Interreg CENTRAL EUROPE
European Union European Regional Development Fund
CHAIN REACTIONS

WPT4
D.T4.1.17

Industrial innovation workshop - regional analysis

Bioeconomy sector

Version 1
4.2021

Project information	
Project Index Number:	CE1519
Project Acronym:	CHAIN REACTIONS
Project Title:	Driving smart industrial growth through value chain innovation
Website:	https://www.interreg-central.eu/Content.Node/CHAIN-REACTIONS.html
Start Date of the Project:	01.04.2019
Duration:	36 Months
Document Control page	
Deliverable Title:	D.T4.1.17 Industrial innovation Workshop – Bioeconomy sector regional analysis
Lead Contractor of the Deliverable:	PP2 – Styrian Technology Park
Responsible PP:	PP9 – Bioeconomy Cluster
Authors:	PP9 – Bioeconomy Cluster
Contractual Delivery Date:	30.09.2020 – 31.03.2022
Actual Delivery Date:	27.04.2021

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1. INTRODUCTION

Following the regional IGAs' actions of the support and implementation of transnational pilots aiming at supporting value chain innovation (WPT3) and establishment of transnational networks of innovations stakeholders as the kick-off activity to develop transregional innovation networks and agendas in selected industrial sectors (WPT4), further activity of project partners is to perform the crucial data obtaining which will later on be included into the elaboration of transnational industrial innovation roadmaps and agendas, as fulfilment of foreseen outputs O.T4.1 Thematic industrial innovation roadmaps and O.T.4.2 Thematic innovation agendas.

Due to COVID situation in Europe, measures in separate countries and dependant issues arising daily by fulfilment of working obligations, project partners decided to perform the in-depth analysis of priority sectors on reginal level, instead of organising a number of workshops with a risk of low participation of key stakeholders.

2. REGIONAL SECTOR ANALYSIS

In terms of history, climatic conditions and geographical location, Slovakia can be considered a rural country with limited resources of fossil energy raw materials and mineral wealth, and therefore the main production potential of our country is in agricultural and forest biomass and water resources. The use of the possibilities offered by the bioeconomy and the transition to sustainable and competitive production of food, feed, biomass and other biological raw materials can contribute to the positive use of the potential of our country. At the same time, implementation of bioeconomy in Slovakia is still an ongoing process without a long tradition.[1]

The understanding and definitions of the concept of bioeconomy differ among countries, and so do the pathways chosen to promote the bioeconomy strategies according to prerequisites of the individual countries. Action plan "Innovation for sustainable growth: A bioeconomy in Europe" suggested a comprehensive approach to addressing Europe's and the world's existing ecological, environmental, energy, food supply, and natural resource challenges. At European level, there have been several strategies, programs and initiatives to promote bioeconomy including Horizon 2020 and Horizon Europe, Green Deal, etc.

Bioeconomy in Slovakia is not governed by an explicit bioeconomy strategy. However, several bioeconomy-related strategies can be found in different sectors, such as forestry, agriculture, energy, environment, and rural development. The need for its future creation and implementation partly results from the **Research and Innovation Strategy for Smart Specialization of the Slovak Republic** (RIS3) that was approved in 2013 and is now being updated. Its goal is to define the vision, objectives, and measures for the Slovak Republic's competitiveness and to consider the principles of smart, sustainable, and inclusive growth.[2]

Agricultural production in Slovakia is characterized by low added value of the primary agricultural production. Despite the fact that Slovak agriculture and the food industry are capable of producing high-quality goods, Slovakia processes only 65% of domestic production and the rest is exported as raw

[1] https://euractiv.sk/section/polnohospodarstvo/linksdossier/biohospodarstvo-minulost-pritomnost-a-buducnost/
[2] https://www.mhsr.sk/inovacie/strategie-a-politiky/strategie-vyskumu-a-inovacii-pre-inteligentnu-specializaciu

materials.[3] At the same time, bioeconomy is a topic that is not yet fully implemented by farmers. There is a need for cooperation between already existing initiatives that create an environment that is suitable for involving farmers, as well as biomass producers in the research and innovation process. However, co-financing represents a significant risk in such cases. It can be difficult for farmers to carry such financial burden.[4]

Agriculture can also have far-reaching negative effects on the environment as a side effect. The expansion of agriculture and agricultural land can often be at the expense of the loss of the original ecosystems and biodiversity. Climate change and the long-term management of natural resources are becoming increasingly common. Modernization, the use of advanced technology, and implementation of digitization are required in agriculture.

This regional analysis was elaborated in line with previous value chain analysis and pilot of BEC and WTP on bioeconomy. In addition to bioeconomy in general, dairy value chain has been analysed in particular as this sub-sector was selected at the start of project implementation and will be addressed also in other project outcomes.

2.1. Overview of sector

What is the history of the sector in the region?
An important milestone for Slovak agriculture in general was Slovakia's accession to the European Union in 2004. Farmers gained financial stability in the form of direct payments, which are part of the **Common Agricultural Policy** (CAP). CAP, as a partnership between agriculture and society, more precisely between Europe and its farmers, aims to support farmers and improve agricultural productivity to ensure a stable supply of available food and fair income for EU farmers. The CAP has brought Slovak farmers greater stability and security of a certain level of income. However, they have not yet used its full potential. It is crucial to set the rules in the new CAP so that they are directed mainly to areas with animal and special crop production, i.e., to areas that bring added value and employment in rural areas.[5] The goal of cattle breeding is to provide the key resources - milk and meat - that contribute significantly to agricultural entities' sales (on average in the Slovak Republic they account for about a quarter of agricultural production and more than half of animal production). Furthermore, milk processing guarantees a steady flow of revenue. In Slovakia, the production and use of dairy products has declined significantly since the 1990s. A characteristic phenomenon in the development of cattle breeding is its permanent decline, but the pace of decline has slowed significantly compared to the period 1990 - 2000. However, in the last decade, milk and, in particular, dairy products, have seen a resurgence in popularity. Slovak milk suppliers, on the other hand, are unable to meet this rising demand. Slovakia supplies 911 000 tons of cow milk per year, accounting for less than 1% of global EU supply. Several

[3] https://ec.europa.eu/info/sites/info/files/food-farming-fisheries/key_policies/documents/rdp-factsheet-slovakia_sk.pdf
[4] https://www.mpsr.sk/aktualne/biohospodarstvo-je-jednou-z-odpovedi-ako-si-poradit-s-klimatickou-zmenou/14317/
[5] Jana Holéciová, spokesperson of the Slovak Chamber of Agriculture and Food. https://index.sme.sk/c/22374433/brusel-chce-zelensie-a-mladsie-polnohospodarstvo.html?ref=tab

crises have hit the dairy industry in recent years, resulting in a decrease in the number of dairy cattle in Slovakia.

The application of modern technological systems in cattle breeding until 1990 was constantly limited by conservative farmers. The advantage of higher concentrations of animals has been used to apply modern technological systems only rarely. In 1995 the Act on the Protection of Animals was approved, which, in the light of known world knowledge, created a basic framework for the technological modernization of animal husbandry, respecting their natural needs. In 1997, in cooperation with the State Veterinary and Food Administration of the Slovak Republic and the Research Institute of Animal Production, an implementing decree of this Act was prepared by a group of experts. At present, the conditions of animal welfare are significantly different from those in our country in the first half of the 1990s. New technological equipment and new materials are available. The technology has been improved and the services have become more efficient. The basic philosophy of most Slovak breeders has changed in relation to the adoption of new trends for modernization. The requirements for respecting animal welfare and protecting the environment are clearly defined. Breeders are aware that without a justified modernization of breeding they cannot succeed in a competitive environment.[6]

In the last decade, the Slovak dairy sector has undergone major reforms, bringing it up to European dairy industry standards. The shift in ownership structure in favour of foreign firms began during the privatization process and intensified during the pre-accession period and after Slovakia's EU membership. In recent years, foreign (European) dairy companies have largely regulated the restructuring and future of the Slovak dairy value chain. With different market shares and a differentiated selection of dairy products, Slovakia and other V4 countries have identified themselves as core European dairy leaders. They usually continued the supply of related domestic brands while still developing their own product lines.

What affects the growth of the sector?

The growth of the sector is affected by the conditions that are created for producers interested in bio-based production. Even though there is a potential for improvement of public image of the producer, as well as being part of the sustainable change towards more environmentally friendly procedures, not all of the subjects see the benefits as prevailing over the conventional practices.

Slovakia is characterized as a country with a low degree of maturity of the bioeconomy. It is lagging behind in the efficient use of biomass, including biomass from waste as a raw material containing valuable substances for further processing, as well as in low developed workforce with the necessary knowledge and skills to work in the biological sector. The application of the principles of circularity and the creation of higher added value of biomass production, which is closely related to the bioeconomy, is also very low. In addition, bioeconomy solutions require intensive application of innovations, while overall the Slovak Republic ranks in the degree of innovation only among moderate innovators.

In order for an economy to be sustainable, society must be part of this process, too. Citizens are generating a market that will push industry to select more costly, but still desirable alternatives.

[6] Zborník z konferencie pre chovateľov hovädzieho dobytka

However, the general public frequently lacks a compact understanding of the bioeconomy, therefore, there is an importance to promote knowledge transfer about bioeconomy in Slovakia.

Support for the development of bioeconomy in Slovakia is provided through selected types of investments of the **Rural Development Programme of the Slovak Republic**, which provides an opportunity to apply for support in the field of investments related to bioeconomy.[7] At the moment, **the EU has a number of instruments in place to support the bioeconomy**. These are not only financial instruments, but also legislation, knowledge-based networks, and programs that discuss and promote the growth of the bioeconomy to varying degrees.

With regard to the dairy value chain, Slovakia is no longer self-sufficient in dairy production and imports the majority of its dairy products. Self-sufficiency in milk is currently about 85 %, however, in butter production, which needs a lot of milk fat, the self-sufficiency is less than 50 %. Dairy farmers are attempting to maximize their productivity, efficiency and added value. In dairy production or livestock in general, digitization is one of the driving forces for progress. This can be accomplished, for example, by **implementing ICT strategies and automated tools** in dairy processing and farm management; investing in emerging technology for milking, feeding, and waste management; and reconstructing and constructing stalls, etc. For several large producers are popular e.g., special drones, which control the condition of the crop in detail, while collecting important parameters: water stress of plants, cultivation or phenotyping of cereals. Modern technologies are becoming increasingly known and popular also for Slovak farmers and breeders, who are beginning to use them in practice. Some Slovak cattle breeders already use modern technologies, such as intelligent GPS collars, thanks to which the farmer has a detailed overview of each piece of cattle and receives real-time information of movement, animal temperature or walked distances of the animals. All this helps with determining whether their movement is normal or signals illness and thus,farmers can respond immediately to the situation and well-being of the cattle.[8] Tracking the origin of animals is also an interesting topic nowadays. It may provide detailed information on the animal's birth data, background, ownership changes, place of breeding, quality of feed and amount consumed during life, medical history, including vaccines and prescriptions provided, and the outcomes of frequent exams.

Patterns in consumer demand are another driver that affect the sector. Awareness of Slovak milk and dairy products rose by nearly 4 % as a result of an advertising campaign aimed at raising consumption of milk and dairy products produced in Slovakia in 2020. This means that today 48.6 % of the population of Slovakia distinguishes Slovak dairy products based on the packaging. The ambition, and one of the advertising campaign's aims, is to increase this awareness by at least 60 %. This campaign continues also in 2021.

Who are the leaders in the sector?

The entire process of developing bioeconomy in Slovakia includes a wide range of stakeholders. The participatory approach is used in the development of bioeconomy through discussions at national

[7] https://sk.euractiv.eu/wp-content/uploads/sites/8/special-report/SPECIAL_BIOHOSPODARSTVO_201610-1.pdf
[8] https://touchit.sk/slovenski-farmari-a-moderne-technologie-vyuzitie-inteligentnych-gps-obojkov-v-chove-hovadzieho-dobytka/286204

and international fora and working groups, where experts discuss and exchange on various topics related to bioeconomy.

The following national level stakeholders are involved in the development of bioeconomy in Slovakia:

- **The decision-making sphere and national and regional-level policy makers;**
- **Science, research and education** - organizations that perform various bioeconomy-related R&D activities, that contribute to the development of added value in individual industries, or provide bioeconomy-related education.These include, e.g.: National Agricultural and Food Center, National Forestry Center, institutes of the Slovak Academy of Sciences, and Slovak Universities.
- **Industry and the third sector** - selected companies, associations, non-profit and non-governmental organizations that have practical knowledge of various sectors of the bioeconomy. These include mainly clusters, chambers and associations that bring together businesses from diverse sectors and raise awareness of bioeconomy.

With a focus on dairy industry, large cooperative-type farms and corporations account for 95 % of milk production in Slovakia. Just a few of these farms are top innovative in their market segment or in the way they produce their goods.

Aside from individual dairy farms, the **Slovak Association of Primary Milk Producers** is a very important industrial actor in the sector, that is an active member of the European Dairy Association. The association's key role is to promote the interests of member organizations by cooperation with national authorities, professional organizations and self-governments, especially in the preparation of conceptual development plans. Moreover, they engage in marketing efforts to promote the consumption of milk and dairy products produced in Slovakia.

National Agricultural and Food Centre is also a key player in the sector and a specialist in the economic optimization and modelling of livestock production processes, as well as the measurement of environmental footprints. Its experts developed a decision-making tool for dairy farm managers **EkonMOD milk**, which is used to evaluate the economic consequences of various farm strategies and gathers knowledge from nutrition, technology, breeding systems and economics into one unit. It has two modules. The first is to determine the number of heifers needed to rebuild the herd. The second calculates the income from the sale of milk, which remains with the farmer after he pays the costs of feed.

Scientific research is one of the priorities of **the Slovak University of Agriculture in Nitra**. Its activities are focused on obtaining original results aimed at the development of knowledge directly applicable in practice, as well as effective connection of scientific research with the educational process. Moreover, **the AgroBioTech Research Centre of the Slovak University of Agriculture in Nitra** is a university-wide, specialized facility that conducts focused innovative research in specific fields aimed at performing new methods and procedures in research, especially applied research, that is

applicable in practice and is related to critical needs in agrobiology, agricultural processing equipment, and agri-food, biotechnology, genomic innovations, agroecology, bioenergetics, and bioeconomy.[9]

The Association of Young Farmers in Slovakia tries to ensure that young farmers receive information, have their activities coordinated, and are represented at the national level. They also want to encourage tools that make it easier for young farmers in the agriculture sector to start a company and facilitate information and skill sharing among young farmers across Europe.[10]

Bioeconomy Cluster (BEC) is another important player in Slovakia when it comes to bioeconomy aspects of primary development. It integrates the institutions of the knowledge triangle and facilitates knowledge sharing, creativity, and R&D collaboration with agribusiness. BEC's participants include research institutes, agricultural university, and small and medium-sized enterprises in the agriculture and food sectors, as well as other bioeconomy-related fields.

An example of a farm that is implementing research and technology in order to improve efficiency of the production, while improving animal welfare and reducing greenhouse emissions, is **AGB Group**. This cooperative has gone through a transformation process to implement IT solutions and become a modern facility that uses the current agricultural trends. They are currently working on the concept of a robotic farm to maximize animal welfare. The tools that are applied within the robotic farm offer a more complete picture of the cattle: their health, fertility and the quality of the milk it produces. These mainly include robotic milking and robotic feeding of cows (precisely mixed dose of feed that is fed robotically - in the exact amount, at the right time). The team strives for better waste management, protection of the environment and cow health, less spread of diseases. In addition, the AGB Group is also working on an effective data management system, which consists of the use of drones.

Are there any specific government regulations related to the sector?

As a member of the European Union, Slovakia has to comply with the legal frameworks and norms that originate from this integration. For example, there is a legal framework related to the Common Agricultural Policy.[11] Producing within bioeconomy means following the rules of bio-farming. Its purpose is to promote environmental protection, preserve biodiversity in Europe and build consumer confidence in bio-based products.

Livestock farmers must also meet special conditions if they want to sell their products with an organic label. These rules include the observance and respect of animal welfare, the feeding of animals in accordance with their nutritional needs. The purpose of these rules is to protect animal health and the environment. One of the objectives in organic production is to reduce the use of external inputs. Any substance used in organic agriculture to fight pests or plant diseases must be pre-approved by the European Commission. The operator is obliged to carry out organic agricultural production according to this Act and according to special regulations, which are in the Regulation of the

[9] https://www.agrobiotech.sk/o-nas/
[10] http://mladyfarmar.asyf.sk/node/31
[11] https://www.europarl.europa.eu/RegData/etudes/BRIE/2018/617494/IPOL_BRI(2018)617494_EN.pdf

European Parliament and the Council (EC) no. 882/2004 of 29 April 2004 on official controls performed to ensure the verification of compliance with food and feed law, animal health and animal welfare rules.

Many regulatory aspects surround milk processing, ranging from animal health to sanitation and sanitary conditions to the use of antibiotics and other supplements. As a result, the dairy industry is highly supervised at any point of the value chain, from cow breeding to raw material transportation to finished product manufacturing.

2.2. SWOT analysis

Strengths	Weaknesses
• Significant production potential of the country in agricultural and forest land, as well as in water resources; • Many small "green" projects within the bioeconomy, which are implemented at the level of cities, regions, NGOs, etc.; • Growing interest of companies in the bioeconomy; • Qualified researchers with world-class knowledge on the agriculture and bioeconomy-related topics; • Availability of research infrastructure (AgroBioTech Research Center, Centers of Excellence, etc.); • Modern and innovative technological and software tools are already implemented or being used on some farms.	• Inconsistency of policies on the bioeconomy and ambiguity of its position and role in development policies; • Low level of cooperation between different organizations; • Low levels of knowledge transfer from research to practice; • Insufficient involvement of Slovak entities in Thematic Networks, Expert Working Groups (EPI-AGRI Focus Groups) and projects for EIP operational groups in the field of bioeconomy; • Low levels of involvement of farmers in the final product processing that is associated with low value added; • Large companies are dominating the commodity market. Deregulation in the markets has caused the food supply chain to become increasingly concentrated in the hands of corporate giants, who now control chemicals, seeds, trade, manufacturing and retail; • Lack of consistency in EU requirements, such as for the development of the market for the secondary raw materials and the high costs of research and development and implementing innovations.

Opportunities	Threats
• Development of business activities in the countryside and the creation of value chains in circular bioeconomy; • Increasing the share of domestic production with higher added value and higher form of processing by using biotechnology and innovative technologies; • Supporting investment in research and innovation from EU, Member State and private sector sources; • Education of farmers in the field of sustainable farming practices.	• Continued focus of producers and processors on production volume and low costs without stopping for added value; • Low awareness of general public on the bioeconomy and sustainability aspects; • Lack of continuity of funding for scientific research activities.
What can be done to take advantage of these opportunities?	What can be done to reduce these risks?
It is important to strengthen markets and competitiveness in the bioeconomy sectors through sustainable intensification of primary production, better use of waste and by-products, but also the exchange of knowledge to increase production and resource efficiency. Development of new technologies and processes in the field of bioeconomy, supporting investment in research and innovation, while making sure that the involved parties including primary producers and consumers are more informed, would be another way how to take an advantage of the opportunities that are available. When it comes to agricultural primary production, it should become more efficient with an aim to achieve sustainable production while preserving biodiversity and healthy ecosystems. This could also help with the progress in food security and more sustainable and innovative economy with lower emissions. It could also bring additional income to the agricultural sector, thus creating new jobs in the sector. Another factor would be to promote the technological advancement and support the production with added value for Slovak producers, especially in dairy sector, while supporting the regional products to have competitive advantage on the market and be more accessible and available for the Slovak customers.	It is essential to create and implement a national strategy for bioeconomy that would be consistent. Also, there is a need to increase the involvement of the general public and enhance their knowledge and interests regarding the bioeconomy, as well as to implement information about bioeconomy into education. This could lead to higher awareness that would start from young age, continuing by developing well established priorities and critical thinking of people that create the demand on the market, as well as future or current farmers and business owners. When it comes to agricultural production, there should be an incentive to support production with added value on the market, which would benefit Slovak farmers, as well as customers who would have access to high quality regional products. For Slovakia to increase self-sufficiency in the production of milk and dairy products, there needs to be an increase in the level of national support for primary milk producers. Primary producers should not be losing from producing and selling dairy products. Higher national support would guarantee them greater competitiveness on the European market. This would lead to greater food self-sufficiency, but there will also be positive effects on higher employment, greater milk freshness and reduced emissions.

2.3. Trends

Some of the identified trends and developments, which affect bioeconomy in general, may include:

- Increasing energy and resource efficiency, the transition to a green circulating model of the economy and efficient investment in green projects are important for the environmentally and economically sustainable growth of the country and increasing the prosperity of society. It is also necessary to have qualified information and best practice examples, which are successfuly applied in practice and transferrable to other applications.
- At EU level, numerous platforms and initiatives have been created, containing tools for information transfer regarding the bioeconomy practices. It is very important for Slovakia to follow the trends and utilize the practices from these platforms to achieve progress in bioeconomy sector. For example, Slovakia is involved in the BIOEAST Initiative, where the Central and Eastern European (CEE) countries set the vision for 2030: to build circular bioeconomy focused on awareness and collaboration, which will help to boost inclusive development and generate new value-added employment, especially in rural areas, while sustaining or even strengthening environmental sustainability. This could be an impetus for further development of bioeconomy in Slovakia.
- Research and Innovation is stagnating in the CEE countries, the macro-region appears to have insufficient R&I infrastructure. There will be a necessity for full application of research outcomes into practice, as well as physical insight into research – they need to be strengthened, especially in Eastern Europe.
- Traditional and creative supply chains are also underutilized, and resources to create value-added systems locally are limited – therefore, there will be a necessity to create bio-based value chains in the region.

Considering the dairy value chain, the following development trends have been analyzed:

- Primary milk producers in Slovakia are willing to increase raw cow's milk supply. After years of declining numbers of farmers and dairy cows, they are hoping that the EU's new CAP will provide a boost to the dairy sector's growth. Slovak primary producers are able to contribute to the fulfilment of European environmental targets and national goals of raising food self-sufficiency. One of the ways how to do that is to increase the number of cattle on the farm, which will increase the production of organic matter boosting the quality of soils, while also increasing milk production. However, there is a need for a favourable CAP, equal conditions with neighbouring countries, and state assistance in order to achieve this.
- One of the most significant decisions in European agricultural policy for the dairy sector is the share of coupled direct payments. Their decline in comparison to the current programming cycle would be undesirable to Slovak primary milk farmers, endangering the achievement of European and national targets. There are more measures that put Slovakia at a disadvantage compared to Western European farmers, but also to our immediate neighbours. The lower funding for dairy farming in comparison to other European countries can be attributed to the disparity in the amount of European and national support provided under state aid schemes. We may take the Czech Republic's funding for the production of the best quality milk as an example. Slovak primary producers and milk processors do not

currently receive this form of assistance, but they are working together to bring this state aid scheme to Slovakia.[12]

- Many of the cattle housing and milking facilities, milking machinery and storage facilities are still obsolete and thus, investments in buildings and automation technology is considered to be important.
- Large cooperative-type farms and corporations account for 95 % of milk production in Slovakia's dairy industry. Just a few of these farms are top innovative in their market segment or in the way they produce their goods. In the other hand, some of them are mostly surviving and are only able to continue operating due to significant capital investments. As a result, losses from animal/dairy production are offset by gains from plant production.
- Technological change is also a vision for innovative and sustainable farming - for Slovak farmers and breeders, new innovations are becoming more familiar and widespread, and they are starting to use technological advancements in real life. When it comes to milk producers' innovative edge, the number of farms using new digital technology is growing in Slovakia. This is due to new Industry 4.0 trends, which are increasingly infiltrating the dairy industry. In order to enhance animal health, minimize greenhouse gas emissions or to maximize production productivity, several farms are partnering with researchers as well as software and technology providers. Some Slovak cattle breeders are now using new technologies, such as intelligent GPS collars, which provide the farmer with a comprehensive description of each piece of cattle and provide real-time information on movement, animal temperature, and walked distances. Moreover, the farmers are nowadays using technologies to prevent the heat stress of animals, which can result in better welfare and productivity. Automatic milking systems also represent a significant advancement in the technical and biological improvement of milking conditions based on the monitoring of milk flow. They can automatically stop milking and thus eliminate the human factor. Equally important is the positive impact on the welfare of dairy cows in the whole milking process which can in a long run result in more quality milk production. Such practices are not a matter of course in Slovakia, however, more farmers are trying to implement them at least partially and slowly adhere and prosper from the technological opportunities.

What are the trends in sales over last 5-10 years?

Since bioeconomy as such is very broad topic, the following parts of the regional analysis have been filled in only for the selected sub-sector, which is dairying.

Consumption of milk and dairy products in the Slovak Republic still lags significantly behind the average of most EU countries. Milk still belongs to the basic nutritional components and is an equally important raw material in production not only in Slovakia, but also in all other countries. Primary milk production in Slovakia represents an active part of agricultural production and accounted for the largest share of more than 11 % of animal production. Although this percentage has fallen sharply in recent years, it is one of the key manufacturing sectors in the food industry. In 2019, the

[12] https://smz.sk/prvovyrobcovia-mlieka-ocakavaju-od-novej-polnohospodarskej-politiky-podporu-investicii/

milk production in Slovakia accounted for approximately 904 260 tons of milk. In 2018 it was 906 620 tons and 911 730 tons in 2017, which shows a declining trend in the most recent years. [13]

At present, larger or smaller businesses and farms focus on cattle breeding and milk production, but their structure and number have changed significantly in previous years. During 2010 and 2016, the number of farms specializing in cow breeding decreased by 21,8 % and almost 77 % were farmers with no more than 10 pieces of cattle.

The current situation in dairy value chain in Slovakia reflects the declining development in the number of companies with primary production of raw cow's milk. While 483 primary producers were registered in 2015, a continuous decline of almost 15 % over three years meant that at the end of 2018 there were only 415 milk producers. These farms operate mainly as cooperatives, representing 61.1 % of all farms. Another group of primary producers consists of small farmers who carry out direct sales and deliveries of only small quantities of raw cow's milk, which come from their own production.

The declining number of primary milk producers can be considered as the most significant structural changes in milk production. It is also related to the reduction in the number of dairy cows and dairy production. The reduction in the number of dairy cows was offset by a systematic increase in the yield of cow's milk per dairy cow. Increasing milk production may be related to improvements in technology, investment in new equipment, or changes in feed production techniques on farms.

The most significant drop in milk production occurred between 2008 and 2009. The extreme price volatility, which was observed already in 2007, caused that in May 2009 the prices of milk of primary producers fell on average to the level of 0.17 EUR / kg, which had significant effect on milk production. Primary producers responded to the situation by reducing the number of dairy cows or cancelling the whole production. The average year-on-year decline in production in the period 2004-2017 was 1,24 %. According to the Slovak Association of Primary Milk Producers, the low decline in production in this period was due to low buying prices of raw cow's milk, rising prices of production inputs and also a lack of state support and low milk consumption.

When we look at the foreign trade balance of milk in recent years, milk imports outweigh exports. In trade, Slovakia achieves a negative balance of foreign trade, which means that we import more products than we export. This balance also shows that the raw material is exported and then the finished products are imported. The largest buyers of Slovak milk are the Czech Republic, Hungary, Italy, Bulgaria and Romania.

According to statistics, domestic milk and dairy product intake is around one billion kilograms. Slovak primary producers will supply the market with more than 800 million kilograms of milk from their own production, bringing the country's milk self-sufficiency to around 80 %. The reality is that Slovakia imports almost 700 million kilograms of milk from other countries in the form of dairy products. The Slovak surplus, estimated at 500 million kilograms, must be shipped abroad by the processors. Net international trade in milk and dairy products has a negative balance of around 200 million kilograms of milk.[14]

[13] https://ec.europa.eu/eurostat/databrowser/view/agr_r_milkpr/default/table?lang=en
[14] https://sebestacni.sme.sk/c/22537577/v-mlieku-uz-nie-sme-sebestacni.html

What is sensitivity of the industry?
The sensitivity of the industry depends on the ability of the given parties to adapt to new changes which in general takes time in Slovakia. Slovakia belongs to moderate innovators group in general and the companies can be considered more conservative. It takes more time to adapt to new work processes and standards, especially in agriculture, where there is high portion of employees who are older, and they have exerted processes that have been in use for many years. Therefore, they may be discouraged by new innovations and technologies, especially if they would require new technological knowledge. The European Commission's recently approved strategy from Farm to Fork is, at first sight, very ambitious, but it presents not only a number of ambiguities but also considerable risks for Slovakia. When it comes to new regulations and new technologies, there is time needed for adaptation that can often be several years, e.g. in case of labelling food products, creating nutritional profiles for foods, replacement of all packaging, and changes in technology. Moreover, the readiness of the industry to prepare the so-called nutritional profiles in the given time horizon is also questionable. Slovak food producers are not ready for such changes in the current situation because if the individual limits in the given foods were exceeded, it would not be possible to promote these foods and it could mean big losses for the producers.[15] A dairy farm's fixed costs are generally high. This makes farms within the industry to push to full capacity. It means that as demand falls, dairy farmers decide to decrease their prices. Owing to large capital costs (primarily due to the structure of farms in Slovakia), as well as government restrictions, the industry's exit barriers are especially high in Slovakia. As a result, companies in the industry seem unable to quit, and they prefer to manufacture at a loss or even with no benefit (which is usually compensated by plant production). Consumers will easily switch to a different producer due to the availability of milk from different suppliers (in this case, milk processors). The price is normally the deciding factor. This has also an effect on the farm that delivers the milk to the processing company. Producers' organizations can be formed by dairy farmers in Slovakia, and this allows them to work together to ensure that their products are sold. Farms are attempting to distinguish their products (at least in terms of quality) so that rivals' activities have less of an impact on their customers, who are looking for specific products with specific nutritional characteristics.
What are management trends in the industry?
Collectivization has had and continues to have an effect on Slovak agriculture. The dominance of large farms still exists in Slovakia today. With the exception of farms larger than 500 hectares, all scale types of farms have been increasing in numbers since 2007. Slovakia's situation differs from that of the majority of EU Member States, where small family farms predominate. The utilization of economies of scale is a benefit of big farms. This is an advantage that big farmers have over small farms in terms of lower unit costs. Slovakia is dominated by two basic legal forms of large farms, namely cooperatives and commercial companies. The percentage of cooperatives decreased and was replaced by a more profitable legal form – commercial company. This trend is due to the fact

[15] https://www.webnoviny.sk/nasvidiek/europska-strategia-z-farmy-na-stol-je-ambiciozna-ale-moze-mat-aj-fatalne-dosledky-pre-slovensko-tvrdi-halgasova/

that commercial companies are a more efficient legal form with a lower number of owners and a higher profit orientation. Commercial companies achieve higher profitability with slightly higher risk.

Big farms control around 71 % of the land in Slovakia. Small farmers must produce extra additional profit from the selling of crop and livestock goods because the volume of assistance is insufficient to meet their financial needs. Owners are required to diversify their profits, and agricultural production accounts for just a small portion of overall earnings. In terms of theory, large farms benefit from economies of scale and can be much more efficient than small farms. The dominance of large farms is an advantage in Slovakia in this respect. In terms of production, farms in Slovakia are mainly engaged in crop production, whose production is growing, and animal production is declining.

The number of farms and enterprises engaged in dairying for the purpose of milk production in Slovakia is declining. Animal production and breeding is labour intensive. The decline in dairy farms and milk production is due to the decline in employment in agriculture. It can be stated that the number of farms engaged in more labour-intensive production in Slovakia is decreasing. On the other hand, the number of growers of cereals and oilseeds is growing, which are typical crops suitable for growing on large areas using modern technologies and techniques that reduce the demand on human labour. Economies of scale have a greater effect on these commodities.

Large farms in Slovakia tend to reduce costs by reducing the number of workers which in turn reflects a declining trend of employment in agriculture. Compared to countries with small farms, the decline in employment in Slovakia is much higher. Large farms in Slovakia tend to replace the workforce with technology more than small farms. Large farms behave rationally and respond to the current setting of the CAP. In production, they focus more on crops than on animal production, which is much more labour-intensive. In crop production, large farms focus on low value-added products and crops, in which intensive large-scale agricultural technology can be used. Therefore, the growth of crop production in Slovakia is due to the focus on cereals and oilseeds and production with low added value.[16]

The bioeconomy, like many other industries, is adapting to new scientific discoveries and technical advancements. The bioeconomy and digitization go hand in hand, and **the Industry 4.0** as well as **Agriculture 4.0** provide new opportunities for the farmers. The use of digitization helps to simplify some processes and reduce the need for manual work in some stages of production. The transformation of existing business models, as well as numerous technologies and service networks, will allow the emergence of new styles of cross-sectoral alliances and value chains, which are part of the digital revolution in agri-food.

2.4. Market analysis (customers & competition)

What are the main target groups of potential customers for sectoral products / svices?
The supply of dairy products on the market has increased significantly in recent years, which was affected by changing dietary habits, available production technologies and the development of market demand. Overall, in previous years, the demand for milk and dairy products on the Slovak market increased slightly. Many consumers have changed their buying habits in line with emerging healthy

[16] http://www.slpk.sk/eldo/2019/dl/9788055221052/9788055221052.pdf

trends, such as popularity of full-fat products, organic brands or new types of dairy products. In 2017, the annual consumption of cow's milk (including dairy products) was 173,5 kg per capita, and these figures indicate that the consumption of milk and dairy products in Slovakia was higher compared to previous years. In 2016 it was 171 kg and in 2015 it was 164,3 kg. However, compared to the other EU countries, it is still below the average.

The largest share of consumption of cow's milk and dairy products is in the form of fresh dairy products. The trends in the consumption of milk and the trends in consumption of other dairy products have been developing differently. Consumption of milk has decreased, while consumption of other dairy products has increased.

What type of lifestyle and/or habits related to consumption exists on the market (B2C and B2B relations)?

People are nowadays more and more interested in ways how to live and eat healthier, as well as how to preserve the environment. Slovak consumers' interest in organic products is increasing, but nevertheless, some organic farmers claim that it is still difficult to gain an advantage on the market. Organic production is more expensive financially, even though it has better quality attributes. People coming from a poorer region tend to buy non-organic and unhealthy products. Bringing more subsidies for livestock, but especially dairying could help, because most farms export milk abroad.[17]

In addition, almost all organic production from Slovakia is exported for further processing or packaging abroad, from where we then import the finalized organic products back.[18] Slovak organic producers are often discouraged by the bureaucratic process of obtaining a BIO certificate. Many of them stay somewhere halfway and sell their products only in local markets. The average consumer is primarily looking at the price of products and less on quality, which is why organic products are less available to Slovaks. If organic products were sold cheaper, it would make them more attractive to buyers in general. Ultimately, however, it would be worse for producers and they would be in loss. The state could therefore compensate for this difference so that organic products are more accessible, and producers are more motivated to produce them.

At the same time, the promotion of Slovak products and their market share should increase slightly. Foreign products compete with the Slovak products mainly in price.

This being said, the demand for bio production on Slovak market is mainly concentrated in places where people have higher purchasing power and are more interested in finding ways to create healthy lifestyle for them.

Milk consumption in Slovakia lags behind other EU countries. Several organizations are trying to implement activities to increase the consumption of milk and dairy products, as well as to promote domestic producers. By increasing the interest of Slovak consumers in domestic milk, the consumption would increase, too. Slovak products are known for their quality, but consumers are often affected by price. One of the initiatives was the installation of milk vending machines throughout Slo-

[17] Ilavská, https://juzneslovensko.parameter.sk/sk/zaujem-o-bioprodukty-sa-zvysil-ale-presadit-sa-na-trhu-je-stale-tazke

[18] https://juzneslovensko.parameter.sk/sk/zaujem-o-bioprodukty-sa-zvysil-ale-presadit-sa-na-trhu-je-stale-tazke

vakia in 2008, when the Ministry of Agriculture wanted to increase milk consumption. Vending machines were popular from the beginning, but over time the lower price of milk in supermarkets won over again.

Another initiative that continues in 2021 is a promotional campaign aimed at increasing the consumption of milk and dairy products originating in Slovakia, financed from the Milk Fund. Moreover, Slovak dairy products began to be marked with a sign on the packaging - an oval with the initials "SK". This step belongs to the promotional campaign aimed at supporting the consumption of milk and dairy products with the Slovak origin, as well as to better differentiate domestic products from the foreign ones.

Who are the main competitors?

The dairy sector in Slovakia processes mostly milk originating in Slovakia. In 2018, 387 companies were approved by State veterinary and Food Administration of the Slovak Republic, which engage in milk processing and the production of dairy products. Included are also small factories owned by primary milk producers, i.e., cooperatives or small dairies focused on the production of regional products.

The ten most important dairies include Rajo, Inc., Milk-Agro, Ltd., Syráreň Bel Slovensko, Inc., Tatranská mliekareň, Inc., Agro Tami, Inc., Savencia Fromage & Dairy SK, Inc., Zvolenská mliekareň, Ltd., Milsy Inc., Agrofarma Ltd. Červený Kameň, Farma Majcichov Inc.

How easy is for other businesses to enter the regional market and become a competitor?

Large agricultural cooperatives are common in Slovakia, and they farm the majority of the country's agricultural land. As a result, starting a business in the agricultural sector and obtaining land, which is needed for animal and dairy production, is difficult. Furthermore, a potential entrant would find it difficult to achieve economies of scale. Large-capacity farms have a cost advantage over modern, mostly small-capacity farms. Local goods are preferred in Slovakia, but residents do not want a dairy farm in their neighbourhood (because of smell, etc.). As a result, the most common choice is to take over an existing dairy farm with particular challenges, such as economy, capacity, or other factors, and restart it under new management.

Milk and dairy goods are perishable, requiring high turnover, dependable delivery systems, and a well-organized supply chain. Existing farms in Slovakia have already developed this environment and partnerships with value chain partners, making it difficult for new farms to start from scratch.

When considering bio production, it is not easy to become a competitor since every producer has to undergo processes to obtain the bio certification. Since these processes are lengthy and pricy, many producers decide to continue on the market without the bio certification, even though they try to get closer to bio production, either by elimination of the pesticides when it comes to crop production, or by elimination of antibiotics and increasing the well-being of animals.

2.5. Summary & recommendations

Bioeconomy in Slovakia is determined mainly by agricultural sector as the primary producer of biological resources, as well as by food industry, which is a traditional sector for ensuring the nutrition and

health of the population. The use of the possibilities offered by the bioeconomy and the transition to sustainable and competitive production of food, feed, biomass and other biological raw materials can contribute to the utilization of natural potential of Slovakia.

Within the value chain analysis of bioeconomy as well as in this regional analysis, BEC focused on the dairying as traditional sector producing traditional product with new tools/business models, i.e. use of data driven decisions in dairying supporting bioeconomy. These topics were discussed also during regional industrial innovation workshop organized within WPT4, where the involved stakeholders defined several priority areas that could be further elaborated on in the transnational industrial innovation roadmap and agenda.

BEC will build on the outcomes of value chain analysis as well as of this regional analysis, when preparing the roadmap and agenda and setting the trends in the sector together with its duo partner WTP. Joint conclusions will be agreed on and broken down into proposal for priority innovation actions to be implemented at regional levels.