have a calorific value of 15-19 MJ / kg, which is comparable to brown coal, or wood briquettes.

In the evaluated area we dealt with the assessment of the suitability of soils for the cultivation of rapeseed. The evaluation found that more than 65% of soils are soils suitable for growing rapeseed, 21.5% of soils are less suitable for growing rapeseed and 13% of land is unsuitable for growing rapeseed. The results are shown by the map output.

In addition to these result we can determine also production potential of the rapeseed. (In suitable soil rapeseed reaches production potential of 2.01 to 2.50 tons per hectare and on less suitable soils, the production potential of rapeseed is 1.51 to 2.00 tons per hectare and on unsuitable soils (in this case it is more than 13% of the total assessed

area) the production potential or rapeseed is less than 1.5 tons per hectare (Soil Science and Conservation Research Institute, Soil maps).

**Map 4 Evaluation of the suitability of rapeseed (Brassica napus) cultivation in the Kapušany area**




Source: VUPOP, 2016

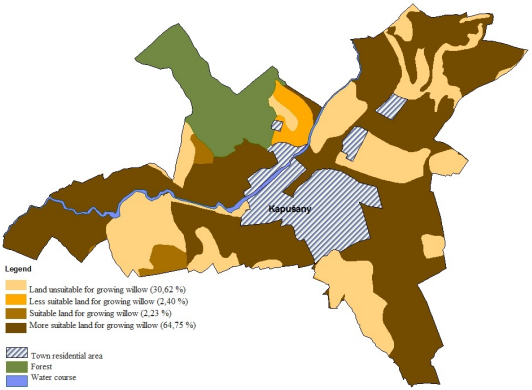
One possible alternative of agricultural land use according to Soil Science and Conservation Research Institute (Soil Science and Conservation Research Institute, Soil maps), which is not profitable to use for food production, is the production of biomass for energy production. The main types of biomass resources include fast-growing tree species (e.g. willow, poplar, alder, and acacia).

Fast-growing tree species in comparison to energy forests are advantageous in terms that the time between planting and harvesting is significantly shorter. It ranges between 2-5 years and the plantation is renewed after 20-30 years. Fast-growing tree species also can annually produce larger volumes of biomass in the same area. The parameters that are critical in the selection of fast-growing trees are their availability, suitability for the type of soil and climate and the potential yield per hectare per year (t/ha/y). The yield is the most important indicator, and the willows grown in our conditions can reach 15 tons of dry matter per hectare per year. The gain of some willows ranges from 2 to 3 meters per year (2-3 cm per day in summer).

For less traditional crops (compared with conventional crops - cereals and oilseeds), we chose willow for our evaluation - as a possible appropriate energy crop. Its cultivation can be cost-effective and beneficial in favorable locations, but due to the return on the initial investment, this is to be expected after about the third cycle of cultivation.

The energy potential of willow:
- The yield is 15 tons per hectare per year.
- The energy content is 16 GJ per ton.
- Potential energy yield is 240 GJ per hectare per year.

**Map 5 Evaluation of the suitability of willow (Salix) cultivation in the Kapušany area**




Source: VUPOP, 2016

In the area under consideration - Kapušany - almost 65% of soils are very suitable for planting willow and 30% of the land is not suitable for growing willow (map 5).

Regarding the specificities of growing willows it is necessary to consider changing "sown structure" and on the land that is not suitable for cultivation of cereals or oilseeds we recommend to set up a plantation (despite higher investment costs).

## 5. Conclusions

The paper evaluates the possibilities of growing crops for energy purposes in a given area, in terms of the available capacity.

Maize, which the company still grow as energy crops has many disadvantages - high inputs, crop variations, the risk of soil erosion and limited area of cultivation (Jamriška, P). From traditional crops are considered suitable for this area also other cereals (triticale, rye), including straw, while energy efficiency of straw is higher than the burning of entire plants.

Although current trends in the use of phytomass for energy use make towards the use of cereals, the search for other alternative and economically efficient sources is conducted. As an example of other crops grown for energy purposes can be mentioned rapeseed (Brassica napus), sunflower (Helianthus annuus), but also grasses - Festuca arundinacea Schreb., Arrhenatherum elatius, Phragmites australis etc..

According to Pekárová (http://old.agroporadenstvo.sk/rv/energrastliny/menej_pp.htm), in generally natural and financial benefit is achieved at the highest quality soils. From this view implies also the concern that our best quality land will be used primarily for the cultivation of crops for energy purposes. With regard to energy crops, the selection must be approached individually, which means to favor unpretentious crops. Knowledge of demands of individual crops on the environment as well as knowledge of potential of particular environment is a prerequisite for the efficient use of land resources. In terms of localization the energy crops have great potential in the farming of less productive land, i.e. secondary agricultural lands that are set aside for alternative agricultural use, for example the production of

bioenergy. Allocation on secondary soils also does not undermine the production of basic agricultural commodities grown on primary soils.

The change of conventional cropping structure in the area under the consideration – Kapušany, would avoid some problems - for example, excessive damaging crops caused by wild animals, which currently represents a significant problem. By the change of cropping structure it is also possible to expect more efficient use of each land (due to their characteristics and production capabilities), but also their (albeit partial) revitalization.

In conclusion, it is necessary to focus further research also to the use of other, alternative crops in this area.

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