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EVALUATION OF SMALL AND MEDIUM-SIZED ENTERPRISES OPERATING IN SHORT SUPPLY CHAINS WITHIN SLOVAK SCHOOL PROGRAMMES

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Despite of reduction of its share on the gross domestic product, agriculture remains a branch generating job opportunities in rural areas. However, through more intensive farming procedures, it puts a pressure on environment and sustainability of agricultural production and prolongs the distance of distributed goods. Reduction of the mentioned impacts is possible through shortening the food supply chain subsequently resulting in increase of local sale, demand for local services and increase of labour market, putting an emphasis on support of small and medium – sized enterprises and their economic viability improvement. This paper evaluates the performance of small and medium enterprises and micro-enterprises which applied for the support and supplied and distributed fruits, vegetables, milk and milk products to kindergartens and primary schools within the School Fruits and Vegetables and the School Milk programme. We suppose that through supplying local schools they contributed to the food supply chain shortening.

Keywords: short food supply chains, micro-enterprises, small enterprises, medium enterprises, School Fruits and Vegetables programme, School Milk programme, receipts from sales of own products

In conditions of the Slovak Republic, short food supply chains are a relatively young concept, using mostly local human and material sources. This is a basic character of the local economic development which is based on endogenous development concept and on sources inside the relevant locality. Agriculture is a branch using mostly local material sources; it is among the most important branches in national economy and one of the most important branches providing job opportunities mainly in rural areas of Slovakia. According to Rovný and Nagyová (2007), "agriculture is significantly involved in creation of rural economy that is created outside of large cities and forms the primary material-producing economy, subsequently associated with services, industry and trade". Although the share of agriculture and forestry in both Slovakia's gross domestic product and employment is declining, in rural areas it is one of the few branches that creates jobs. According to Ilbery et al. (2004), agriculture remains the economic backbone of lagging rural regions with "geographical remoteness, poor infrastructures, low population densities, limited employment opportunities and poor development capacities", however, according to De Fazio (2016), "implementation of farming methods, which are getting more and more intensive, puts pressure on the environment, on the sustainability of the agricultural industrial production process and increases the number of kilometres the goods have to travel in order to be distributed". As De Fazio (2016) furtherly states, "lengthening of the supply chain seen in the last decades – through the multiplication of intermediaries – has produced effects from environmental, economic, social and territorial points of view that cannot pass unnoticed". The emergence of synergies between agriculture and other rural activities, like tourism and handicraft (Gralton and Vanclay, 2009), as well as economic gains provided by less transportation (Rong, Akkerman and Grunow, 2011), are important effects of shortening food supply chains (Sellitto, Machado Vial and Viegas, 2018) which seems to be a logical solution of current situation. According to Kneafsey et al. (2013), shortening the number of links in the supply chain results in increased local sales, increased demand for local services, and increased labour market. Although often associated to other concepts such as "local food", "alternative food chains", "local food systems", "direct sales" etc. (Galli and Brunori, 2013), more detailed evidence shows that short food supply chains are different systems with different characters and typology.

Van der Ploeg (2000) defines "new food supply chains as a commonly recurring phenomenon in several fields of rural development centred around distinctive product qualities including organic farming, high quality production and region-specific products". A key characteristic of short supply chains is their capacity to re-socialize or respatialize food, thereby allowing the consumer to make value-judgements about the relative desirability of foods on the basis of their own knowledge, experience, or perceived imagery (Marsden et al., 2000).

According to Kneafsey et al. (2013), "the relative importance of local sales or short food supply chains will vary in relation to enterprise size and scale, as well as

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geographical location (e.g. proximity to urban markets or tourism destinations)", while from the point of view of economic success the author states that farmers and producers "may interpret success not in narrow economic terms, but in terms of their social and environmental contribution". There is a similar opinion on economic aspects of short food supply chains provided by Galli and Brunori (2013), emphasizing the importance of short food supply chains mostly for small and medium enterprises especially because "they are often less competitive in the conventional chains due to their higher costs of production (because of the lack of economies of scale and the different organisation of production processes) and the higher prices" and due to a fair access to the market they can increase their economic viability.

Micro-enterprises, small enterprises[1] and medium enterprises are at a significant disadvantage in the conventional food chain compared to large enterprises, mainly because of the high cost of production and the prices they sell their products for. On the other hand, they are an important source of innovation in the food chain, while the aim of the Common Agricultural Policy of the EU is to help ensure the livelihood of millions of small farmers in the European Union while promoting competitive and sustainable agriculture. Particular attention is paid to how small farmers are able to address the growing consumer demand for high-quality and traceable foods that support local economies and communities, as we assume that by providing products to local customers (local consumers, schools, kindergartens, social facilities services), their products achieve higher added value due to their higher quality.

In this paper we evaluate the performance of small and medium enterprises and micro-enterprises within short food supply chains which applied for the support and supplied and distributed fruits, vegetables, milk and milk products to kindergartens and primary schools within the School Fruits and Vegetables and the School Milk programme.

Material and methods

Shortening the supply chain through the supply of fruit, vegetables, and milk and dairy products to local facilities and through the support provided by the Agricultural Paying Agency under the school programs, we assume that successful applicants for support achieved better economic results in the observed period. Data to verify this assumption were obtained from the following sources:

– Agricultural Paying Agency, section Market organisation (http://www.apa.sk/organizacia-trhu), within the School Fruits and Vegetables and the School Milk programmes we gained the list of approved applicants for the school year 2017/2018;
– Register of Financial Statements of the Ministry of Finance of the Slovak Republic – from the financial statements of the monitored enterprises, we gained data on the receipts from sales of own products. We collected the data for enterprises that applied for support under the school programmes, observing the years 2015 and 2016, i.e. two years before the start of supply and distribution of fruit and vegetables, milk and dairy products to school facilities, when we supposed the enterprises did not perform in the short supply chain yet, and in 2017, when we expected enterprises (approved applicants) to begin deliveries to school facilities within the I. delivery period, i.e. from 1 September 2017 to 31 December 2017; Subsequently, we calculated and compared the average value of receipts from sales of own products of the observed enterprises in the given years;
– Agricultural Paying Agency. InfoService. ATIS, Market reports – milk and dairy products (http://www.apa.sk/mlieko-a-mliecne-vyrobky) – from the market reports on milk and dairy products, we calculated from the individual months of 2015, 2016 and 2017 the average values of average purchase prices of raw cow milk and compared them with the average values of the receipts from sales of own products. The aim of this step was to find out how the average value of the receipts from sales of own products changed in the observed period together with the average purchase price of raw cow milk. The limiting factor when determining the data was their unavailability for 2018.

1 In accordance with the Commission Regulation (EU) No 651/2014 of 17 June 2014 declaring certain categories of aid compatible with the internal market in application of Articles 107 and 108 of the Treaty, a small enterprise is defined as an enterprise which employs fewer than 50 persons and whose annual turnover and/or annual balance sheet total does not exceed EUR 10 million. A micro-enterprise is defined as an enterprise which employs fewer than 10 persons and whose annual turnover and/or annual balance sheet total does not exceed EUR 2 million.

Results and discussion

The call for tenderers for the supply of fruits, vegetables and their products under the school programme for the school year 2017/2018 was published on May 25, 2017. The call for applicants for activities in the school programme for the school year 2017/2018 (part – school milk) was published on July 31, 2017. The call for approved applicants for activities in the school programme for the school year 2017/2018 for the submission of applications for the allocation of the maximum amount of support for the school year 2017/2018 for both school programmes was published on August 24, 2017. For this school year, the maximum amount of support for 42 applicants under the School Fruits and Vegetables programme and for 9 applicants under the School Milk programme was approved. Applicants were assigned to individual categories of enterprises based on the definition of the Commission Regulation (EU) No. 651/2014, using receipts from sales of own products as a determining indicator for defining applicants to be within the category of the micro, small or medium-sized enterprise. Under the School Fruits and Vegetables programme, 27 micro-enterprises (64%), 11 small enterprises (26%) and 4 medium enterprises (10%) were approved for the support. Under the School Milk programme, the support was approved for 4 micro-enterprises, 3 medium enterprises and 2 large enterprises (Figures 1 and 2). Figures 3 and 4 show the development of the average values of the applicants' receipts

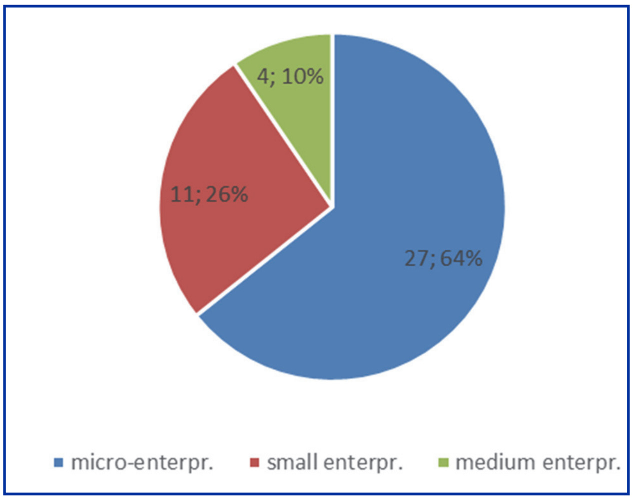

Figure 1 Number of applicants (according to categories of enterprises) approved within the School Fruits and Vegetables programme
Source: Agricultural Paying Agency, 2017

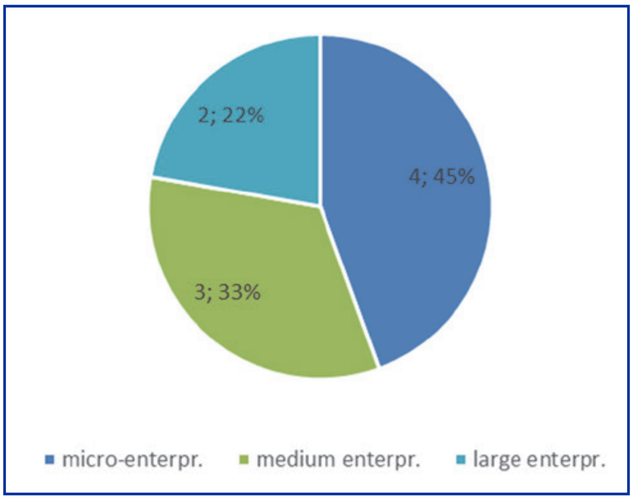

Figure 2 Number of applicants (according to categories of enterprises) approved within the School Milk programme
Source: Agricultural Paying Agency, 2017

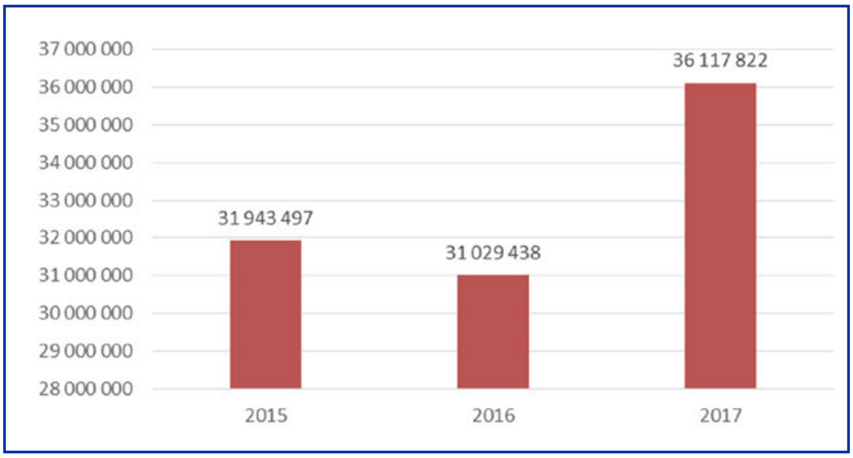

Figure 3 Average values of receipts from sales of own products of enterprises within the School Fruits and Vegetables programme
Source: Ministry of Finance of the Slovak Republic, Register of Financial Statements

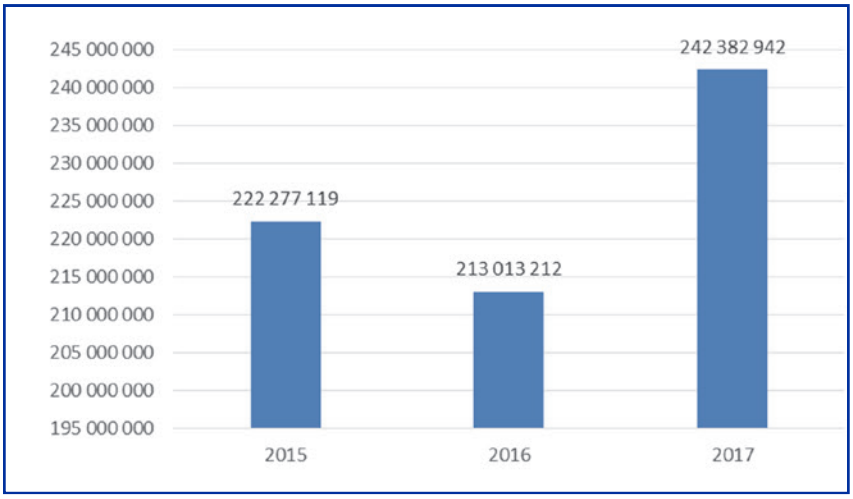

Figure 4 Average values of receipts from sales of own products of enterprises within the School Milk programme
Source: Ministry of Finance of the Slovak Republic, Register of Financial Statements

from sales of own products within the two school programmes, which was unbalanced in the monitored years 2015, 2016 and 2017. While in 2016 there was a drop in sales of applicants approved under both programmes in comparison with 2015, in 2017 they increased by 16.4% in the School Fruits and Vegetables programme and by 13.79% in the School Milk programme. It can be assumed that this increase in sales was related to the supply of fruit, vegetables, milk and milk products to pre-school and school facilities, as we see in Figure 3 and 4. However, these figures may be distorted in certain extent, as other factors may have affected the increase in sales, e.g. the price of the various types of fruit and vegetables that have been delivered to school facilities or the purchase price of raw cow milk. For this purpose, as an example, we calculated the average price of raw cow milk for each reference year from the purchase prices of raw cow milk in the individual months of 2015, 2016 and 2017. The development of these average prices is shown in Figure 5 compared with the development of average value of receipts from sales of own products of applicants approved under the School Milk programme, while the development of both indicators was the same in the observed period. The average purchase prices of raw cow milk decreased in 2016, but in 2017 the average purchase price (compared to 2016) increased by 22.4%.

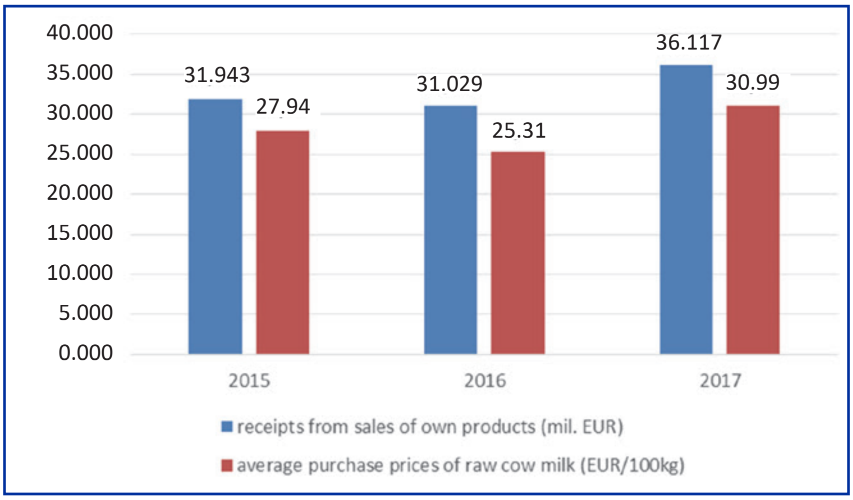

Figure 5 Comparison of development of receipts from sales of own products of enterprises within the School Milk programme and the average purchase prices of raw cow milk
Source: Agricultural Paying Agency

Conclusion

From the achieved results of the work we can evaluate the performance of small and medium enterprises in the short food supply chain through school programmes as generally successful, both in terms of the number of applicants and in terms of receipts from sales of own products. We evaluate very positively the fact that the vast majority of participants in school programmes were micro-enterprises (64% in the case of the School Fruits and Vegetables programme and 45% in the School Milk programme), while in terms of their categorisation in accordance with the Commission Regulation (EU) No. 651/2014, we prefer to consider their annual turnover.

From the point of view of receipts from sales of own products we can state that enterprises supplying the local preschool and school facilities with fruit, vegetables, milk and dairy products under the school programmes, achieved much higher sales in 2017 (by 16.4% in the School Fruits and Vegetables programme and by 13.79% under the School Milk programme compared to 2016), when they already supplied fruit, vegetables, milk and dairy products to kindergartens and primary schools in the 1st delivery period from September 1, 2017 to December 31, 2017. However, it is distorting in this perspective that in order to simplify the process of comparing the individual years, we calculated the average values from receipts from sales of own products of individual applicants, separately for the School Fruits and Vegetables programme and separately for the School Milk programme, which we then compared. This means that the increase in sales in 2017 did not have to occur for each applicant, while the largest sales of own products in 2017 could be achieved by large companies due to their high economic performance. Other factors could also have an impact on the increase in sales, which was confirmed by comparing the development of average values of receipts from sales of own products under the School Milk programme with the development of the average purchase prices of raw cow milk, where we found that the development of both indicators in the observed period was identical. This finding leads us to the conclusion that performance of an enterprise in the short food supply chain does not necessarily imply an improvement in its economic situation, even with the support of the relevant managing authority (Agricultural Paying Agency for school programmes). It is necessary to take into account other factors which have an impact on its economic performance, e.g. its size (large enterprises in terms of their performance have a more stable position in the market) or the purchase price of the supplied commodity in the market.

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ENTREPRENEURSHIP OF CITIES THROUGH BUSINESS COMPANIES IN THE SLOVAK REPUBLIC

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Local self-governments in the Slovak Republic have many possibilities to do business to capitalize their assets and generate their own budget revenues. The purpose of the article was to identify and evaluate business companies through which local self-governments conduct business from different perspectives. We focused on businesses with asset ownership of municipalities with city status. When analyzing businesses, we have taken into account their size, spatial layout, legal form, subject of activity, and their economy. Slovak cities have a long-term experience with conducting business through business companies. Most of these are companies with 100% ownership of the cities, in terms of the legal form of a limited liability company. The research results confirm that the significant effect of government-run business is the increase in the value of assets.

Keywords: local self-government, entrepreneurship, assets of local government

Almost in all developed, but also in developing countries of the world we can meet with some form of public enterprise. Such business has a long tradition in providing certain types of services. According to Arapis (2013) today, the importance of public enterprises is, above all, to build infrastructure, stimulate economic growth, and provide public services and the diversification of revenues of public budgets.

Bel et al. (2010) state that there are five factors that may affect public enterprise, namely:

- management support,
- motivation of employees,
- big expectations,
- the division of labour ("the right person in the right place"),
- and services.

The government, along with the local self-government, plays an important role in promoting entrepreneurship in order to accelerate regional economic growth (Bruton et al., 2015). Garrone et al. (2010) argue that public business plays an important role in relation to the performance of local self-governments.

In drafting the basic legislation that concerns the status of municipalities and cities of Slovakia, when adopting Act No. 369/1990 Coll. on Municipalities, the assets -legal position of the local self-government was clearly defined as follows: "The municipality is a legal entity which, under the conditions established by law, independently manages its own assets and own revenue." Thus, the municipality is a territorial unit in the form of a legal entity, where the law directly assumes that one of its main activities will be the management of its own assets.

Owning assets is the basis for any economic activity of any entity that creates tangible goods or provides services. Therefore, this ownership also applies to municipalities that are required to carry out certain activities under current legislation (Voorn et al., 2017).

Municipalities and cities have a number of opportunities to engage in entrepreneurial activities in the Slovak Republic and thus appreciate their assets (Benčo, 2006). What form of business the municipalities and cities decide for is up to them and this decision is determined by the way of management and controlling the business activities.

The basic legislation governing the local self-government business and the management of public assets in the administration of any municipality is considered as follows:

- Act No. 369/1990 Coll. on Municipalities,
- Act No. 513/1991 Coll. Commercial Code,
- Act No. 595/2003 Coll. on Income Tax,
- Act No. 523/2004 Coll. on the Financial Regulation of General Government.

According to Papcunová and Balážová (2006), municipalities and cities can establish three types of entities for the purpose of doing business:

- Allowance organizations established by a city,
- Businesses with 100% city ownership,
- Companies with a city ownership of less than 100%.

Hajšová and Kútik (2009) argue that in the beginning of the general establishment a mandatory transformation of municipal enterprises into budget or allowance organizations took place. Budgetary and allowance organizations are established by a resolution of the municipal council, where the municipality issues a founding deed on their establishment. An allowance

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organization is a legal entity that can be set up by a municipality on the basis of basic public functions or intended for public service activities. This organization's budget is made up of revenues, costs, and an economic result. The advantage of this organization is also the possibility of taking a loan.

The municipality can establish a commercial company on the basis of Act No. 513/1991 Coll. Commercial Code. In this Act, a company is defined as a "legal entity established for the purpose of doing business." In terms of the business activities of a municipality, commercial companies are among the most interesting forms of securing those goods and services where profitability is important. By decisions of municipal councils, municipalities may set up commercial companies, mostly joint stock companies or limited liability companies (Tóth et al., 2014).

Material and methods

The main goal of the paper was to identify and analyze business companies in which local self-governments have ownership from various perspectives. We focused on municipalities with a city status in Slovakia; there are 140 of them. Enterprises with ownership of cities were analyzed from the following points of view:

- the number of companies as of December 31, 2018,
- spatial layout
- the level of the city's ownership,
- legal form,
- year of establishment,
- amount of basic capital,
- number of employees,
- field of activity according to SK NACE,
- economic result,
- revenue,
- and asset value.

The economic result, revenues and value of assets were monitored during the period of 2012–2017. The FinStat database was used as the main data source.

Results and discussion

The use of public assets for business purposes is realized in three basic forms in Slovakia. First and foremost, it is through business companies, secondly, municipalities can also carry out their business activities to a limited extent through their allowance organizations, and in the case of municipalities with lower population, self-businesses are also used, that is doing business in municipality's own name under the Trade Licensing Act. In our research, we have focused on local self-governments making business through business companies.

When monitoring the number of enterprises owned by local self-governments for the period of 2005 to 2017, we can say that they significantly reduced (Figure 1). This is a 22.9% decline over the reporting period.

Currently, from all 140 Slovak cities, only 11 have no ownership in any company, namely: Hanušovce nad Topľou, Ilava, Leopoldov, Modrý Kameň, Nováky, Rajecké Teplice, Spišská Stará Ves, Strážske, Turany, Veľké Kapušany and Zlaté Moravce. Table 1 below provides an overview of the number of companies in which cities have ownership.

Based on the results of the research, we can conclude that there are currently 324 companies with municipal ownership. From the spatial point of view, least municipalities with the status of a city are located in the Bratislava Region (18 trading companies) and vice versa, most of them are in the Banská Bystrica Region (49 trading companies). Although there is the largest number of cities in the Banská Bystrica Region, the largest number of companies with a capital participation does not operate there.

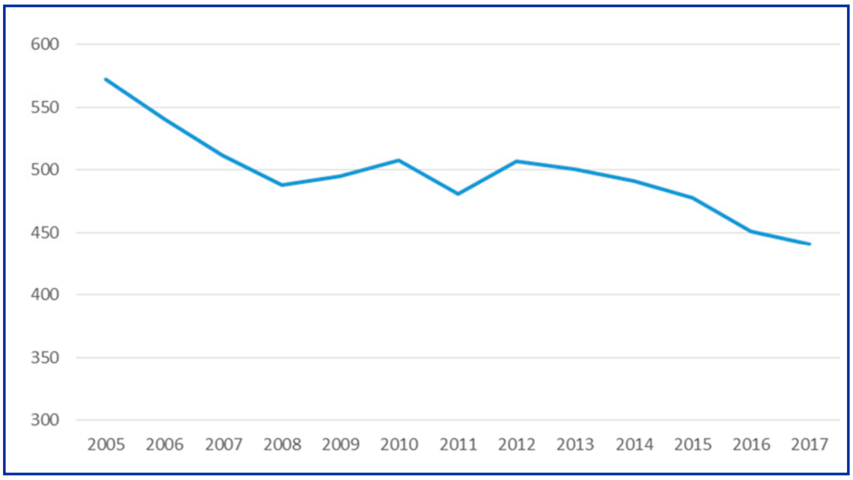

Figure 1 Development of Number of Enterprises Owned by Local Authorities (Municipalities and Cities)
Source: Own processing based on Statistical Yearbooks from 2006 to 2017

Table 1 Number of companies owned by Cities as of December 31, 2018

Region	Number of cities	Number of companies
Bratislava Region	6	18
Trnava Region	18	43
Trenčín Region	18	47
Nitra Region	15	27
Žilina Region	19	42
Banská Bystrica Region	24	49
Prešov Region	23	60
Košice Region	17	38
Total	140	324

Source: Own processing of data from finstat.sk

Table 2 Businesses by the height of share ownership of cities as of December 31, 2018

Business companies owned by local self-governments ownership share	Number	%
Business companies owned by local self-governments – ownership share 100%	213	65.74
Business companies owned by local self-governments – ownership share over 50% and less than 100%	34	10.49
Business companies owned by local self-governments – ownership share 50%	7	2.16
Business companies owned by local self-governments – ownership share less than 50%	70	21.60
Total	324	100.00

Source: Own processing of data from finstat.sk

The region where most of these companies operate is the Prešov Region (60 trading companies).

Of the total number of 324 business companies, there are 213 cases (65.74%) of companies with 100% share ownership of cities (Table 2). In 34 companies (10.49%), the capital participation of cities is between 50% and 100%. Seven companies have a 50% share ownership. The last group are the businesses with a minority share ownership, there is 70 (21.6%) of them.

In terms of legal forms, these are predominantly limited liability companies (93.21%) and in twenty-two cases (6.79%) joint stock companies (see Table 3). Other legal forms of companies are not represented, because they are considered not suitable for local self-government. In a public business company, shareholders are liable for their obligations with their entire assets and the murevenuenicipality owns assets that is used for public purposes. As far as the commandite limited partnership is concerned, the municipality can only act as a limited partner, which is liable for its obligations only up to the amount of its outstanding deposit.

Table 4 shows the number of companies with ownership of cities by the period of establishment. Most companies (58.95%) were established by 2002. Based on this, we can say that these are long-term companies and that cities have long-term business experience. 110 companies (33.95%) were established between 2003 and 2012. Since the year 2013, only 23 new companies have been established (7.1%).

In the following Table 5, companies with equity holdings were divided into three groups by basic capital. The first group includes companies with a basic capital of up to € 50,000; it is the largest group, involving 195 (60.19%) companies. They are followed by companies with a registered basic capital ranging from € 50,000 to € 100,000, where 17 (5.25%) of them fall. There are 112 (34.57%) companies with registered basic capital of over 100,000 €.

When examining companies with capital share of cities, attention was also paid to the assessment of the size structure in terms of the number of employees. Five size groups have been identified (Table 6). Up to 166 (51.23%) companies have fewer than 10 employees, so in terms of staff we can say that they are so-called micro-enterprises. There are 50 (15.43%) of the 10 to 19 employees and 68 (20.99%) of the 20 to 49 employees. Another group, of 50 to 249 employees, which can be described as a group of so-called medium-size enterprises, is made up of 35 (10.80%) companies. There are only 5 (1.54%) companies with over 250 employees (we call them large enterprises). These companies are: Bratislava

Table 3 Business companies with capital share of cities by legal form as of December 31, 2018

Legal form	Number	%
Limited liability companies	302	93.21
Joint stock companies	22	6.79
Total	324	100.00

Source: Own processing of data from finstat.sk

Table 4 Business companies with capital share of cities by year of establishment as of December 31, 2018

Year of establishment of company	Number	%
Up to 2002	191	58.95
2003 to 2012	110	33.95
After 2013	23	7.10
Total	324	100.00

Source: Own processing of data from finstat.sk

Table 5 Business companies with capital share of cities by amount of basic capital as of December 31, 2018

Basic capital of companies	Number	%
Up to 50 000 €	195	60.19
50 000 € to 100 000 €	17	5.25
Over 100 000 €	112	34.57
Total	324	100.00

Source: Own processing of data from finstat.sk

Table 6 Business companies with capital share of cities by number of employees as of December 31, 2018

Number of employees	Number	%
Less than 10	166	51.23
10 to 19	50	15.43
20 to 49	68	20.99
50 to 249	35	10.80
Over 205	5	1.54
Total	324	100.00

Source: Own processing of data from finstat.sk

Transit Company, Waste Removal and Disposal (Bratislava), Prešov Transit Company, Hospital of Snina, LLC, and Žilina Transit Company.

The distribution of enterprises according to their activity is presented in Table 7. The largest group deals with steam supply and cold air distribution (13.58%). It is followed by real estate management companies that operate based on fees and contracts (9.26%) along with forestry companies (9.26%). Among the multiple groups of enterprises we can also include enterprises whose activity is the collection of non-hazardous waste (8.33%) as well as enterprises engaged in the rental and operation of their own or leased real estate (8.02%).

The subject of interest was also the management of the identified companies through which the cities conduct business. Profit or loss of these companies for the period 2012–2017 is shown in Table 8. During the period under review, the vast majority of companies managed a profit (from 205 in 2012 to 194 in 2017). In 2012, profits ranged from 44 € to 1,580,852 €. The profit of 1,580,852 € was achieved by FCC Trnava, LLC, the owner of which is the city of Trnava. The company is engaged in collecting non-hazardous waste and generated sales of 7,317,799 € in that year. At the end of the reporting period, in 2017, profits ranged from 119 € to 821,220 €. The company with the highest profit was Bytkomfort, LLC, in which the city of Nové Zámky has the 51% share in the registered basic capital. Its business is the supply of steam and cold air distribution.

When examining the amount of revenue, individual companies with capital share of cities were divided into five groups (Table 9). In each year, the largest group is a group of companies with sales over 1,000,000 €. In 2012, there were 83 companies and in the last year, in 2017, there were 79 companies. The average amount of sales in 2012 reached

Table 7 Business companies with capital share of cities by their field of activity as of December 31, 2018

Field of activity – SK NACE	Number	%
35300 Steam supply and cold air distribution	44	13.58
68320 Real estate management companies based on fees and contracts	30	9.26
02100 Forestry	30	9.26
38110 Collection of non-hazardous waste	27	8.33
68200 Rental and operation of own or leased real estate	26	8.02
38210 Processing and disposal of non-hazardous waste	22	6.80
93120 Sports club activities	16	4.94
93110 Operation of sports facilities	15	4.63
60200 Television broadcasting and television subscription programs	14	4.32
81290 Other cleaning activities	12	3.7
81300 Landscaping activities	7	2.16
59110 Production of films, videos and television programs	5	1.54
Other	76	23.46
Total	324	100.00

Source: Own processing of data from finstat.sk

Table 8 Business companies with capital share of cities by economic result

Economic result	2012	2013	2014	2015	2016	2017
Profit	205	231	210	229	228	194
Loss	51	62	73	54	49	44

Source: Own processing of data from finstat.sk

Table 9 Business companies with capital share of cities by revenue

Revenues	2012	2013	2014	2015	2016	2017
up to 50 000 €	32	31	28	32	32	25
50 000 € to 100 000 €	16	20	21	19	18	20
100 000 € to 500 000 €	65	74	75	74	74	67
500 000 € to 1 000 000 €	49	57	61	60	51	41
over 1 000 000 €	83	89	84	84	91	79

Source: Own processing of data from finstat.sk

Table 10 Business companies with capital share of cities by asset value

Asset value	2012	2013	2014	2015	2016	2017
up to 100 000 €	54	81	67	64	86	7
100 000 € to 500 000 €	40	56	60	56	61	7
500 000 € to 1 000 000 €	21	31	36	36	34	6
1 000 000 € to 5 000 000 €	61	87	80	83	75	7
over 5 000 000 €	31	38	40	39	52	174

Source: Own processing of data from finstat.sk

1,274,159.74 €, and in 2017 it was less by 10.04%, that is 1,146,237.64 €. Approximately 10% of businesses generated sales of up to 50,000 € in the period under review.

The object of interest was also the analysis of the development of the value of the assets of the companies in question. From this point of view, five groups of companies have been identified and presented in Table 10. In the period under review, we can observe a gradual increase in the value of the assets of enterprises with capital share of cities. While in 2012 only 31 companies belonged to the group with a value of over 5,000,000 €, in the last year of 2017 it was 174 companies. An important positive effect of doing business by local self-governments through companies is to increase the value of their assets.

Conclusion

Public business can be found at all levels of governance within public administration, at supranational, federal, national, regional and local levels. The reasons why public enterprises in the world have been created vary depending on the local context.

In the paper, we focused on public enterprise, specifically on businesses with ownership of cities and on the use of self-governing assets for business purposes in Slovakia. As mentioned above, the use of public or self-governing assets for business purposes is realized in the Slovak Republic in three basic forms (business in the form of trading companies, through allowance organizations and doing business in municipality's own name under the Trade Licensing Act). However, what particular form of business to choose is always an individual decision of a given local self-government and this decision is also determined by the way of management and controlling the business activities. In practice, we often encounter entrepreneurship of local self-government through business companies.

Cities in the Slovak Republic have long-term business experience through business companies, which is confirmed by the fact that more than 58% of the identified enterprises were established before the year 2002. In terms of share of ownership, it is predominantly a company with 100% ownership share (65.74%). Up to 93.21% of all businesses were limited liability companies. The basic capital was mostly 50,000 €. 51.23% of enterprises employ fewer than 10 employees, so they are so-called micro-enterprises and only 5 enterprises qualify as large enterprises. The business activities of the companies under investigation are various; according to the SK NACE classification, the largest group of companies (13.58%) is dedicated to steam and cold air distribution. In terms of economic results, in most of the monitored years, the vast majority of companies managed to be profitable. The research results confirm that an important effect of entrepreneurial activity of local self-governments is to increase the value of their assets.

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DIFFERENCES IN AGRICULTURAL SUPPORT BETWEEN COUNTRIES – THE OECD MEASUREMENT

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Countries provide different levels of support from public expenditures to farmers. Some countries subsidise their agricultural producers more significantly. On the other hand, other group of countries provides less support to their producers from public resources. Different international organisations and institutions provide their own indicators as in the case of the Oranisation for Economic Co-operation and Development (OECD). The OECD provides a comprehensive framework to measure the level of support and to identify its structure. This measurement provides a comparable review of support to agriculture from public budgets and helps to evaluate the transfers from taxpayers to producers or consumers. The aim of our work was to present this measurement framework, the differences in support between OECD and some non-OECD countries and to see if there is an evidence of development in level and/or in structure of supports in agriculture in the 2016, 2017 and 2018´s editions of OECD publications taken into consideration. The comparative analysis shows that not only the level, but the composition of support differes from country to country.

Keywords: agricultural policy, differences in agricultural support, policy monitoring and evaluation, OECD support indicators, producer support estimate

The Organisation for Economic Co-operation and Development (OECD) is an inter-governmental organisation which provides a multilateral forum to discuss, develop and reform economic and social policies. It is a place to address common challenges of member countries. The OECD´s main mission is to provide advise and help countries to respond to new developments and challenges of globalisation in line with its main motto: "Better Policies for Better Lives". The Organisation provides a setting to compare national policies, seek solutions to common concerns, identify good practice and promote policies for sustainable economic growth and employment and a rising standard of living.

From 1986 OECD is doing a comprehensive and comparable review of agricultural support provided from public budgets to help the agricultural sector to be more competitive. In 1986 OECD published a complex system of indicators to measure the transfers from taxpayers to producers or consumers. The OECD indicators were created in order to monitor and evaluate developments in agricultural policies, to establish a common base for policy dialogue among countries, and to provide economic data to assess the effectiveness and efficiency of policies (OECD, 2016a). Since 1986, when the indicators work was mandated by OECD Ministers, the calculations have been done for an increasing number of countries.

Based on the OECD measurement, the developments in level and changes in structure of the agricultural support from mid-1980s to present days are possible to be identified. Other important comparisons accross OECD and non-OECD countries of agricultural policies are possible, as well as the detailed analysis of recommendations which are formulated by the Organisation to help the agricultural sector to be more competitive. However, the aim of this paper is to explain the principles of the measurement and to show the differences across the whole range of OECD and non-OECD countries in providing support from public expenditures to farmers.

A relatively limited number of research papers dealing with the OECD measurement is available. Exept of the whole range of OECD papers and publications with the aim to bring the comprehensive system of indicators up to date, Siudek and Zawojska published in 2012 the results of their empirical research covering the investigation period from 1986 to 2009. In 2007, Bielik et al. conducted a comparative analysis of the OECD and EU agricultural support policies. Finally, there is a series of academic polemics or critical exchanges of views on limitations of the OECD measurement between French and Dutch economists on the one hand and the OECD represented by Stefan Tangermann on the other hand, trying to argue that correct interpretation of the indicators is needed more than a revision of the concept used by the OECD (Tangermann, 2005). The last revision of the set of indicators was done in 2016. This is the reason why we make references mainly to the 2016 version of the so called PSE Manual. In 2016 the revision was focused especially on the GSSE indicator.

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It is important to mention that except of the OECD, also other international organisations and institutions deal with their own indicators (e.g. the United Nations Food and Agriculture Organisation – FAO, and the World Bank). However, the OECD PSE/CSE concept has provided a solid resource of internationally comparable information on support levels in agriculture for over the last more than 30 years.

Material and methods

In general the method that we used in our paper is the comparison of data calculated by the OECD as result of data entered in the PSE/CSE indicator calculations. A comprehensive review of recent available literature, covering a relatively limited number of materials dealing with the OECD measurement and original OECD publications formed the basis of our empirical research.

Over the examined period, the number of covered countries by the OECD measurement differs and it has a rising tendency. We explained below both the timeframe as well as the number of covered countries. It is almost impossible to present in this simple paper the complete picture of possibilities how to use this system of indicators and its developments accross time and countries or regions to evaluate trends in agricultural policies and level and structure of supports applied by different countries. Despite this, countries on which we put our emphasis are the EU member countries or more precisely, the EU as a single economic area.

The Slovak Republic as a part of the European Union from 2004 is in the OECD agricultural monitoring and evaluation publications covered under the EU chapter. For this reason, the EU members are shown in one single aggregated EU chapter.

The OECD uses a comprehensive system for measuring and classifying support to agriculture – the Producer Support Estimate (PSE) and other related indicators, CSE – Consumer Suppor Estimate, TSE – Total Support Estimate and GSSE – General Services Support Estimate (OECD, 2016b). They provide insight into the increasingly complex nature of agricultural policy and serve as a basis for OECD´s Agricultural Policy Monitoring and Evaluation publication series (OECD, 2017). The OECD indicators of support measure monetary transfers to individual producers (PSE), consumers (CSE) and to producers collectively (GSSE). In PSE and GSSE the focus is on primary agriculture.

In our paper we use examples in particular from the PSE indicator and its percentage. A % PSE e.g. of 20% means that the estimated value of transfers to individual producers from consumers and taxpayers is equivalent to 20% of gross farm receipts (OECD, 2011). However the whole set of indicators shows the best the complete scale of subsidising agriculture from public resources. Detailed data and documentation for calculations of supports are available in OECD PSE/CSE database on www.oecd.org/agriculture/PSE.

We decided to make a representative choice and use the time framework which is based on data published in 2018, 2017 and 2016 versions of the OECD Monitoring and Evaluation of Agricultural Policies publication, which cover data from the years 2013–2017. More than 50 countries (51 in 2018, 52 in 2017 and 43 in 2016) are covered in last three editions of this publication series of OECD reports that monitor and evaluate agricultural policies across countries. Countries covered in our research are mainly OECD member countries[1], but to better demonstrate the differences in support across countries some non-OECD countries are taken into consideration as well[2]. In total countries covered in these three last editions of the Monitoring report account for about two-thirds of global agricultural value added.

Those indicators do not measure the impact of policies but they can be used as inputs in different models. PSE calculations are used e.g. in the Policy Evaluation Model (PEM) – a partial equilibrium model of the agricultural sector developed by the OECD. The model has been designed to translate PSE data into economic impacts of policies on markets and producers. It is the main tool to assess the impact of policy reforms (Brooks, Dyer and Taylor, 2008). OECD uses this economic model to better understand the development and evaluation of effectiveness of agricultural policies and their impact on agro-food production, trade, incomes of farmers, environment and others (OECD, 2016b). This model is used to estimate e.g. the impact of EU CAP reforms on production, trade and land use as well.

From the very begining of evaluation and monitoring work, based on data collected and PSE/CSE calculations, OECD provides a range of findings and recommendations for member as well as non-member countries.

Results and discussion

As it is evident also from the Table 1 below, the support to agricultural sector varies widely across the OECD countries. At the one extreme, countries like Norway, Japan, South Korea, Switzerland or Iceland subsidise their agricultural producers more significantly, close to or above 50% of gross farm receipts. On the other hand, countries like New Zealand, Australia, South Africa, Brazil and Chile provide less support to their producers from public resources, with the % PSEs below or around 5% in 2014–2016. The average of OECD in total is approximately 18% over the period analysed.

Government transfers and subsidies in agriculture have a long history and have evolved significantly. Meuwissen considers that the motivation for state intervention

1 The OECD member countries in 2018 were 35: Australia, Austria, Belgium, Canada, Chile, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Japan, Korea, Latvia, Lithuania, Luxembourg, Mexico, the Netherlands, New Zealand, Norway, Poland, Portugal, the Slovak Republic, Slovenia, Spain, Sweden, Switzerland, Turkey, the United Kingdom and the United States. In 2017 OECD had 35 members as well. In 2016 there were 34 OECD members (without Lithuania).

2 The non-member countries analysed in edition 2018 were: Brazil, China, Colombia, Costa Rica, Kazakhstan, the Philippines, Russian Federation, South Africa, Ukraine and Vietnam. In 2017 OECD analysed Brazil, China, Colombia, Costa Rica, Indonesia, Kazakhstan, the Philippines, Russian Federation, South Africa, Ukraine and Vietnam as non-OECD members. In 2016: Brazil, China, Colombia, Indonesia, Kazakhstan, Russian Federation, South Africa, Ukraine and Vietnam.

Table 1 Producer Support Estimate by country, Agricultural Policy Monitoring and Evalutation, editions 2018, 2017 and 2016
Percentage of gross farm receipts in years 2013–2017

Country	% PSE (edition 2018 – years 2015–2017)	% PSE (edition 2017 – years 2014–2016)	% PSE (edition 2016 – years 2013–2015)
Ukraine	-7.7	-8.6	-6.3
Vietnam	-0.9	-2.5	0.6
New Zealand	0.9	0.8	0.7
Australia	1.7	1.9	1.6
Chile	2.6	3.0	3.2
South Africa	2.7	3.2	3.1
Brazil	2.7	3.8	3.1
Kazakhstan	5.5	5.0	12.5
Canada	9.3	9.3	9.7
United States	9.6	9.5	8.8
Mexico	8.8	9.8	10.2
Costa Rica	7.8	10.0	not covered
Russian Federation[1]	13.3	13.9	14.6
China	15.5	14.9	20.1
Colombia	13.1	15.5	16.6
Israel	17.3	15.7	9.7
European Union[2]	19.3	19.6	19.0
Philippines	26.1	24.5	not covered
Indonesia[3]	not covered	24.9	24.6
Turkey	25.3	26.5	20.9
Japan	46.0	47.0	48.2
South Korea	52.3	49.3	49.7
Iceland	57.6	55.5	49.1
Switzerland	56.0	57.7	55.7
Norway	57.3	59.7	59.7
OECD average[4]	18.0	18.0	17.0

Sources: OECD (2018, 2017, 2016), Producer and Consumer Support Estimates, OECD Agriculture statistics (database). dx.doi.org/10.1787/agr-pcse-data-en
Notes: 1 – for Russia, the used data in edition 2016 is from 2012–2014: unweighted avareges; 2 – EU28; 3 – for Indonesia, the used data in edition 2017 is from 2013–2015; 4 – only OECD member countries covered (35 in edition 2018, 35 in edition 2017 and 34 in edition 2016); does not include the non-OECD EU member states

in agriculture and agricultural markets is various, but one of the major objectives has been to stabilise farm income (Bojnec and Fertő, 2019). The distinction how countries provide the support to farmers is at least as important as the level of the support. As Czyzewski and Smedzik-Ambrozy (2017) explain for the case of the EU, the productivity of resources in agriculture is affected not only by the total amounts of subsidies, but by their structure as well. Governments have a large portfolio of measures at their disposal: they can provide payments on the basis of farm output area, animal numbers or couple the payments to specific production practices, for example to achieve sustainable development goals or environmental objectives. The comparative analysis shows that not only the level, but the composition of support differs from country to country as well.

In most countries, the majority of support continues to be provided through measures with the highest distortive potential (OECD, 2018). One of the potentially most distorting measures considered by the Organisation as one of the most harmful for the agricultural production and trade, is the market price support (MPS) which is continuosly widely used in several OECD and non-OECD countries. Depending on the exact policy mix, this type of support tends to have negative impacts on the environment as it gives additional incentives to expand and intensify land use (OECD, 2017). In many OECD countries – as well as in most emerging economies – this type of support is still the largest part of supports to producers. The reason why this support is still so popular is that it does not affect public budgets, as the support is paid by consumers of some protected products. In the whole OECD area, the MPS was around 45% of the PSE in 2014–2016. In comparison, the MPS is at least 80% in Israel, Japan and Turkey and more than 90% of the PSE in South Korea.

The negative impact of this approach is known – such policies promote trade friction, distort incentives, and in many cases have proven as ineffective at reaching their goals. Many OECD countries have put in place reforms to target and deliver better their supports. Progress can be seen in countries that provide a more significant level of support to their agricultural sector as well as those who have historically subsidised their agriculture less (Martini, 2011).

Less-dirtorting forms of supports are provided e.g. by Australia, Brazil, Chile, Mexico, the European Union and the United States. These forms of support include payments based on other inputs or payments based on animal numbers, farm receipts or farm income. These instruments are typical mainly for the European Union (64% PSE in 2014–2016) or the United States (45% PSE), among others.

Other significant trend is not to couple payments with production decisions. This is typical for the EU, where payments based on current area or animal numbers have been cut in favour of direct payments based on non-current criteria without production requirements (OECD, 2017).

In some countries, payments are increasingly used to be conditional and to encourage producers to adopt specific practices to improve environmental performance of farming or to assure animal welfare measures. Payments may also be linked to overcome agri-environmental constraints or to programmes which farmers can adopt on a voluntary basis. These approaches are more reflecting the growing importance to face societal concerns and expectations, such as maintenance of agricultural landscapes or biodiversity.

For example, over time, the Common Agricultural Policy of the EU has developed a range of support measures that address environmental constraints in agriculture. Most direct payments in the EU are conditional on meeting the cross-compliance goals. As well as some of payments from the EU Rural Development Programme are provided as compensations to farmers who fulfill more stringent conditions as cross-compliace standards. These include the agri-environmental payments and organic farming payments, or Nature 2000 and Water Framework directive payments which are also associated with compulsory environmental requirements. Other more current example of measure adopted at the EU level is the Greening, introduced into CAP in 2014–2020. A recent OECD analysis shows that the environmental components in the CAP 2014–2020 may have a positive, if limited, impact on environmental outcomes (OECD, 2017).

The level of the % PSE achieved by the EU is approximately 18%. From all analysed reports, as well as from the OECD PSE/CSE database across time comparison, it is visible, that the EU has gradually reduced its support to agriculture since the mid-1990s. New instruments have gained weight and price distortions have been significantly reduced. At the same time, in the EU, more payments have to fulfill environmental requirements.

Few recommendations are formulated by the OECD in the framework of the EU agricultural policy developments assessment. After the end of milk quota in 2015, and the sugar quota in 2017, wich are considered by OECD as important steps away from production and trade distortion, further steps in other sectors remain to be done. However, about 50% of support to producers is conditional on mandatory environmental constraints, the efficiency of the environmental measures should be assessed in the future. Amendments of the CAP should focus on offering European farmers a levelled playing field, deepening market orientation and better targeting support to improve the long-term productivity, sustainability and efficiency of the sector. The allocation of a greater share of the budget to research and innovation programmes under Horizon 2020 is a move in the right direction (OECD, 2017).

Substantial variability between countries during the examined period occurred. In accordance with the Table 1, some countries provide to farmers smaller and some of them more significant support in terms of annual PSE percentage. The taxation of producers affects negatively the PSE in some countries (e.g. Ukraine). The empirical results from regression models of Siudek and Zawojska (2012) reveal, among other, that when countries are becoming richer, the percentage of the PSE is generally decreasing.

As it is shown in the Table 1, European countries are comprised in the single EU-chapter dealing with aggregated data of individual countries. For this reason it is not possible to formulate recommendations for individual EU members and to compare them among themselves. This applies also for the case of Slovakia. It is due to the fact, as Pokrivčák and Ciaian (2004) stated as well, that after its accession to the EU Slovakia lost its independent national agricultural policy. The EU agricultural sector is currently highly subsidised. Examining the effects of the Common Agricultural Policy of the EU is therefore becoming increasingly important (Zbranek and Chrastinová, 2018).

Conclusions

Out of the years 2016, 2017 and 2018´s editions of the OECD Monitoring and evaluation publication, it is evident that public policy support continues to be important for the agricultural sectors of some countries and countries provide different levels of support from public expenditures to farmers. The support to agricultural sector varies widely across the OECD and non-OECD countries.

The comparative analysis shows that not only the level, but the composition of support differs from country to country. The OECD recommends having more ambitions and move from trade distorting policies towards policies more related to environmental protection and sustainable use of natural resources. The burden of agricultural support on countries´ economies has generally declined over the time, but public support is still important for the agricultural sectors of some countries (OECD, 2017).

The continued strong use of market price support is evident from PSE/CSE calculations in many countries. The distortions created by these policies can have significant negative impacts on markets (OECD, 2017). OECD recommends that the countries review their agricultural policy packages with the aim to better reach the policy objectives and to ensure more coherent approach with economy-wide policies and better deal with market or climate risks.

Over the time, the importance to provide support to the agricultural sector from public expenditures has changed. In most OECD countries, producer support has declined from mid-1990s. However, producer support has increased since 1990s in some emerging countries. Another significant finding is evident from these OECD reports as well: support to producers in the OECD area and emerging economies converge (OECD, 2017).

The PSE indicator and its percentage show how OECD and different non-OECD countries support their agricultural sectors from public resources. However, in order to lead to conclusions with more considerable results we have to take into consideration the whole range of OECD indicators which enter the PEM model to measure supports in agriculture from the OECD PSE/CSE system and data. This effort could be a continuation of our research work in the future.

As Slovakia is currently covered under the aggregated EU chapter in the OECD agricultural monitoring and evaluation publications, this could be considered as one of the limitations of the OECD measurement. The identification of possible other limitations could be the subject of our future research as well.

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VERIFICATION OF THE GREEN MICROALGAE BIOMASS USE FOR BIOGAS PRODUCTION

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The article reviews the energy potential of microalgae as an alternative raw material for anaerobic digestion. Currently, energy security is one of the main topics among researchers. The amount of generated fossil fuels is limited, it is a question of time when fossil fuels will not continue to be accessible at low cost. There is a need to find an alternative carrier of energy which will replace the fossil fuels in the World. Green microalgae can be proposed as a possible bio raw-material, which can be used as an input material in order to produce energy. Lots of alternative technologies of algae cultivation are currently being developed all over the world. There is a necessity to search for a sensible way to produce algal biomass for bioenergy purposes, while maintaining all requirements involved in environmental and economic issues. The research results presented in the science article show that microalgae biomass is the proper alternative material for biogas production with the method of anaerobic fermentation. We believe that these research results can contribute to the future development of all forms of renewable energy in the Slovak Republic.

Keywords: biomass, microalgae, anaerobic digestion, biogas

The search for new alternative input materials for biogas plants is currently highly topical because of growing capacity to produce maize silage which is limited and at the same time also impinges on economic issues (high cost input material). Slovak Republic committed to increase the use of Renewable Energy Resources (RERs) in gross final energy consumption from 6.7% (2005) to 14% by 2020. The expected total energy consumption from Renewable Energy Resources for 2020 is approximately 80 PJ. Moreover, the Renewable Energy Directive (2009/28/EC) puts more emphasis on renewable energy than on biofuels by noting that 10% of energy used in transport should be renewable by 2020 (EU, 2009). Considering that, we should raise our awareness of alternative energy resources (for example algal biomass).

Cultivation of microalgae biomass – phases of growth of algae

We can underline the following phases in the growth of microalgae (Edmundson and Huesemann, 2015):

Lag Phase – the process of adaptation of algal suspension (inoculum) in a growth medium (culture). Generally, the duration of the initial phase is basically proportional to the duration time of process of inoculation.

Exponential Phase – the most important phase in the whole algae growth, the phase where we are able to control algal growth, by changing the parameters and environmental conditions (spectrum of light, pH, temperature, nutrients content, circulation time) created in a bioreactor with algal suspension. The density of algal cells increases.

Stationary Phase – the phase where the speed of algal growth is stabilised. In this phase the limiting factors (solid particles blocking the light, high concentration of phosphorus, nitrogen) are balanced.

Senescent Phase – this phase is called "culture crash". In the period of the last phase (culture collapse) the level of nutrients and water quality is not sufficient to sustain the growth of new cells. The number of algal cells usually quickly diminishes.

Basic factors required for the cultivation of microalgae

One of the most essential elements for the general positive result in algae cultivation process is proper selection of microalgae species, which is the most appropriate for the specific application (differences in cell wall structure, oil content, and growth parameters).

Light and heat

The photosynthetic activity of microalgae is usually limited due to availability of light intensity, nutrients and technological design of culture system. The highest data for the outdoor cultivation of microalgae in the world performs 30–40 g of dry weight m^2/day (Goldman, 1979). Light exposure should be kept in an optimal range (light and dark cycle), light duration can have a huge influence on final concentration of biomass, content of proteins and fatty acids (Ren, 2014). As defined by Schlagermann et al. (2012), effectiveness of light conversion into biomass is determined by photo-conversion efficiency (PCE) which is a decisive

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parameter. It is characterised by energy obtained by the process of conversion in comparison with available sunlight delivered to the conversion process.

Mixing

Mixing is a crucial parameter during the process of algae cultivation (Richmond, 2004). The proper intensity of mixing is required to transfer biomass in water. Mixing can reduce the concentration of nutrients as well as the gradient of temperature (Vasumathi et al., 2012). Moreover, mixing is very important for the cell growth, it prevents sedimentation of algal cells, the attachment of cells to the walls of bioreactor (cultivation system) and formation of dead zones (Carvalho et al., 2006).

CO_2 (e.g. flue gas)

As defined, algae were universally accepted as the proper solution for monitoring the greenhouse gas emissions. The research has demonstrated the efficient uptake of CO_2 (the amount of 159 mg/l per/day with 93% of CO_2 consumption efficiency) (Tsai et al., 2017). The capacity of microalgae to fix CO_2 enables to allocate carbon in cells of algae (Klinthong et al., 2015), pH controls CO_2 supply, which means carbon capture (Ying et al., 2014). The biogas plant produces various types of off-gases that are rich in CO_2 and thus can be used for the production of different types of microalgae. The CO_2 content in the exhaust gases is usually between 3–15%. Exhaust gases from agricultural biogas plants have relatively higher levels of CO_2 (approximately 12%). These gases are suitable as the carbon source for the cultivation of microalgae (Van Iersel and Flammini, 2010).

pH

The pH of microalgae suspension is a very important factor which affects the algal growth. The unsuitable pH level can have a negative impact and can be the inhibiting factor during the process of biomass generation. Generally the acidic media (pH 5–7.5) are beneficial for freshwater eukaryotic algae (Razzak et al., 2013).

Temperature

When the light intensity is reduced, temperature is the crucial parameter which has a huge impact on growth of algae. Temperature can affect the photosynthetic rates of different algae. As examined by Xiao et al. (2009) the temperature is an essential factor during algal growth, it determines intracellular processes, which can influence the final concentration of algal suspension. Temperature conditions can affect directly the growth rate of green microalgae (Singh, 2015).

Nutrients

The growth medium is aimed to supply the important inorganic factors, being in a further process the main components which build microalgae cells, these being: nitrogen, phosphorus, potassium and iron. The chemical estimation of the minimum content of the nutrients which have to be provided for the algae cultivation is specified in accordance with the molecular formula especially formulated for the biomass of algae: $CO_{0.48}H_{1.83}N_{0.11}P_{0.01}$ (Chisti, 2007).

Elimination of oxygen

Green microalgae produce oxygen in proportion to their growth. Oxygen should be removed, it is strongly connected to the activity of CO_2-fixing enzyme RuBisCO, which is responsible for the generation of biomass (competition between oxygen and enzyme) (Lodish et al., 2000; Haas et al., 2013).

Material and methods

The genus of microalgae *Chlorella sorokiniana* was selected for this study. The cultures of microalgae were cultivated in the laboratories of the Environmental Institute, Koš (Slovakia) within the biotechnological process conducted in an enhanced Bold's Basal medium (Andersen, 2005). For the cultivation of *Chlorella sorokiniana*, there was used a 10-liter bioreactor, which was later replaced by a 100 L bioreactor (10 L of algae suspension was added to 90 L of culture medium) while maintaining the optimum temperature between 25–28 °C. The bioreactor was not covered. The cool-white lamp (Sun-Glo T8 Fluorescent Aquarium Bulb, 30 Watt, 29.7 µmol/ s/m^2, 4200 K, 36 Inch) was used for the cultivation (photoperiod: 16 : 8, light:dark ratio). The proper pH level was kept between 7.0 and 7.3, using pH controller (digital pH CO_2 controller PH-201; electrode L: 100 mm, D: 10 mm; measuring range: 0.00 to

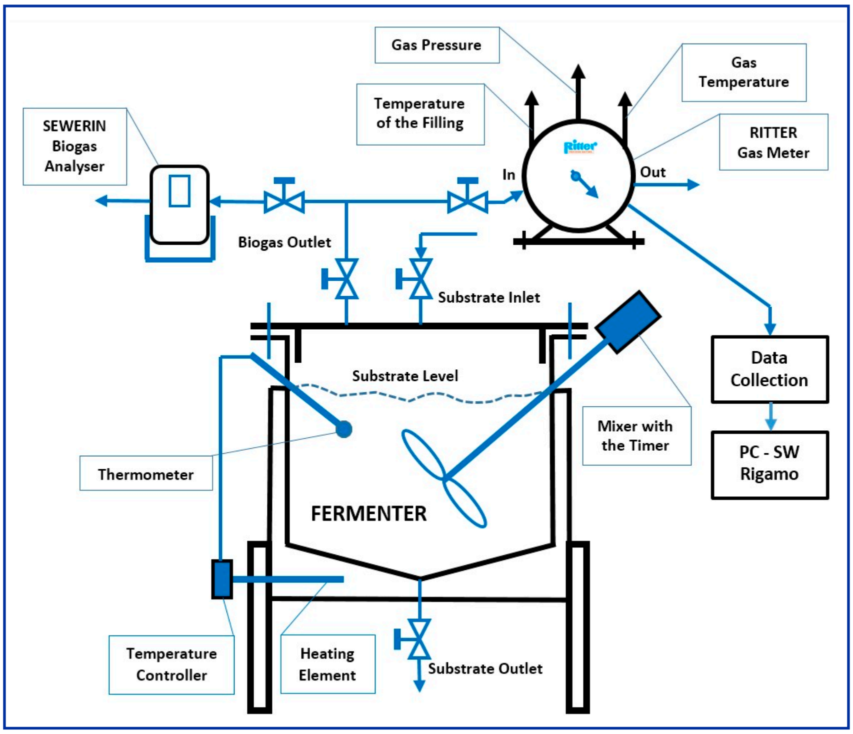

Figure 1 The technological scheme of the experimental fermenter 100 L
Source: author

Figure 2 The substrate: the inoculum + microalgae after filling of the fermenter
Source: author

14.00 pH; power supply: 230 V/50 Hz; dimensions: 100 × 20 mm). The algal suspension was circulated in the bioreactor (24 hours) with the use of CO_2 diffuser TURBO (diameter approx. 4.5 cm of height with base approx. 7.5 cm, height of the cover approx. 2.5 cm; power supply: 230 V).

Production of biogas from *Chlorella sorokiniana*

The microalgae biomass (3.5 L) from *Chlorella sorokiniana* (Figure 2), concentration of DM 1.05%, was processed during the comparative test of biogas yield in the workplace of the Department of Regional Bioenergy in Kolíňany. For our experiment we used the experimental fermenter (as presented on Figure 1) for batch tests.

The fermenter was filled with the inoculum taken from the biogas plant in volume of 97 L, where the microalgae (3.5 L) were added. The fermenter was constructed from the following parts: stainless steel tank (100 L of net volume), electric water heating, digital temperature control, electric low-speed mixer (12 cycles of mixing per day from 20–30 minutes). The value of the achieved biogas was recorded every hour. Each experiment directed to detection of the yield of biogas is carried out in the period of 30 days. After closing of the fermenter, it was set to auto mode control heating at 40 °C ±1 °C, as well as the automatic recording mode of the cumulative biogas production. The value of biogas production was recorded every hour. The processed outputs of individual endpoints are shown in the following tables and graphs.

Results and discussion

The processed outputs of the monitored parameters are given in the table and graphs. The values of monitored parameters and chemical composition of microalgae and inoculum are presented separately in Table 1. The cumulative production of the biogas is presented in Figure 3. The course of methane, carbon dioxide and hydrogen sulphide content in the biogas is showed in Figure 4.

The performed experiment has shown that algae *Chlorella sorokiniana* is a biomaterial, which can be used as an input material in order to produce biogas (as shown in Table 2). The significant result was in level of hydrogen sulphide which was low (267.32 ppm), the low content is important due to the fact that generated biogas will later require the

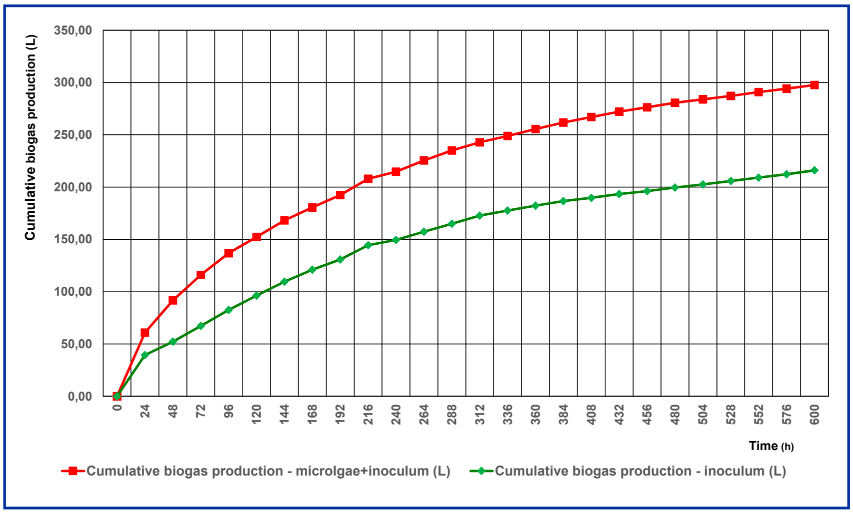

Figure 3 Comparison of the biogas cumulative productions from two substrates: microalgae *Chlorella sorokiniana* + inoculum and inoculum
Source: author

Table 1 The measurement of algae biomass *Chlorella sorokiniana* and inoculum

Input material (amount)	Temperature (°C)	pH	DM (%)	ODM (%DM)	COD (mg/L)	Ntot (mg/L)
Chlorella sorokiniana	20	8.2	1.05	73.91	13000	294
Inoculum	20	7.3	1.20	68.97	14000	300

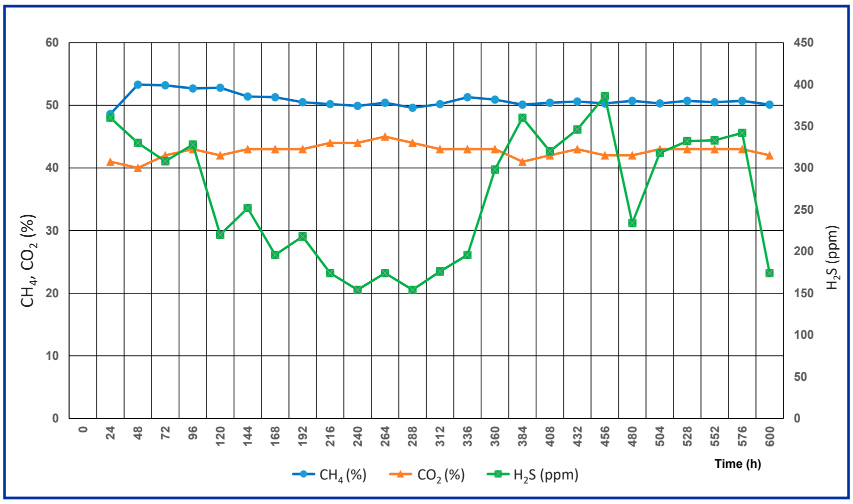

Figure 4 The course of methane, carbon dioxide and hydrogen sulphide in the produced biogas (author)

minimum desulphurisation. The average daily production of biogas was 11.90 L (in total 297.60 L). The conversion of biomass to the value of dry matter and organic dry matter (DM %, ODM %) of microalgae in the fermenter was as follows:

DM = 0.037 kg of DM of substrate

ODM = 0.027 kg of ODM of substrate

The average overall production of biogas (BP) on the unit of DM and ODM of the substrate was as follows:

BP production = 2.215 m^3/kg of DM

BP production = 2.997 m^3/kg of ODM

In comparison with results from the same experiment, with the use of liquid manure (inoculum 97 L, 1.20% DM) in the content of: pig liquid manure (80%) and cattle manure (20%). The total biogas production (in total 216.08 L) was 0.186 m^3/kg per unit of DM with the methane content of 50.83%. The results are presented in Table 2.

Comparing our results with biogas production achieved from maize silage (from previous experiments), the production of biogas was 0.689 m^3/kg per unit of DM and 0.954 m^3/kg per unit of ODM. Our experiment with the use of *Chlorella sorokiniana* gave the result of higher productivity, which means 2.215 m^3/kg per unit of DM and 2.997 m^3/kg per unit of ODM. However, we should also note the value of obtained hydrogen sulphide in produced biogas which was low (267.320 ppm), the low content is very important due to the fact that the generated biogas will not later require desulphurisation process. Based on our experimental results we should underline the high amount of achieved methane (CH_4) in biogas produced from microalgae *Chlorella sorokiniana*, which was 50.83%. Comparing our results with other research testing the potential of microalgal biomass for biogas production we can notice lower methane contents. Based on research results performed by Wang et al. (2013) they stated 19% of improved methane yield in case of *Chlorella* sp. (41% of DM), as well as taking into account the results provided by Olsson et al. (2014) where there was achieved 18% of improved methane yield in case of mixture *Chlorella* sp. and *Scenedesmus* sp. (37% of DM). The obtained results have shown that biomass of green microalgae *Chlorella sorokiniana* can be used as an input material to produce biogas with the method of wet fermentation. Green biomass can produce quite high values of methane (CH_4), and obtained biogas contains low values of hydrogen sulphide (H_2S), as indicated in Table 2. The obtained results give us a positive view into the future, it shows that there is a way to replace the traditional raw materials with algal biomass, which can be cultivated and harvested through the whole year, regardless of weather conditions and land area.

Conclusion

The results of the research collected in this science article allow formulating the following conclusion that microalgae biomass from *Chlorella sorokiniana* is the proper input material for biogas production, it generates the biogas with high methane content and low content of hydrogen sulphide. We believe the work will contribute to the comprehensive program for the use of all forms of renewable energy in the National Research Area.

Table 2 The average calculated values and the comparison of composition of the produced biogas from microalgae and liquid manure

Substrate (input material)	Total biogas production (L)	Average dose of substrate (kg)	Average biogas production per unit of DM (m^3/kg)	Average biogas production per unit of ODM (m^3/kg)	Average methane content (%)	Average carbon dioxide content (%)	Average hydrogen sulphide content (ppm)
***Chlorella sorokiniana* 3.5 L**	81.520	0.037	2.215	2.997	50.830	42.680	267.320
Liquid manure 97 L	216.080	1.164	0.186	0.269	50.830	41.720	253.240

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ENERGY PRODUCTION POTENTIAL OF WOOD BIOMASS FROM SRC PLANTATIONS IN CADASTRAL AREA OF NOVÉ ZÁMKY

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The renewable energy sources play an important role in the discussions on the future energy generation. The European Union has set certain goals to increase the share of renewable energy sources and to reduce carbon emissions. The paper focuses on the evaluation of energy production from short rotation coppice (SRC) plantations in the cadastral area of Nové Zámky. The study area is located in south-western Slovakia. The energy production was evaluated based on GIS analysis of agricultural land suitable for establishment of short rotation coppice plantations. The high-quality arable land was excluded from the biomass production. The wood biomass should be produced on marginal, low-quality soils and contaminated or degraded land that is unsuitable for food production. There are only high and medium-quality soils classified in the qualitative groups 1–7 in the study area. The land potentially used for biomass production represents an area of 1,536 ha. If the whole area would be covered by short rotation coppice plantations, it would produce 4.8 kWh/day per person. Taking into consideration the overall losses of 33% in the process of the energy conversion, the potential power from the wood biomass production is 3.2 kWh/day per person. The plantations would provide 61 new jobs in the study area.

Keywords: renewable energy, short rotation coppice, soil quality, south-western Slovakia

Renewable energy sources (RES) are considered as a new model of energy for sustainable development (Dincer and Acar, 2017; Vidadili et al., 2017). In Europe, efforts are being made to completely replace fossil fuels and produce the overall energy from the RES based on the Smart Energy System concept (Connolly, Lund and Mathiesen, 2016). The term green economy is becoming increasingly common. It is defined as a system that leads to the improvement of human well-being and social equality while significantly reducing environmental risks and ecological shortcomings. In the green economy, revenue growth and employment are generated by public and private investments that reduce carbon emissions and pollution, increase energy efficiency and resource use and prevent loss of biodiversity and ecosystem services (Gasparatos et al., 2017). The European Union (EU) has set goals to increase the share of renewable energy sources and to reduce the amount of carbon emitted to the atmosphere by anthropogenic activities. However, climate change goals could be missed unless there is larger decarbonization of the energy sector (Khanam et al., 2017). Bioenergy is seen as a tool that could help to reduce the dependence on energy importing countries and promote sustainable development. There are certain constraints though that need to be considered including the amount of land required and carbon leakage in the process of biomass production (Bilgili et al., 2017). Biomass energy currently accounts for about 10% of global energy production. Two-thirds are generated in less developed countries, with only 7% of biomass resources being used worldwide (da Costa et al., 2018; Welfle, 2017; Narayan, 2007). Wood biomass from plantations in the combination with wood from forest could play an important role as an energy alternative in Europe (Mola-Yudego et al., 2017). The aim of the paper is to assess the potential of local energy production from short rotation coppice plantation in the cadastral area of Nové Zámky.

Material and methods

The study area

The cadastral area of Nové Zámky is located in the southwestern part of Slovakia on the Danubian Lowland (47° 59′ 08″ N 18° 09′ 28″ E) at an altitude of 119 masl (Figure 1). The land relief does not pose any obstacles to territorial development or transport and provides suitable conditions for economic and agricultural use of the territory. The town is an administrative centre of the Nové Zámky District. The population of Nové Zámky is 38,486.

The District is characterized by a warm and very dry climate with a mild winter. It is the warmest area in Slovakia (Lapin et al., 2002).

The arable land has a dominant position in the land use of the study area. The total area of the cadastre is 7,256.5 ha and the agricultural land represents 5,388.4 ha which is 74% (Aurex, 2016). The soils are moderate loam with the dominance of chernozem. The humus content is high, more than 2.5% (Marsina and Lexa, 2002).

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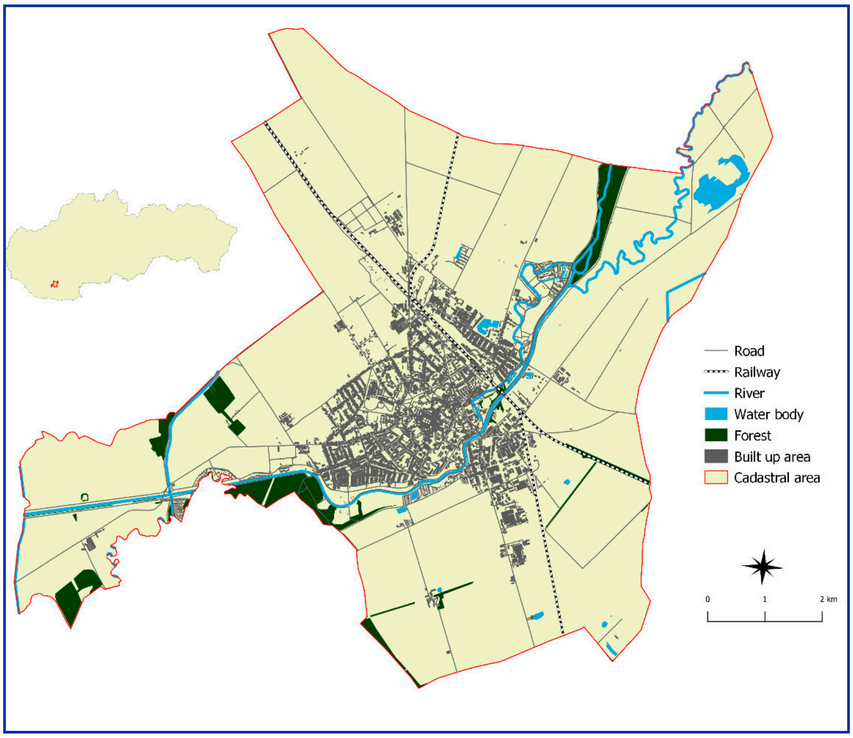

Figure 1 Cadastral area of Nové Zámky
Source: author

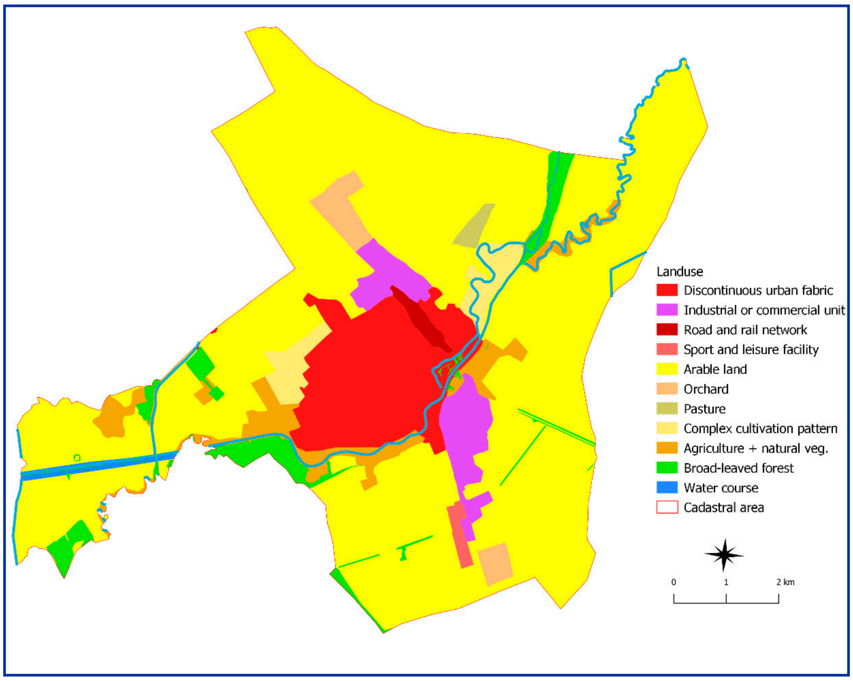

Figure 2 Current land use of the cadastral area of Nové Zámky
Source: author

At present, there are two facilities utilizing renewable energy sources in the cadastral area: hydropower plant Zúgov and cogeneration unit for wood chips and natural gas combustion producing heat and electricity.

Data collection and processing

The available vector and raster data for the GIS analysis were obtained from the soil portal of the Soil Science and Conservation Research Institute (SSCRI), the European land cover mapping project Corine Land Cover 2012 (CLC) provided by EEA, Geofabrik GmbH Karlsruhe and National Geoportal of the Slovak Republic (Geodetic and Cartographic Institute Bratislava). The data obtained were processed in the open source GIS software QGIS (version 2.16.3). The vector data of evaluated soil-ecological units were analysed to determine the soil types and the soil qualitative groups. The lowest quality soils in the study area were located. These soils were evaluated as potentially suitable for the establishment of short rotation coppice plantations. The rest of the arable land consisting of the high-quality soils should be used primarily for the food production. The amount of the energy produced from the plantations was calculated based on the total area of the plantations and the average dry above-ground biomass production of 12 t/ha (Tóth, Stričík and Kuffa, 2015). The potential number of jobs was calculated according to Varga and Bartko (2010).

Results and discussion

The arable land represents the biggest share of land use in the cadastral area of Nové Zámky. It is used mainly for food production and covers 5,017.5 ha. The forest area represents 295.2 ha. The areas of permanent grasslands and orchards are 29.7 ha and 121.6 ha, respectively (Figure 2).

There are five soil types in the study area. Chernozems and mollic fluvisols are the most dominant (Figure 3). The whole area is characterized by very fertile and high-quality soils and belongs to the most important agricultural region in Slovakia. The least fertile soils in the study area are regosols that represent only about 1% of the arable land.

According to the Act No. 220/2004 on the Protection and use of agricultural land, the soil-ecological units are divided into 9 qualitative groups. The groups 1–4 are high-quality protected agricultural soils. The groups 5–7 are medium-quality soils and the groups 8–9 are low-quality soils. The groups 5–9 can be used for alternative purposes including biomass production. The study area is characterized by the prevalence of high-quality soils. There are no low-quality soils (Figure 4).

The soil erosion was analysed based on the System of evaluated soil-ecological units (Streďanská and Budaj, 2006). The analysis showed that there is no potential threat of water erosion in the study area. Only 27 ha and 562 ha of agricultural land are potentially threatened by extreme and high wind erosion, respectively. It represents around 10% of the total agricultural land (Figure 5).

The establishment of fast-growing tree plantations in the study area would be possible on soils classified in the qualitative groups 5–7 (medium-quality soils). The total area of these soils potentially suitable for wood biomass production is 1,536 ha (Figure 6).

According to Tóth, Stričík and Kuffa (2015), SRC willow plantations can provide dry above-ground biomass yields ranging from 12 to 15 t/ha in our conditions. Taking into consideration the lower value (12 t/ha), the SRC willows could provide 18,432 t of dry above-ground biomass in the study area. Several studies showed that except of SRC willow, also poplar and miscanthus might be promising crops used for energy purposes in the conditions of south-western Slovakia (Kotrla and Prčík, 2013; Kotrla, Mandrlová and Prčík, 2017a; Kotrla, Mandrlová and Prčík, 2017b; Prčík and Kotrla, 2015).

MacKay (2009) assumes that the best performance of any energy crops in Europe is 0.5 W/m^2. If the whole area of 1,536 ha were covered with SRC plantations it would represent 399 m^2 per person. The plantations would produce 200 W per person and that is 4.8 kWh/day per person. Taking into consideration the overall losses of 33%

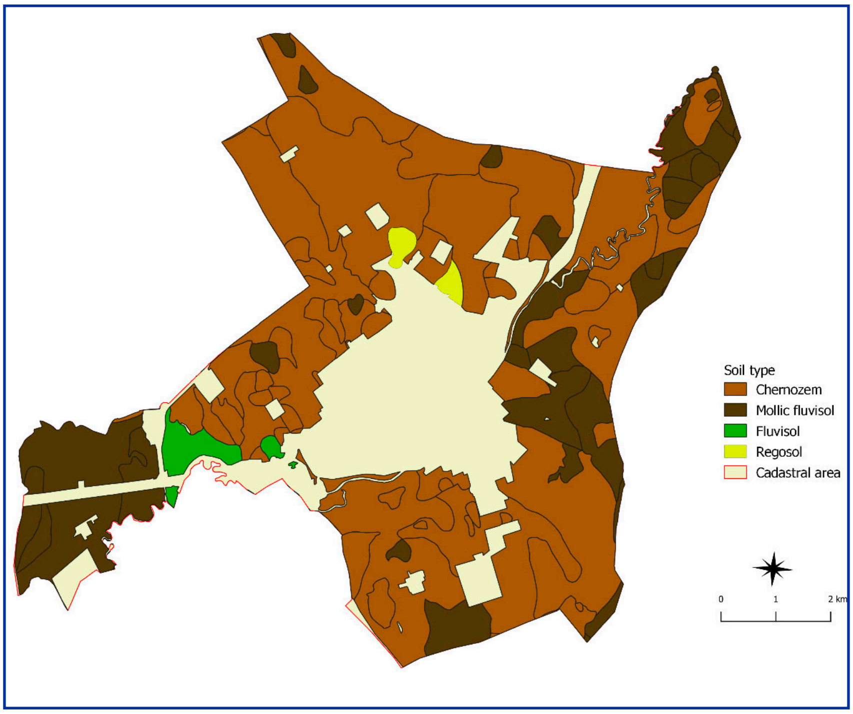

Figure 3 Soil types in the cadastral area of Nové Zámky
Source: author

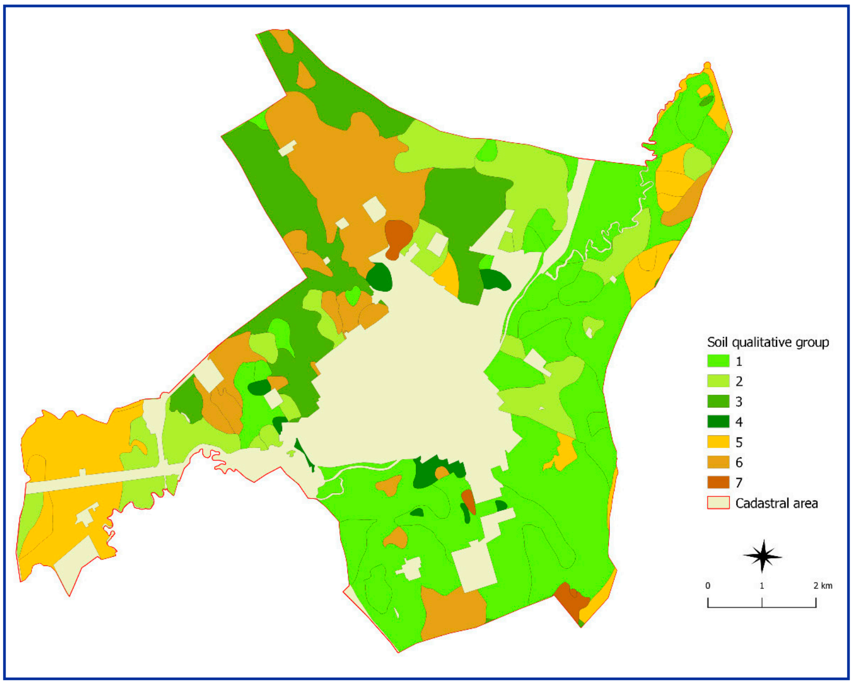

Figure 4 The qualitative classification of the soils
Source: author

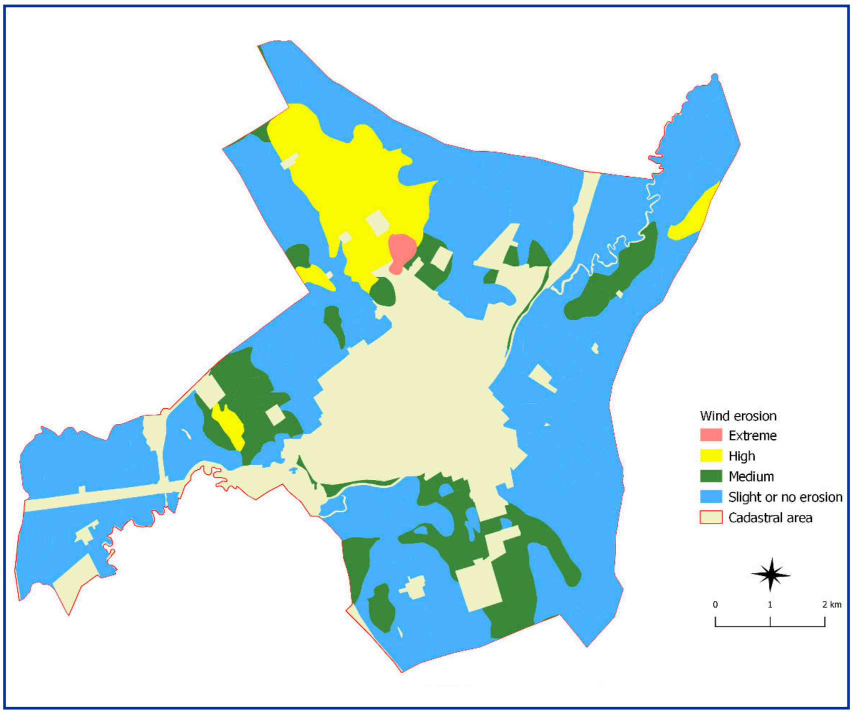

Figure 5 Wind erosion status of the study area
Source: author

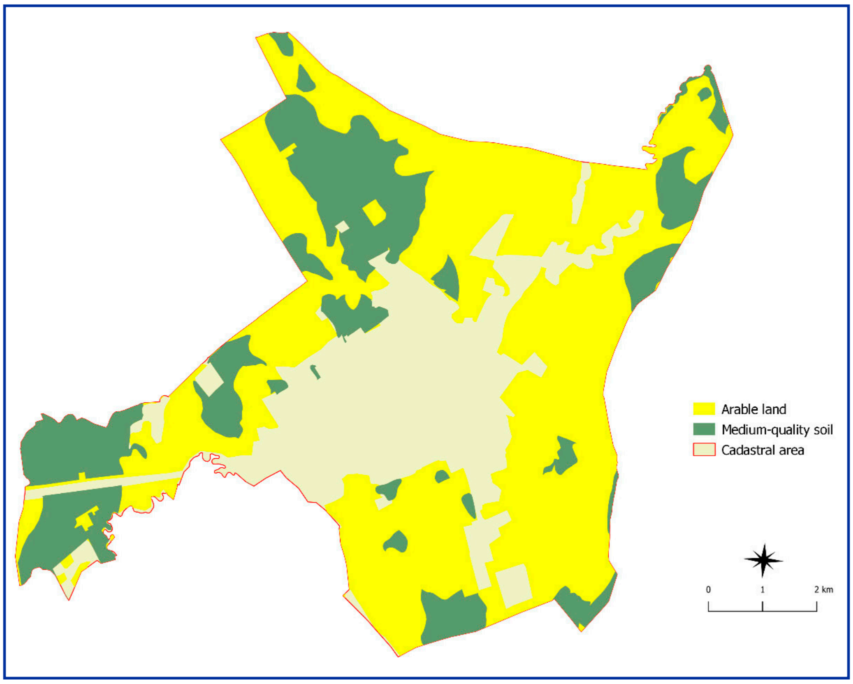

Figure 6 Medium-quality soils potentially suitable for alternative use
Source: author

in the process of energy conversion, the potential power is 3.2 kWh/day per person.

The calculation of the number of jobs created in biomass production on a short rotation coppice (SRC) plantation was based on Varga and Bartko (2010). The assumption is that 4,000 jobs would be created per 100,000 hectares, i.e. 0.04 jobs per ha. Therefore, if the SRC plantations were established in the area of 1,536 ha, 61 new jobs could be created.

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