SUSTAINABLE, RESILIENT AND FAIR FOOD SYSTEMS IN THE EU AND GLOBALLY

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FOREWORDS

Dear readers,

I am pleased to introduce to you a collection of scientific papers presented during the international scientific symposium “Sustainable, resilient and fair food systems in the EU and globally,” organized by the Faculty of Economics and Management of the Slovak University of Agriculture in Nitra, Slovak Academy of Agricultural Sciences and the Union of European Academies for Science Applied to Agriculture, Food and Nature (UEAA) in Bratislava and Nitra on October 6 and 7, 2022.

The main topics of international scientific symposium “Sustainable, resilient and fair food systems in the EU and globally,” were related to sustainability issues in agriculture, food marketing, distribution systems and production systems both at national level as well as at local regional level. The sustainable food systems are one of the flagship initiatives of the Farm to Fork Strategy, which will be adopted by the Commission by the end of 2023. The main objective is to promote sustainability issues in all food-related policies and foster its resilience at EU level and national level. The symposium provided platform for presentation of research papers of experts coming from Slovakia and other European countries, with special attention devoted to Young scientists.

Dear readers, I hope that the collection of symposium research papers in proceedings will provide you inspiring ideas for further reading and valuable knowledge and information regarding sustainable food systems, which are fair and resilient.

Dr.h.c. prof. Dr. Ing. Elena Horská
Dean of the Faculty of Economics and Management,
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REGISTER

Analysis of the development of the wheat price as an important agricultural commodity

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Abstract

Wheat is a key commodity that is traded on all exchange in the world. After corn, it is the second most cultivated crop in the world. In the V4 countries, it is one of the main crops included in rotation of crops because it doesn't require a higher need of human labour of special agrotechnical procedures, and its price can cover production costs. This paper is about analysis of the development of wheat prices in the V4 countries from 2011 to the present. Price is one of the important attributes that affects the production or profitability of this commodity. Market prices in countries are based on the Marché à Terme International de France (MATIF). Among the important factors that affect the price of wheat are weather forecasting in the world, which significantly affects the harvest, the exchange rate of the euro to the dollar, the price of oil-seed rape, the prediction of the harvest from the corresponding institutions, world production, consumption and stock affecting the demand and supply of the given commodity, singing and terminating contracts, trade agreements, etc. In the years 2011 - 2014, the minimum price of wheat was at the level of €176.50/t. During the year 2021, a new price maximum was recorded, when wheat cost €313.5/t in November, which was affected not only by inflation, but also by the increase in energy prices. The conflict between Russia and Ukraine contributed to new price records, when in March 2022 the price reached the level of €450/t. From the point of view of the V4 countries, the average price for the analysed period was the lowest in Slovakia (€168.20/t) and the highest in Poland (€178.03/t). The price premium represents the difference between prices on the MATIF and physical prices on the market. Based on the quantification, we conclude that the highest average price premium among the V4 countries was in Slovakia (€28.59/t) and the lowest in Poland (€16.60/t). The price of wheat mainly affects the price of flour, where 70 – 80% of production costs are consisting of the price of wheat. Support schemes are one of the compensations for the high prices of raw materials and energy.

Keywords: *price, price premium, V4 countries, wheat*

JEL Classification: *Q02, Q10, Q11*

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1. Introduction

The agriculture in Slovakia has undergone significant changes, not only in terms of its position in the national economy, but also in terms of its importance at the regional level. The agricultural subsidies are an essential aspect of agriculture and play an important role in international trend (Kravčaková Vozárová & Kotulič, 2016). Grains are the mainstay of crop production in Slovakia. Their share in gross agricultural and gross crop production is increasing every year. In the years 2017-2019, they participated in the gross agricultural production on average 27.4% and in the gross production of crop production 44.7%. The decisive commodity is wheat, the share of which reached an average of 21.8% of gross crop production. It is grown in all production areas and regions in Slovakia, the most productive region is the Nitrian region (Jamborová, 2021). The harvested area of wheat in Slovakia reached 387.1 thousand ha in the economic year 2020-2021. The average yield per ha of wheat was 5.51 tons. The average prices of all grains decreased by 2020 compared to 2019, the average price of food wheat was 152.26/t € and industrial wheat 137.30/t €. Grains are further processed by the mill, malting, distillery, starch, and feed industries. The produced products are sold on for processing to the food industry, trading companies and final consumers (Grains – Situation and Outlook Report, 2021).

Grain production is one of the most crucial branch of Polish agriculture. Poland has a second place in the EU in grain production. For years, national demand for grains oscillated between 26-28 mil. tons. (Gorlach et al., 2018). Hungary is traditionally an agricultural country, and the agricultural sector is still a dominant one in the economy. On a global scale wheat is one of the most important grain products both globally and in Hungary as well. During the past years wheat has the second biggest volume after corn on the local market (Szerb & Csima, 2016). The area used for wheat production purposes occupies 22-26 % of Hungarian arable land. The other crucial component of production is yield, which has increased significantly, by almost 45 % over the last 11 years (2010-2020) (Mizik & Máté Rádai, 2021). Wheat production reached 4,902.5 thousand tones in 2020. Even in the Czech Republic, wheat is the dominant crop on the cereal market, accounting for 60.3% of all grains. In the economic year 2020/21, the area planted with wheat was 798.6 thousand ha. The average total yield was 6.14 t/ha (Grains- Situation and Outlook Report, 2020).

The EU is a major player in the global wheat market. Paper of authors Dawson et al. (2017) examine the pricing behaviour of EU wheat exporters using a pricing to-market (PTM) analysis. Over the last decade, commodity prices have registered substantial booms and busts marked by extreme volatility. Wheat in particular, one of the main nonoil commodities, has registered a roller coaster in price levels which seems to be inconsistent with supply and demand fundamentals (Algieri, 2014). According to the latest FAO-AMIS (Agricultural Market Information System) outlook, agricultural commodity markets have been volatile in light of this year, with prices reaching record highs due to low global grain stocks, but also due to geopolitical risks (military conflict in Ukraine). Dry weather, high energy and transport prices also have a negative impact. The current price of wheat on the 7/10/2022 MATIF Paris exchange was €351.25/t (Cereal Growers Association). Shaping of prices of agricultural raw materials results from the impact of wide range of factors that influence prices in different links in the marketing chain. Political changes, especially sudden ones, which abruptly changed farming conditions, were on of the reasons for the asymmetry in price transmission (Kusz, Kusz & Hydzik, 2022). However, the prices of commodities are influenced by the set of different variables, i.e., supply and demand factors. The empirical results indicate that the main price drivers of wheat are crude oil prices, exchange rate and stock of wheat lagged one period (Alekneviciene & Bendoraityte, 2015). The results of grain production have a significant impact on the volume and profitability of the whole agricultural sector and, consequently, on the performance of the national economy (Vincze et al.,

2020). The analysis, using a two-sector econometric model, indicates that output and stock-holding of major exporters like USA, Canada and Australia hold large implications for the stability of world wheat markets (Sekhar, 2003). The warming of the climate and shrinking freshwater resources pose serious challenges to European agriculture. However, a major part of the Mediterranean and the Carpathian-Balkan regions and Eastern Europe recorded the driest soils over recent decades. Summer half-year moisture declined across almost the entirety of Eastern Europe, threatening the reproductive stage of wheat and maize vegetation period (Pinke et al., 2022).

Climate change poses complex impacts on the global wheat supply and demand chain. The impacts of climate change on average wheat yields are reasonably well studied. Zhang, et al. (2022) show that future global wheat prices will exhibit steeper spikes at 2^0C global warming despite a 1,7% increase in production given that CO2 fertilization benefits crops. Such economics stresses could be abated by trade liberalization with lower prices. In modern wheat management it is necessary to harmonise the agroecological, biological and agrotechnical elements to increase the yield quantity, quality and stability, and to decrease the harmful environmental effects (Pepo, 2001).

2. Data and Methods

The main goal of the contribution is price analysis on the MATIF market, analysis on local markets in countries V4 with evaluation of price premiums, analysis of the impact of fundamentals on the price. Research is made in the period of 2011 to year 2020, i.e., in a ten-year period. Due to the need for a lot of data, the information is drawn from several secondary sources. These are data from Research institute of agricultural and food economics, Statistical office of V4 countries, EUROSTAT. Mainly mathematical-statistical methods, synthesis, analysis for the needs of describing changes in indicators during the monitored period as well as the method of comparison are used to evaluate the price development. Due to the timeliness of the data and the need for specific information, specialist monthly articles were used from professional databases available online and websites from relevant sources, whose content is also in line with the topic addressed. The graphs and calculations were made using the platform of portal investing.com.

- simple individual indexes, namely basic and chain:

$$i_{j/0} = \frac{q_j}{q_0} \text{ or } \frac{p_j}{p_0} \qquad i_{j/j-1} = \frac{q_j}{q_{j-1}} \text{ or } \frac{p_j}{p_{j-1}} \tag{1}$$

- variation ranges for expressing the difference between the maximum and the minimum

- absolute changes to determine the differences between individual years:

$$\Delta y_t = y_t - y_{t-1} \qquad \text{t = 2, ..., n} \tag{2}$$

- moving averages used to determine the trend:

$$MA = \frac{(P_1 + P_2 + \cdots + P_n)}{n} \tag{3}$$

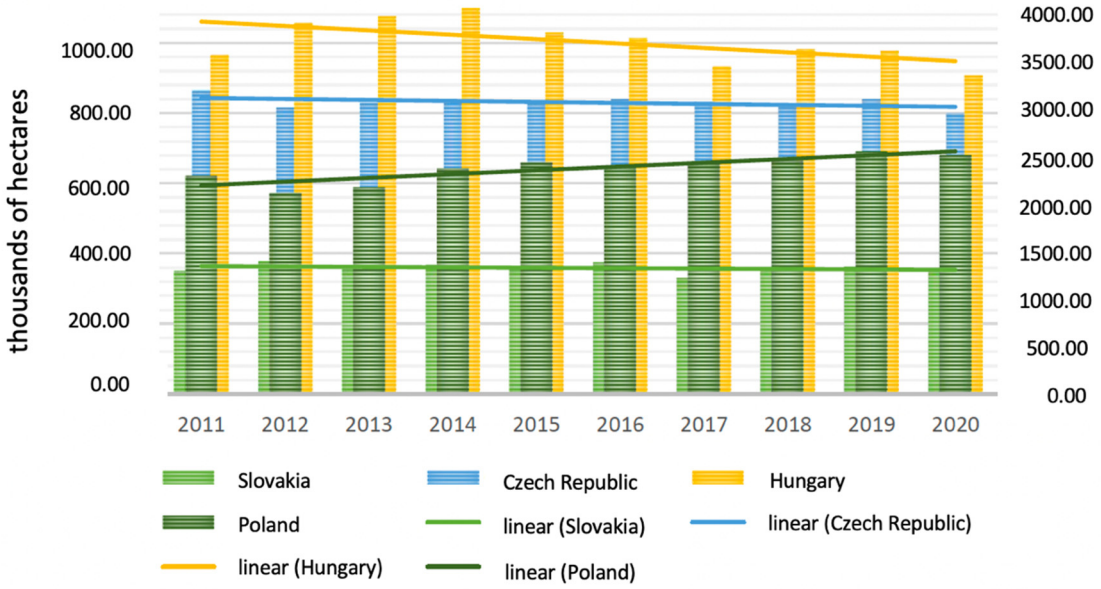
- price premium indicator in €:

CP = stock-exchange value - price on the market (4)

3. Results and Discussion

In the case of analyzed countries, the harvested area of wheat depends significantly on the size of the country's territory, as due to localization, the countries have relatively similar conditions for its cultivation. Thus, we record the highest harvesting areas in the case of Poland, where wheat areas occupy an average of 2,336.63 thousand hectares over the course of ten years. It is a significantly higher value, which is why a second vertical axis is also used in the in Figure 1 to describe the values. Hungary is the second largest country among the V4 countries by area, and for that reason, wheat areas in Hungary occupy an average of 1004.18 thousand hectares, which is 1332.23 thousand hectares less than in the case of Poland. In the Czech Republic, the area of cultivated wheat is spread over an area of 830.32 thousand hectares, and in the case of the Slovak Republic it is approximately 2.3 times less, where the average area of wheat is located at 358.94 thousand hectares. In the case of Poland, also due to the size of the hectare areas, we record the highest average year-on-year increase in the harvesting area by 23.65 thousand hectares. It is an average year-on-year change of 1.1%. Evidence of the increase is also given by the linear trend line, which clearly shows a progressive development. During the period, the areas in Poland increased by 212.85 thousand hectares, which is a change of 9.42% compared to the initial year. The relatively stable development of areas is measured in the Slovak Republic, where the average year-on-year growth during the period shows a growth of 230 hectares per year. However, the difference between the initial and final year is not large, as the value in 2020 is higher by 2.04 thousand hectares. The highest year-on-year increase in areas is observed between the first and second analyzed years, when the areas increased by 26,590 ha. We recorded the highest year-on-year decrease between 2016 and 2017, when wheat areas decreased by 43,190 ha.

Figure 1: Development of wheat harvesting areas in V4 countries



Source: own processing (Eurostat)

The figure below shows the development of monthly wheat prices on the MATIF exchange with the opening, closing, lowest and highest prices for the analyzed period. Commodities are very volatile assets, as reported by the standard deviation of average monthly prices at the level of 38.46. According to the analyses, the development of wheat prices is developing progressively based on the average month-on-month price increase of 1.06 €/t, which represents an increase of 0.6%. During the period, prices increased by 141.63 €/t. However, high average monthly prices were achieved both in the initial period of the analysis and in the final period of the analysis. Therefore, if we analyze the average minimum and average maximum value from the file, we find that the difference is 263.63 €/t. If the average values are omitted, the difference between the maximum and the minimum in the set is 310.5 €/t. In the Figure, it is possible to observe the development of the moving average over 12 periods, in our case over a year. The indicator is in the growth phase 55% of the analysed time, based on which we can state a progressive price development.

Figure 2: Development of the moving average indicator for monthly wheat prices

Source: own processing (investing.com)

In the initial years of the analysis, i.e., in the years 2011-2014, monthly wheat prices moved in one price channel, which formed the minimum price at the level of 176.5 €/t and the maximum price at the level of 283 €/t. We can observe the resistance level in Figure 3 labeled 2. The resistance was reached in February and May 2011 and in November 2012, while the maximum price was also reached in these periods. On the contrary, the support level from October to December in 2011 and also in August 2013. The support level is marked with the number 1 in the picture. As you can see, the change occurs in July 2014, when the support line was cut and there was a downward trend with recoveries until March 2016. A significant decrease occurs between May and September in 2014, when the average monthly price of wheat decreased by 42.75 €/t. However, from October to

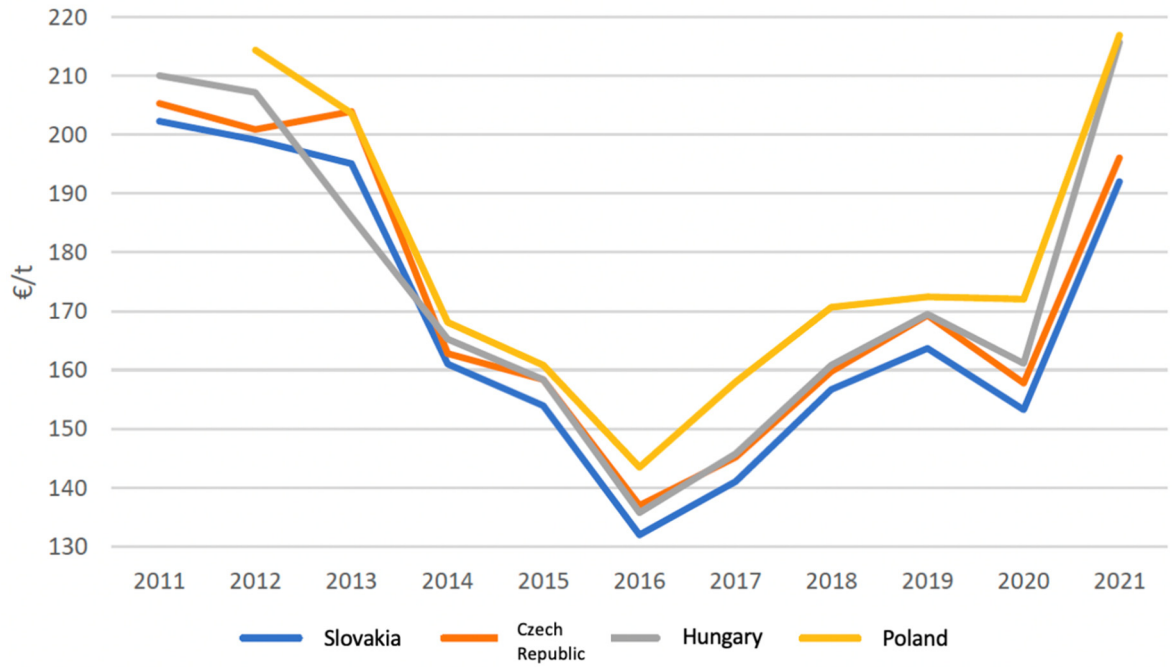
December 2014, the price recovered by 31.63 €/t. Between January and May, respectively May and July 2015, price variability occurs downwards, but also upwards. However, the changes between July 2015 and September 2016 are significant, when the price per ton decreased by 67.25 €/t. Very low prices have been reached since September 2015, which are marked in the Figure with the label 3. In September 2016, the price minimum for the entire set was reached, when wheat was traded on the MATIF exchange at a price of 139.5 €/t. During this analyzed period, prices were mainly influenced by the amount of wheat production in the world, when it was possible to achieve record growing results several times in a row. In particular, based on this, we could observe a downward trend. The slight recovery during this period was mainly caused by the Russian-Ukrainian conflict and also the introduction of an export tax on crops in Russia, which is a major exporter of wheat. From the price minimum in 2016, it is possible to state a growing trend of development until the end of the analysis. It is obtained by deduction, when the picture shows a growing trend of significant minimum prices in individual periods. The minimum price in September 2017 was 147 €/t, in September 2019 it was 151.25 €/t, in March 2020 it was 170 €/t and in July 2021 196.25 €/t (the development is shown in Figure 3). During the development of the period, a new support and resistance line formed by lines 3 and 4 was also formed. We can notice that the minimum prices in 2017 and 2019 are located near this line, while the downward trend in these periods turned in favor of growth. Also, line 4 extends from the period from 2014 to 2020, when after approaching the lines, the trend turned into a downward phase. The crossing of line 4 is recorded only in 2021, when the resistance line became a support line. Wheat prices started in 2017 with a positive trend that was carried throughout the entire three-quarters of the year. During this period, the minimum wheat price differed from the maximum by 17.75 €/t. However, in the fourth quarter, under the impression of strong harvests in the main regions of the world (especially a record harvest in Russia), the price of wheat weakened significantly and returned to the lows from the beginning of the year. On a monthly basis, the minimum differed from the maximum by 32.5 €/t, so a more significant decrease can be noted. From the beginning of 2018, the price increased again until the summer, but this time more significantly. The variation margin was 65.5 during this period, so it was 47.75 higher than the previous year. In the period of nine months in 2019, prices decreased by 56 €/t, which was caused by favorable production in the EU, above-standard production in Ukraine and also decent results in Russia. A more significant price drop was recorded in March 2020, which was caused by the pandemic. However, this slump was not long-lasting, and the response of the food supply of the countries and the people raised the wheat prices again in the pre-harvest period. After a slight drop in prices during the beginning of the pandemic, the price of wheat entered an upward trend, when the variation range between March 2020 and January 2021 was 70.25 €/t, which indicates a high increase in prices during this period. In the period during the beginning of 2021, there was a crossing of line 4 and the resistance became a support line from which prices reflected upwards.

Figure 3: Development of wheat prices from 2011 to the present

Source: own processing (investing.com)

As mentioned, wheat prices on the markets of individual European countries are strongly influenced by price developments on the French MATIF exchange. The proof is shown in the Figure 4, which shows the development of average market prices for individual years from the beginning of the analysis in 2011 to the end of the analysis in 2021. The graph shows a similar course of prices in the analyzed markets, while the individual prices in the markets are not the same. If we proceed to the analysis, we will find that the highest average prices for the analyzed period are in Poland at the level of 178.03 €/t, in Hungary at 174.11 €/t, in the Czech Republic at 172.38 €/t and the lowest are in Slovakia at the level of 168, 20 €/t. Compared to Poland, prices in Slovakia are on average 9.83 €/t lower, which puts Slovak farmers at a significant disadvantage in terms of economic results. We recorded the highest volatility of prices in Hungary, when the standard deviation was at the level of 26.87, resulting in the highest variation margin at the level of 79.9. The lowest standard deviation is measured in Slovakia at the level of 24.66 with a variation range of 70.27. However, the lowest range of variation was not in Slovakia but in the Czech Republic, where the measured value was 68.3.

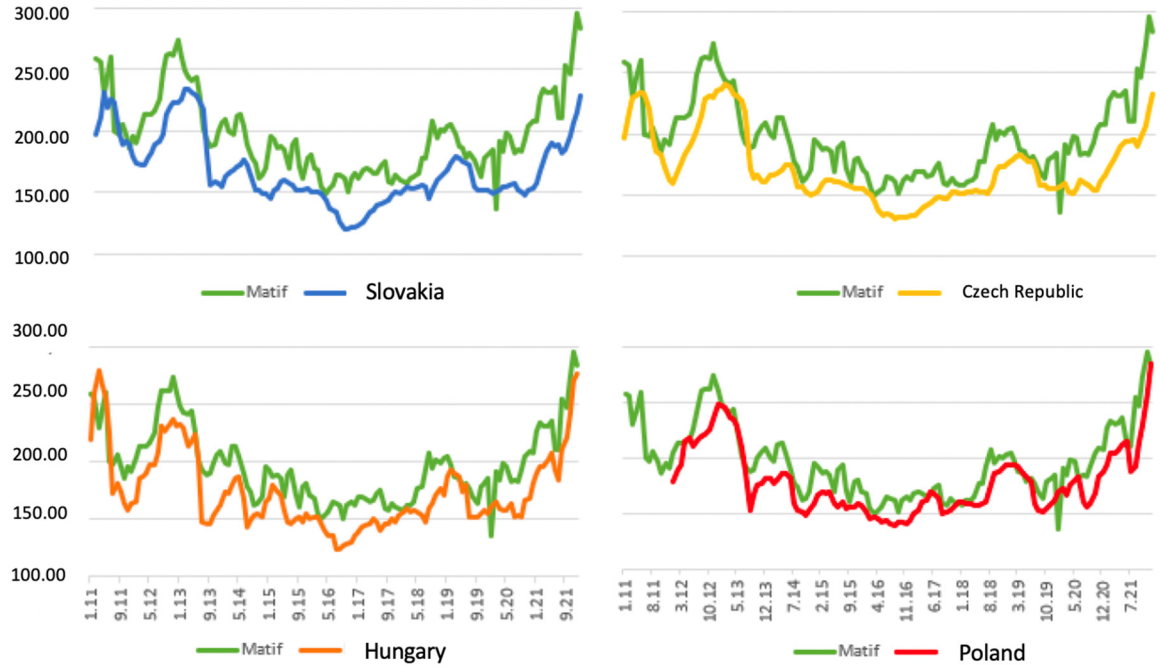
Figure 4: Development of wheat prices on markets in V4 countries from 2011 to the present



Source: own processing (statistical offices of V4 countries)

Below we can see the price development on the MATIF exchange compared to the monthly average prices on the markets in the V4 countries. We can observe significant trend copying from the MATIF exchange, noting the price differences between market and exchange prices. To prove the dependence of the prices of the V4 countries with the prices on the stock exchange, we calculated the correlation coefficient for individual countries. The highest dependence is observed in Hungary (91.4%), Poland (91.03%), Slovakia (85.78%) and the Czech Republic (84.26%). Based on the calculation, we can state a high dependence between stock exchange and market prices. The aforementioned difference between the prices on the MATIF exchange and the price on the market is called the price premium. The price premium is made up mainly of transport costs. The highest is precisely during the harvest when the storage units are filled the most. For each country, this indicator is different, while it depends on the location of the state, the level of consumption and the level of exports of the given state. Therefore, if the state is a priority exporter, this will be reflected in the amount of transport costs and the price premium is higher. Throughout the period, exchange prices appear to be higher than domestic market prices. When studying in more detail, we see that there are periods when market prices in countries are close to stock exchange prices or even subtly exceed them. These periods mainly occur with a sharp drop in prices on the stock exchange when domestic market prices react later to stock market developments.

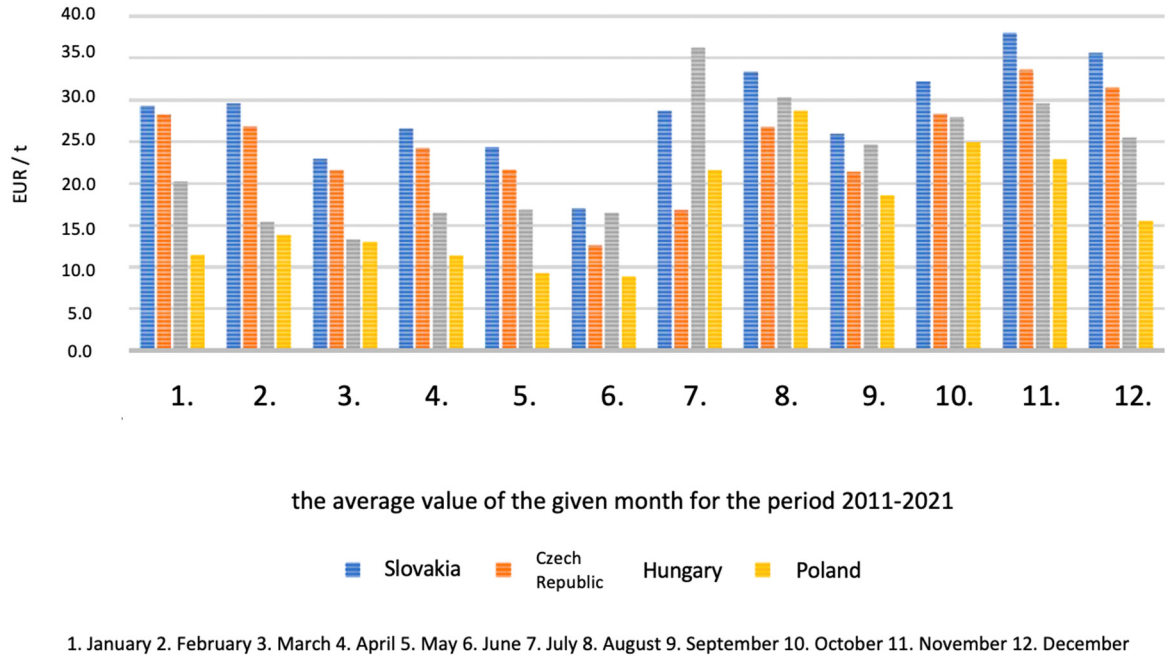
Figure 5: Comparison of average monthly wheat prices on markets and on the MATIF exchange in V4 countries from 2011 to the present



Source: own processing (statistical offices of V4 countries)

Based on the calculations, we conclude that the highest average price premium is in Slovakia (28.59 €/t), the Czech Republic (24.41 €/t), Hungary (22.68 €/t) and Poland (16.60) €/t). The difference in premiums between Slovakia and Poland is 12 €/t. The difference between exchange prices and prices on the domestic market is subject to considerable seasonality during the year, which emerged from the analyses. The price premium is the least advantageous immediately after the harvest, when there is enough commodity on the domestic market, while this premium is gradually adjusted in favor of the farmer. We show seasonality in Figure 6, in which we capture the average values of price premiums in individual months for the period from 2011 to 2021. The highest average values are reached in the month of November, when the average price premium for that month in Slovakia is 38 €/t. The maximum values are also reached in the Czech Republic at the level of 33.6 €/t. In Hungary and Poland, the maximums are reached during the summer months. Hungary – July (36.2 €/t). Poland – August (28.7 €/t). Already according to the maximum values, the order of the states can be seen, in which are arranged based on the amount of the price premium. At the same time, it is possible to observe a decrease in the price premium approaching the minimums reached in the pre-harvest period, when warehouses are the emptiest. Based on the average values in individual years, the lowest values of the difference between exchange and market prices are reached in June 17 €/t in Slovakia, 12.6 €/t in the Czech Republic and 8.8 €/t in Poland. In Hungary, the lowest average values of the price premium were reached in March at the level of 13.3 €/t. From the point of view of the development of the amount of the price premium, it is worthwhile for the farmers to keep the harvest in the warehouses, if possible, in order to achieve the best possible economic result. However, this can be problematic in terms of the need for finance for further operation or in terms of storage costs.

Figure 6: Comparison of price premiums in V4 countries based on average values achieved in the months from 2011 - 2021



Source: own processing (statistical offices of V4 countries)

4. Conclusion

Agricultural production is therefore one of the jobs, with the most specific productions in national economy and at the same time is one of the most important productions ever outputs from it are an integral part of meeting the needs of the population, without which the company would not be able to function properly. Amount of production in individual years it does not depend only on the amount of production factors or on their quality, but also on the factors on which man does not have the reach and abilities to influence them, such as climate conditions that have a very high diversity in Slovakia. It is also important biological nature of agricultural production, when individual processes can be carried out only at a certain specific time depending on the change of seasons.

In conclusion, it is essential to mention that we are experiencing high price volatility, which is caused by pandemic-related measures that have increased inflation. In such periods, investors try to protect their capital from depreciation, and it goes precisely to commodities, which pushes prices upwards. It is also important to note that a new price maximum was recorded during 2021, when wheat cost 313.5 €/t in November. Not only inflation, but also the sharp increase in energy prices contributed to the record increase in commodity prices, as many of them are linked to the production of biofuels. We should also not forget the exchange rate of the euro against the dollar, when it strengthened the dollar against the euro and that helped European wheat, which was cheaper. After the highs in November, there was a downward trend until January 2022. However, prices do not only respond to technical analysis, but also to fundamental analysis, which determined the next price trend. Russia and Ukraine account for 29 percent of the world's wheat exports, so their conflict contributed to new price records, when the price of one ton of wheat increased by 72% in one month. A new price record was thus achieved, when the maximum was reached in March 2022 at the level of 450 €/t. Due to the unclear situation on the market, further price development is questionable and will depend

mainly on the development of individual partial foundations. If it weren't for the current war situation in Ukraine, wheat prices would probably go down, since inflation is at its peak and individual central banks should soon suppress inflation with a stricter monetary policy, and this would lead to a decrease in prices. However, with significant restrictions on Russia, expect that Russia will not be very willing to export wheat to the world. The harvest in Ukraine is also at risk due to the delay in spring work, which is complicated by the war. If the war continues during the year, the world can expect a significant reduction in production in Ukraine, which could lead to further price increases in the event of a lower wheat harvest in the world.

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References

[1] Alekneviciene, V. & Bendoraityte, A. (2015). Long-term drivers of wheat and maize commodities prices. 7Th International Scientific Conference Rural Development 2015: Towards the tranfer of knowledge, innovations, and social progress. Lithuania: Aleksandras Stulginskis University. ISSN 1882-3230

[2] Algieri, B. (2014). A roller coaster ride: an empirical investigation of the main drivers of the international wheat price. *Agricultural Economics,* 45 (4), pp. 459-475. Doi: 10.1111/agec.12099

[3] Dawson, P., Gorton, M., Hubbard, C. & Hubbard, L. (2017). Pricing-To-market Analysis: The Case of EU Wheat Exports. *Journal of Agricultural Economics,* 68 (1), pp. 301-315, doi: 10.1111/1477-9552.12199

[4] EC. EUROSTAT [online database]. [cit. 2022-09-25]. Available online: https://ec.europa.eu/eurostat/web/agriculture/data/database

[5] Gorlach, K., Nowak, P., Jastrzebiec-Witowska, A. & Dabrowski, A. (2018). Super-expensive wheat cropping in Opolskie voivodeship. 20 pp. Available online: https://www.sufisa.eu/wp-content/uploads/2018/09/D__2.2-Poland-Summary-wheat.pdf

[6] Jamborová, M. (2021). The current situation of wheat supply and demand on the Slovakian agro-food market. Available online: https://www.agromanual.cz/cz/clanky/management-a-legislativa/management/aktualna-situacia-ponuky-dopytu-psenice-na-agropotravinarskom-trhu-slovenska

[7] Kusz, D., Kusz, B. & Hydzik, P. (2022). Changes in the Price of Food and Agricultural Raw Materials in Poland in the Context of the European Union Accession. *Sustainability,* 14 (8), 4582. doi: 10.3390/su14084582

[8] Kravčáková Vozárová, I. & Kotulič, R. (2016). Quantification of the Effect of Subsidies on the Production Performance of the Slovak Agriculture. *Procedia Economics and Finance,* 39, pp. 298-304. Doi: 10.1016/S2212-5671(16)30327-6

[9] Mizik, T. & Máté Rádai, Z. (2021). The Significance of the Hungarian Wheat Production in Relation to the Common Agricultural Policy. *Review on Agriculture and Rural Development*, 10 (1-2), pp. 36-43. Doi: 10.14232/rard.2021.1-2.36-43

[10] Grains- Situation and Outlook Report to 31.12.2020. (2021). NPPC-VÚEPP, Bratislava, 57 pp. ISSN 1338-483X

[11] Pepo, P. (2001). Variety-specific fertilization in wheat production. 6th International Wheat Conference. Wheat in a global environment. Hungary, 9, pp. 639-645

[12] Pinke, Z., Decsi, B., Kardos, M.K., Kern, Z., Kozma, Z., Pásztor, L. & Ács, T. (2022). Changing patterns of soil water content and relationship ith national wheat and maize production in Europe. *European Journal of Agronomy,* 140, doi: 10.1016/j.eja.2022.126579

[13] Sekhar, CSC. (2003). Price formation in world wheat markets – implications for policy. *Journal of Policy Modeling.* 25 (1), pp. 85-106. Doi: 10.1016/S0161-8938(02)00198-9

[14] Situační a výhledová zpráva obiloviny. (2020). Praha: Ministerstvo zemědělství, 113 pp. ISBN 978-80-7434-611-8

[15] Szerb, A.B. & Csima, F. (2016). The Situation of the Hungarian Wheat from the Grain Trading Point of View in 2016. International Conference on Eurasian Economies. Hungary, pp.82-86. Doi: 10.36880/C07.01809
[16] Vincze, J., Bujdosó, Z. & Antal, S. (2020). Analysis of the situation and market trends in the grain sector in Hungary. *Economics of Agriculture*, XX. (2), pp.14-27. ISSN 1338-6336
[17] Združenie pestovateľov obilnín (2022). (cit. 10.13.2022) Dostupné online: https://www.obilninari.sk/ceny/
[18] Zhang, T., Van der Wiel, K., Wei, T., Screen, J., Yue, X., Zheng B., Selten, F., Bintanja, R., Anderson, W., Blackport, R., Glomsrod, S., Liu, Y., Cui, X. & Yang, X. (2022). Increased wheat price spikes and larger economic inequality with 2^0C global warming. *One Earth,* 5 (8), pp. 907-916, doi: 10.1016/j.oneear.2022.07.004

CHALLENGES AND TRENDS IN THE ROMANIAN FOOD SYSTEM

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Abstract

The transformation of the Romanian food system into a viable, pliable, answerable, varied, competing and inclusive system is a need. The paper presents the results obtained in the Romanian Policy Lab study of evaluation of the Romanian food system status and the identified priorities for change. The aim of 'Policy Labs' is to increase and align public/private R&I policies/programs on food and nutrition security, building on and expanding existing national/regional networks. Firstly, a SWOT analyse was conducted to identify the challenges, strengths, weaknesses and opportunities as well as barriers that can be met during the process. Secondly, a "Trends cards" exercise was organised with relevant stakeholders from the food chain to understand the main trends, which will influence the food system in Romania in the next 10 years in order to elaborate recommendations and suggest solutions for actions in building an updated food system. The trends exercise was applied for the four Food2030 priority areas: 1. Nutrition and health, 2. Climate and sustainability, 3. Circularity and resource efficiency and 4. Innovation and communities. A large group of stakeholder's representatives (food industry (n=27), research (n=6), university (n=2), food education (high school level n=5), food associations and platforms (n=4), NGOs (n=2)) took part to this activity. Thirdly, a Vision of the Romania food system for 2030 and beyond exercise was conducted with more than 70 stakeholders from the entire food chain to conclude on Research & Innovation priorities. Two roadmaps were drafted: one for food safety and one for food waste (including food plastics) including the main actions to be implemented and the responsible organisations. The results of the study revealed the R&I actions needed, some idea, opportunities and development of recommendations for the new research programmes and the new Strategy for research at national level.

Keywords: *food system: challenges, trends, SWOT analysis, R&D priorities*

JEL Classification: *Q18: Agricultural Policy • Food Policy, L66: Food • Beverages • Cosmetics • Tobacco • Wine and Spirits, O33: Technological Change: Choices and Consequences • Diffusion Processes, O38: Government Policy*

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1. Introduction

The concept of food system has progressed over the decades. The food system covers the entire framework of food chains from growing, harvesting, processing, production, packaging, marketing, transporting, marketing, utilization and removal of food and food-related products. If in the past, policies related to food focused on primary production and on consumption, nowadays a more holistic approach is necessary, as shown in Science Advice for Policy by European Academies (SAPEA) (2020) document and mentioned by Okpala (2020), to involve: governance, human participation, environmental, nutrition and health and social aspects. The following definition of food systems was adopted as mentioned in European Commission-Staff Working Document (EC-SWD) (2016): "The definition of food systems goes beyond the production and delivery of sufficient food for all (quantity) to include the provision of safe and nutritious food for healthy and sustainable diets".

Food systems are also heavily globalised and interdependent as shown in the documents elaborated by European Commission, Directorate-General for Research and Innovation, Unit 03 (EC-DGRI), Chief Scientific Advisors–SAM, EGE, (2020) and the EU imports significant quantities of food and feed from third countries being also an important exporter of food products based on the data from Eurostat (2020).

The global drivers of food system change to 2050 are presented by World Resources Institute (WRI) (2020): growing world population to 9.7 billion which will impose an increase in global food production up to 70% and the agriculture will have to support the economic and social development; ageing population which will bring significant social transformations with implications for nearly all sectors of society, including the demand for specific goods and services as shown by United Nations (UN) (2020); malnutrition; biodiversity loss; antibiotics and pesticides use; climate change; water scarcity; animal welfare; land-use conflicts. Moreover, the food system has some values such as: sustainability, affordability, accessibility, diversity, inclusiveness, power balance, competitiveness, innovative capacity which are not entirely valorised and the system has not a proper functionality.

1.1 Food2030 Policy

Food2030 is the EU research and innovation policy response to the recent international policy developments including the Sustainable Development Goals (SDGs) and COP21 (2015 Paris Climate Conference) commitments (http://www.cop21paris.org/about/cop21/, 2015). The Food2030 framework as shown in the documents of European Commission, Directorate-General for Research and Innovation (DG-RTD), Directorate F–Bioeconomy, Unit F.3–Agri-Food Chain, (2017) is built on the following four key Food and Nutrition Security priorities: "Nutrition for sustainable and healthy diets", "Climate smart and environmentally sustainable food systems", "Circularity and resource efficiency of food systems", "Innovation and empowerment of communities".

The objective of the three-year Fit4Food2030 Horizon 2020 project launched in 2017 is to create a sustainable multi-stakeholder platform that connects food stakeholders and will support the urgently needed transformation of research & innovation on food and nutrition security by providing a network of instruments for the adoption of a food system and Responsible Research and Innovation approach to R&I. For this purpose, three interlinked instruments were developed: EU Think Tank, Policy Labs and City Labs.

The Romanian Policy Labs exercise will be presented in the following chapters. The aim of 'Policy Labs' is to increase and align public/private R&I policies/programs on food and nutrition security, building on and expanding existing national/regional networks (Fit4Food2030 project, 2018, www.fit4food2030.eu).Your paper will be part of the conference proceedings.

1.1.1 The Romanian Policy Lab

The Romanian Policy Lab was set up within the framework of the Fit4Food2030 project in November 2017, with the support of the Ministry of Research and Innovation, The Academy of Agricultural and Forestry Sciences "Gheorghe Ionescu-Şişeşti" and The National Institute of R&D for Food Bioresources IBA Bucharest. The Policy Lab action aims to bring together important actors such as stakeholders, decision-makers in the fields of food, nutrition, health, to analyse the current situation of the entire food chain and to define the weaknesses in knowledge, opportunities and the need to design appropriate research and innovation policies.

According with The National Rural Development Programme 2014-2020 (MARD, 2014) which covers the entire territory of Romania, 61.3% from the land is agricultural land (approx. 14.6 mil. ha, of which 64.2% arable land, 32.9 % meadows and natural grasslands and 2.7% plantations of trees and vineyard); 28.3% forests and other forestry vegetation lands; 10.4% the built area of the localities, waters, roads, railways and unproductive lands

The food industry in Romania is having a turnover of about 12.5 billion euro annually as it is reported by FoodDrinkEurope (2019). In this field, 9134 food companies activate; 8.72 million of tonnes of food products are produced of which 13.8% are exported. The cost of logistics services for food products in Romania is estimated at 2 billion euros, of which 1.1 billion euros are spent on primary logistics, the rest being allocated to secondary logistics (stores and wholesalers). The local food industry is dominated by a number of 50 large companies which make over 40% of the production of the Romanian food sector and obtain a profit of over 4 billion euros. The food industry represents 27% of the total value of agricultural production and provides over 183,200 jobs, i.e. 11.6% of the total number of employees in the Romanian industry and 2.1% of the total workforce in Romania. The food industry is one of the few sectors in which the share of Romanian capital exceeds 60%. At the same time, according to the same source, the added value achieved by the food industry represents almost a quarter of the total added value of the manufacturing industry. Based on the report of Nitulescu (2016), the Romanian food and beverage market is the seventh largest in the European Union and the second largest in Eastern Europe, after Poland and it is valued at 25.9 billion euros, of which 20.6 billion EUR (79.5%) in retail trade and EUR 5.3 billion (21.5%) in food services.

In this context, the paper presents an analysis of the Food System Awareness & System Understanding a successful good practice of industry-education-research synergy in the agri-food sector, applied within the Policy Lab Romania activity through the European project Fit4Food2030 “Towards Food2030 - Future-proofing the European food systems through research & innovation”.

2. Data and Methods

The Policy Lab activity aimed to analyse the current situation of Romanian food system (by a SWOT analyse) and to discuss the influence of various trends on the Food2030 priority areas in order to define topics of interest for research and innovation in Romania in the upcoming years.

Firstly, the SWOT analysis examined the strengths, weaknesses, barriers and opportunities of the Romanian food system.

Secondly, the trends exercise was applied for the four Food2030 priority areas: 1. Nutrition and health, 2. Climate and sustainability, 3. Circularity and resource efficiency and 4. Innovation and communities. A large group of stakeholder’s representatives (food industry (n=27), research (n=6), university (n=2), food education (high school level n=5), food associations and platforms (n=4), NGOs (n=2) took part to this activity. The 46 participants were divided into 4 groups according to preferences where they freely presented their ideas, based on the pre-defined questions. Each group

focused on one of the four priority areas and they discussed, guided by a facilitator, the trends (identified by the Fit4Food2030 consortium) and the influences on those particular areas. The trends cards were provided for consultation on each table, so people from a group could have a look at the particular trend and comment on it. For each priority areas under discussion, the following questions were proposed to open the discussions: 1. Which trends strongly influence this field (make a list of the top 5 most influential trends)? 2. Explain why each of the five chosen trends influences this area? 3. Explain how the 5 trends (favourable/unfavourable) influence the respective field. 4. Build a consensus on the top 5 trends affecting this area. 5. What kind of decision makers/stakeholders need to be involved for each of the 5 trends? 6. What barriers does each of the 5 trends raise? 7. What opportunities can arise related to each of the 5 trends? 8. Can additional trends be formulated? 9. What policies/strategies should be developed by 2030? 10. How do you see research and innovation in this field until 2030? The moderators summarized the results of the discussions and the conclusions are presented below.

The trends which were considered for the four priority areas of Food2030 (based on the data from Fit4Food2030 project results, www.fit4food2030.eu) were:

- **Megatrends**: climate change and environment, malnutrition, rise of non-communicable disease, urbanisation, demographic change, migration, scarcity of natural resources, rise in energy consumption, industry 4.0.-digitization in food production, big data analysis, economic globalisation.
- **Agricultural production trends**: modern digital technologies in agriculture, alternatives to conventional pesticides, changes in farm structures, agricultural pollution, biodiversity loss, transboundary pests and diseases, organic farming, genome engineering, bio-fortification, indoor cultivation systems, urban agriculture/urban farming, food from the sea, closing the loop in aquaculture, permaculture.
- **Food processing trends**: block chain technology for secure food supply chain, cultured/*in-vitro* meat, new technologies in food production, high/ultra-processed food, clean eating/transparent labels, novel food, natural preservatives & milder processing methods, alternative protein sources, functional foods incl. Pro&Prebiotics.
- **Consumer trends**: health and food consciousness, responsible consumers, specific diets like vegetarian, vegan or low carb, destabilized consumer trust, fast and convenient food, low prices-high calories, "free-from" products, smart personalized food, changing households and food, globalisation of diets, consumer engagement, tradition and do it yourself, social media and food.
- **Market, economy, retail and logistic trends**: concentration in food retail markets, new shopping behaviour, short food supply chains, chain, physical internet (logistic).
- **Packaging and waste trends**: bio-based packaging, packaging 4.0, reduction of plastic packaging, packaging & health, food waste valorisation.
- **Policy and other trends**: women's empowerment, responsible research and innovation (RRI), food regulation (Wepner et al., 2018, https://fit4food2030.eu/wp-content/uploads/2018/10/FIT4FOOD2030_D2.1_Report_on_trends_final-compressed.pdf.).

Thirdly, a Vision of the Romania food system for 2030 and beyond exercise was conducted with more than 70 stakeholders from the entire food chain to conclude on Research & Innovation priorities. Two roadmaps were drafted: one for food safety and one for food waste (including food plastics) including the main actions to be implemented and the responsible organisations.

3. Results and Discussion

The SWOT analysis results are presented below and the main societal challenges, strengths, weaknesses, barriers and opportunities are highlighted (Table 1).

Table 1. Swot analysis of Romanian food system

<table>
<tr><td colspan="2">Main societal challenges of the food system in Romania:</td></tr>
<tr><td colspan="2">▶ Farm's fragmentation with low efficiency;
▶ Insufficient training programs and motivation ways for human resources in agri-food domain;
▶ Young population migration from rural areas & ageing;
▶ Inadequate inter-relationships between policy makers (agriculture, food, health, research, education) & between food systems stakeholders;
▶ Deficient knowledge to attract R&D funds for research and innovation;
▶ Lack of food system waste valorisation programs/projects;
▶ Poor linkage between industry and research;
▶ Low level of application of innovative and new technologies to perform research (biotech, ICT, etc.);
▶ Insufficient R&D projects on food security, food nutrition, food safety;
▶ Scarce of technical and financial support;
▶ Deficient appreciation and support for small and medium-sized producers;
▶ Low level of sustainable production methods implementation according to needs of local conditions, markets and consumer demands;
▶ Inadequate support for vulnerable farmers (through assessment and provision of market and weather information, crop insurance, debt restructuring, and shifting from disaster relief to early warning systems to ensure, as far a possible action well in advance of food emergencies, as well as develop contingency plans to tackle emergencies).</td></tr>
<tr><td>Strengths</td><td>Weaknesses</td></tr>
<tr><td>+ Geographical position
+ Management capacity
+ Highly skilled personnel
+ Product and Process Quality
+ Open exchange of experience in research and technology development
+ Public-private cooperation
+ Product Diversification</td><td>– No clear international orientation
– Low financial capacity
– Weak understanding between researchers and industry which complicates joint projects
– Lack of formal collaboration between actors
– Poor networking with public actors</td></tr>
<tr><td>Barriers</td><td>Opportunities</td></tr>
<tr><td>○ Insufficient funding of R&D&I in agro-food domains and difficult access to financial instruments of small and medium-sized farmers;
○ Long food chains with no correlation between production-processing-storage-marketing
○ Lack of management procedures implemented on the food systems and traceability methodologies
○ Deficient knowledge transfer due to low skills and pour finance
○ The problem of job creation and stability measures in rural areas (stabilization of rural population)
○ Lack of systematic education research to find solutions to the problems of rural</td><td>➢ High agro-food potential and biodiversity
➢ EU Structural Funds
➢ Legislation in force to promote domestic production through EU quality protection schemes for traditional food products
➢ Changes in consumers' food attitude (i.e. request for local short food chain).</td></tr>
</table>

space (rural sociology research); potential analysis of various areas of the rural economy.	

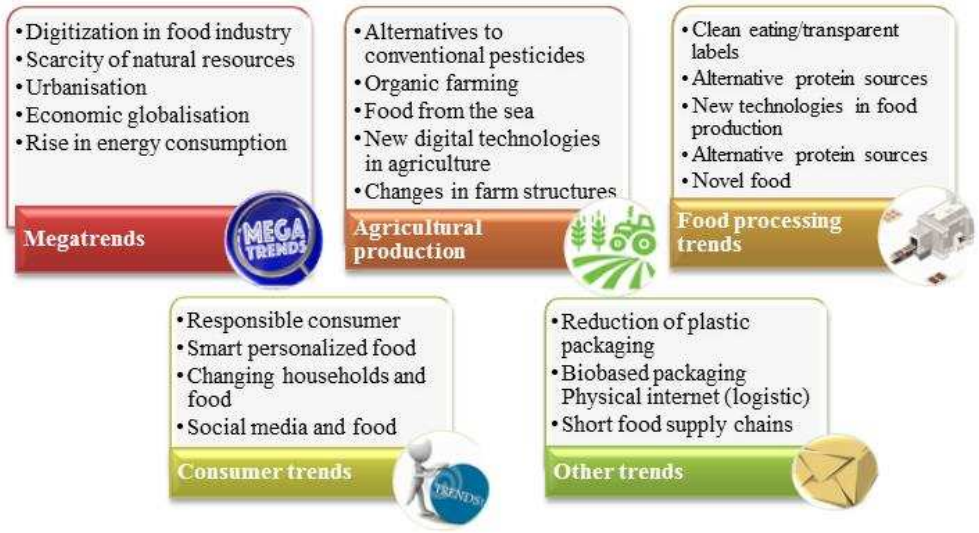

Fig.1. The main trends that will influence the all four key Food2030 priorities

Thirdly, a Vision of the Romania food system for 2030 and beyond exercise was conducted with more than 70 stakeholders from the entire food chain to conclude on Research & Innovation priorities. Two roadmaps were drafted: one for food safety and one for food waste (including food plastics) with the main actions to be implemented and the responsible organisations.

The Vision on food waste/plastics for 2030 and beyond outlined the following points: the changing of dietary pattern in favor of vegetables (decreasing meat consumption and processed food), using regional and seasonal foods through short supply chains; food waste reduction (at least 30% reduction of food waste by 2025; fast recyclable/biodegradable food packaging materials).

The Vision on food safety for 2030 and beyond outlined the following main points: food safety should have a broader approach including social, environmental and nutritional aspects: food labels should include sufficient info about nutritional composition (using QR code, lights, colors); food chain should be more transparent, including a very strict traceability, a more clear/updated policy of storage, a trusted/checked food provider e-commerce; education and training of young people should be considered; the official controls (Food safety Authorities, Consumer Protection Authorities) should be optimised.

In order to improve the R&I landscape to work towards your vision, roadmaps were drafted for food waste and food safety domains.

DRAFTED ROADMAP FOR FOOD WASTE DOMAIN

	The main actions to be implemented:	Responsible organizations
1	Better quantification of food waste	National authorities
2	Research and innovation for bioplastics	R&D units and companies
3	European rules/laws for waste management	Countries + EU
4	Consumer education (young generations from high school)	Universities + government
5	Valorization and side production (by products), incentives for companies	Companies and R&D units
6	Short supply chains (storage-market demand-consumers)	Companies, R&D units and local authorities
7	New qualifications	Universities + VET

DRAFTED ROADMAP FOR FOOD SAFETY DOMAIN

	The main actions to be implemented:	Responsible organizations
1	National policy programs More control on food chain Higher engagement of local authorities for improving local production chains Enhanced use of national standards on food safety and technical aspects	National authorities
2	Anticipations emerging hazards + risk assessment methods + study exposure Intensify risk communication Open data traceability Dedicated research programs based sensitive topics regarding food safety Tight collaboration between R&D and policy maker	National authorities, R&D units and companies
3	Multi sectoral research programs Health by good quality products (prevention) Interdisciplinary research for preventing the illness caused by unsafety foods IT for traceability, integrity, transparency New methods of plant breeding in research	R&D units and companies
4	Education Multidisciplinary researches	Universities + government
5	Food clusters Development collaborative platforms	Companies, R&D units, local authorities
6	Curricula for training, Educate the farmers, producers, suppliers, consumers	Universities + VET
7	More involvement of the retail sector, the main interactor with final consumption. Retailers already have large data-basis on behavior of their consumer and they may/can contribute to the influence of the consumer habits	Stakeholders
8	Involvement of consumers association in educating people regarding food safety	Consumers' association

4. Conclusion

On 20 May 2020, the European Commission adopted the "From Farm to Consumer" strategy to ensure a healthy, environmentally friendly and trustworthy food system. The strategy will allow the conversion to a sustainable EU food system, which guarantee food security, access to healthy food on a healthy environment; establish concrete targets for changing the EU food system like a 50% reduction in pesticide use, at least 20% reduction in fertilizer use, 25% of agricultural land dedicated to organic farming.

For further Romanian food system transformation there is a need for boosting R&I in this field through funding multidisciplinary projects involving all the relevant stakeholders on the whole food chain. Innovations are needed in the following fields: bioplastics, valorization and side production (by products), short supply chains, new qualifications, anticipations emerging hazards + risk assessment methods + study exposure, intensify risk communication, open data traceability, health by good quality products (prevention), interdisciplinary research for preventing the illness caused by unsafety foods, IT for traceability, integrity, transparency, new methods of plant breeding in research, food clusters, curricula in food safety.

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References

[1] EC-DG-RTD. (2017). FOOD 2030: Future-Proofing our Food systems through Research and Innovation, European Commission, Directorate-General for Research and Innovation, Directorate F–Bioeconomy, Unit F.3–Agri-Food Chain, On line at: https://fit4food2030.eu/wp-content/uploads/2018/02/food2030-future_proofing_our_food_systems.pdf.

[2] EC-DGRI. (2020). Towards a Sustainable Food System, European Commission, Directorate-General for Research and Innovation, Unit 03 Chief Scientific Advisors–SAM, EGE, Group of Chief Scientific Advisors, On line at: https://ec.europa.eu/info/sites/info/files/research_and_innovation/groups/sam/scientific_opinion_-_sustainable_food_system_march_2020.pdf.

[3] EC-SWD. (2016). European Research and Innovation for Food and Nutrition Security, European Commission-Staff Working Document, On line at: https://ec.europa.eu/transparency/regdoc/rep/10102/2016/EN/SWD-2016-319-F1-EN-MAIN.PDF.

[4] EC. (2020). A Farm to Fork Strategy for a fair, healthy and environmentally-friendly food system, European Commission, 381 final Communication from the Commission to the European Parliament, The Council, The European Economic and Social Committee and The Committee of The Regions, On line at: https://ec.europa.eu/info/sites/info/files/communication-annex-farm-fork-green-deal_en.pdf.

[5] Eurostat. (2020). Extra-EU28 trade of food, drinks and tobacco (SITC 0+1), by main partners On line at: https://ec.europa.eu/eurostat/web/products-datasets/-/tet00034.

[6] FoodDrinkEurope. (2019). Data&Trends EU Food&Drink Industry, On line at: https://www.fooddrinkeurope.eu/uploads/publications_documents/FoodDrinkEurope_-_Data__Trends_2019.pdf.

[7] Gill M., den Boer A.C.L., Kok K.P.W., Breda J., Cahill J., Callenius C., Caron P., Damianova Z., Gurinovic M.A., Lähteenmäki L., Lang T., Laperrière A., Mango C., Ryder J., Sonnino R., Verburg G., Westhoek H., Regeer B. J., Broerse J.E.W.. (2018). A systems approach to research and innovation for food system transformation, On line at: https://fit4food2030.eu/eu-think-tank-policy-brief.

[8] Knorr D., Khoo C.S.H., Augustin M.A. (2018). Food for an Urban Planet: Challenges and Research Opportunities, *Frontiers in Nutrition,* 4, 1-6.
[9] MARD. (2014). National Rural Development Programme for the 2014–2020 period, Ministry of Agriculture and Rural Development, On line at: https://www.madr.ro/docs/dezvoltare-rurala/programare-2014-2020/PNDR_2014_EN_-_2020_01.07.2014.pdf.
[10] Nitulescu G.. (2016). Radiography of the Romanian food industry (Romanian language) *RoAliment,* On line at: https://www.roaliment.ro/editia-1/radiografia-industriei-alimentare-romanesti/
[11] Okpala C.O.R. (2020). Toward Sustaining Global Food Systems for the Future, *Frontiers in Sustainable Food System*, 4, 1-4.
[12] SAPEA. (2020). A sustainable food system for the European Union, Science Advice for Policy by European Academies, Berlin, On line at: https://doi.org/10.26356/sustainablefood.
[13] Sonnino R., Callenius C., Lähteenmäki L., Breda J., Cahill J., Caron P., Damianova Z., Gurinovic M.A., Lang T., Laperriere A., Mango C., Ryder J., Verburg G., Achterbosch T., den Boer A.C.L., Kok K.P.W., Regeer B.J., Broerse J. E.W., Cesuroglu T., Gill M.. (2020). Research and Innovation Supporting the Farm to fork Strategy of the European Commission, On line at: https://fit4food2030.eu/reports-publications/(2020).
[14] UN. (2020). Ageing, United Nations, On line at: https://www.un.org/en/sections/issues-depth/ageing.
[15] UNEP. (2016). Food systems and natural resources, United National Environment Programme, The International Resource Panel, Working Group on Food Systems and Natural Resources, On line at: https://www.resourcepanel.org/sites/default/files/documents/document/media/food_systems_summary_report_english.pdf.
[16] UNFCCC COP21, The 2015 Paris Climate Conference, United Nations Framework on Climate Change, On line at: http://www.cop21paris.org/about/cop21/.
[17] Zasada I.. (2011). Multifunctional peri-urban agriculture–a review of societal demands and the provision of goods and services by farming, *Land use policy*, 28, 639-648.
[18] Wepner B., Giesecke S., Kienegger M., Schartinger D., Wagner P. (2018). Deliverable 2.1. Report on baseline and description of identified trends, drivers and barriers of EU food system and R&I, On line at: https://fit4food2030.eu/wp-content/uploads/2018/10/FIT4FOOD2030_D2.1_Report_on_trends_final-compressed.pdf.
[19] WRI. (2020). FOOD. Supporting agriculture, environment, and sustainable development, World Resources Institute, On line at: https://www.wri.org/our-work/topics/food.
[20] www.fit4food2030.eu.

Slovakia's self-sufficiency in selected food products

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Abstract

Food production is a basic branch of the processing industry not only in the Slovak Republic, but also in the entire European Union. Food production has a priority role in ensuring the nutrition of the population. The agrarian sector is, on the one hand, an important integral part of the national economy and, on the other hand, maintains its own specific position. Food self-sufficiency in the Slovak Republic has been declining for a long time, the decline accelerated after the country joined the EU. The food industry is closely related to agriculture and performs important functions such as ensuring the receipt, storage and processing of agricultural products, the production of food products and the supply of food to the population. The goal of this contribution was the evaluation of production and food self-sufficiency in selected food products of animal origin. The following commodities were analysed: pork, beef and veal, poultry, table egg production
and raw cow's milk production. All analysed indicators were characterized in the period from 2019 to 2021. In production self-sufficiency, Slovakia achieves relatively good results in the production of beef, where the average value for the period 2019 to 2021 is 86.45%, in the production of table eggs in the shell 86.10% and in cow's milk 78.91%. The critical situation is in the production of pork, where it is covered only 46.44% of consumption on average. Compared to other small open economies, the Slovak Republic has a low level of food self-sufficiency, which continues to decrease relatively quickly. During the monitored period, the average food self-sufficiency at the level of 60-70% was recorded in the production of poultry meat, and higher self-sufficiency is achieved in the production of table eggs. In the production of pork, beef and milk, food self-sufficiency oscillates around 30%, which is mainly caused by problems in the processing industry and not satisfactory subsidy policy.

Keywords: *food industry, food self-sufficiency, production self-sufficiency*

JEL Classification: *Q10, Q18, L66*

1. Introduction

The food industry is the largest processing industry in the EU. According to FoodDrinkEurope, the European Association of the Food and Beverage Industry, food businesses in EU countries provide employment for 4.82 million inhabitants, generate a turnover of 1,205 billion euros and 266 billion euros of added value, making this sector the largest manufacturing sector in the EU. The largest food sector within the EU is the meat processing industry with a 20% share of turnover, followed by the production of beverages (15%) and the bakery sector (14%) [2].

Food consumption is closely related to the food self-sufficiency. In Europe there are countries with great agriculture capacity and conditions for food export, as well as countries dependent on food

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import [1]. In a study on regional self-sufficiency in the European Union, the ratio of domestic production to consumption was examined in three aspects: animal products, agricultural products, and primary agricultural biomass; a systematic concept was presented for self-sufficiency ratios [4].

Current studies are exploring alternative options for sustainable regional food systems that are based on the regionalization of diets, thereby shortening food supply chains, and increasing the resilience of the food system [11]. Resilient food systems require an integrated approach between the optimal localization of production and changes in food consumption. Through the designed food self-sufficiency index, it would be possible to evaluate self-sufficiency at the selected level, e.g., in the region, country, or worldwide [5].

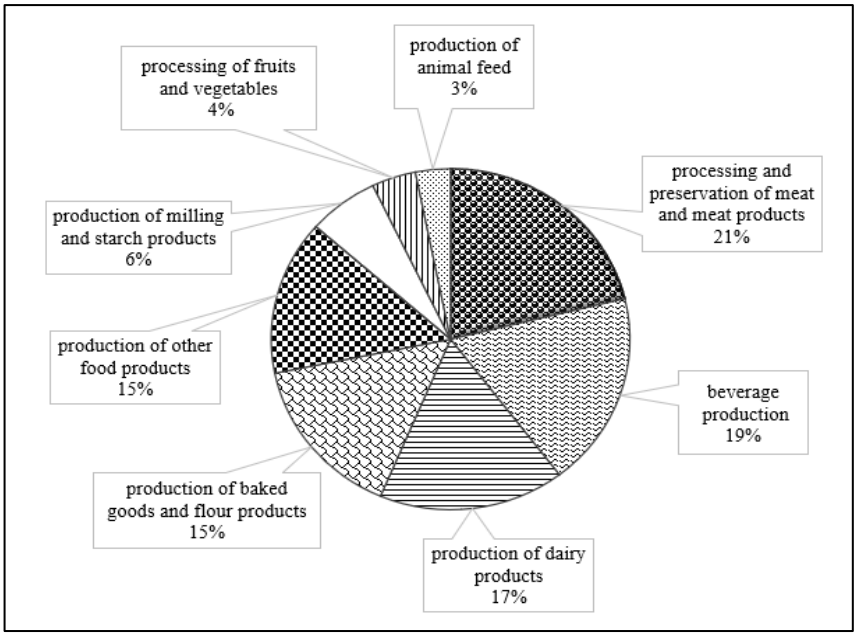
Contemporary Slovak consumers care about the sustainability of food products, but their positive approach is not always demonstrated in real purchasing behaviour as stated [3]. Interesting fact associated with products of animal origin is that a part of the young population does not consume these products. Their eating habits can be classified as vegetarians and vegans as reported by Skylare [8] in Sweden it is approximately 20% of the younger population.

In Slovakia the food industry is closely related to agriculture and performs significant functions such as provide for takeover of products, storage and processing of agricultural products, the production of food products and the supply of food to the population. The food industry is significant part of the national economy and belongs to important sectors of economic activity. In the food industry, there must be a functional food chain that connects three sectors: agriculture, food processing industry and food retail. The functioning of the vertical of the entire chain can be negatively affected by the instability and structural problems of any link of mentioned chain.

The food industry represents a very important sector in the industrial portfolio and economy of Slovakia, which is directly related to primary agricultural production. The food industry has a strong presence in all regions of Slovakia and produces a wide range of food products, from meat processing to bakery, dairy and other products, to the production of various types of beverages.

The production and consumption of food is currently of great importance to society. Dairy and meat industry are the dominant branches in terms of market share (sales) (Figure 1).

Figure 1: Market share of selected food products of the food industry (%)



Source: Annual report 2020, VÚEPP [12]

In the Slovak meat market, there have been changes during the last decade: a reduction in the number of pigs among Slovak breeders and an increase in the import of pork and meat products to Slovakia. [6]. The question of Slovakia's food self-sufficiency and the associated goals for farmers and food producers are gaining importance, especially in connection with the current threats and crises of various kinds in Europe and the whole world. The availability of food in the EU is not yet at risk, as the Union can be largely self-sufficient in the case of many agricultural products. However, Slovak agricultural sector is a net importer of some products, for example feed protein [9].

2. Data and Methods

The rate of production self-sufficiency expresses the percentage coverage of the consumption of individual commodities of agricultural production by own production without including imports and exports. Food self-sufficiency is the ability of a country to cover the needs of the domestic market with its own production potential, i.e., domestic food. Simply, producers will export the surplus, import what the domestic market doesn't have, and they will also make money. The evolution of consumer behaviour has changed, is evolving and has a major impact on food exports and imports.

The article evaluates production and food self-sufficiency in selected food products of animal origin. All analysed indicators were characterized in the period from 2019 to 2021. To better explain the issue, the results are shown in graphs. In the contribution, there were used method of observation, analysis, and the method of synthesis. Evaluated data about commodities were obtained from the Situational and outlook reports of commodities presented by National Agricultural and Food Centre (NPPC) and Research Institute of Agriculture and Food Economics (VÚEPP) [7].

3. Results and Discussion

3.1 Production self-sufficiency in selected livestock production commodities in Slovakia

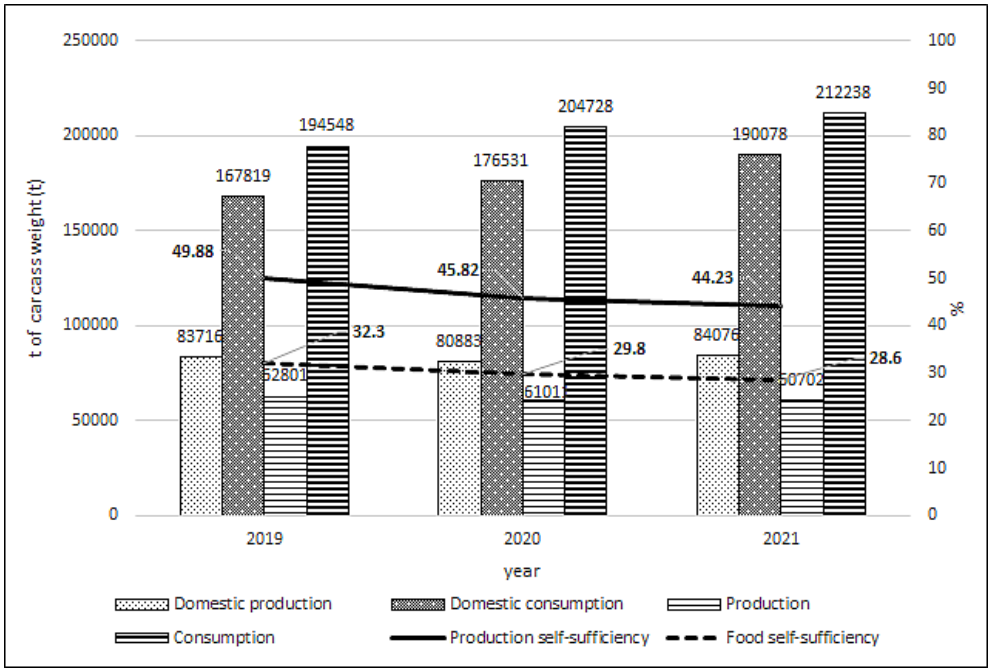
In this contribution these commodities of animal origin are analysed: pork, beef and veal, poultry, table eggs and raw cow's milk production.

First analysed commodity is pork meat.

In Slovakia the contemporary situation in pig farming is alarming. Livestock numbers are declining, and farms are being wiped out by the African swine fever. This fact was also reflected in the gross production of pork. The gross domestic production of pork in the observed period of 2019 to 2021 had a fluctuating trend. In 2019, production was 83,716 t carcass weight, in 2020 it decreased by 3.38% (80,883 t), in 2021 it increased by 3.95% compared to 2020 and by 0.43% compared to 2019 (84,076 t) (Figure 2).

The development of domestic consumption of pork in the monitored period had an increasing trend. In 2019, we recorded 167,819 t of carcass weight, in 2020 an increase of 8,712 t (by 5.19%), in 2021 an increase of 13,547 t (by 7.67%) compared to 2020 and by 22,259 t (by 13.26%) compared to 2019. In the monitored period, the rate of self-sufficiency in pork production was 49.88% in 2019, 45.82% in 2020, and 49.29% in 2021, which means that Slovakia is significantly behind in the pork production.

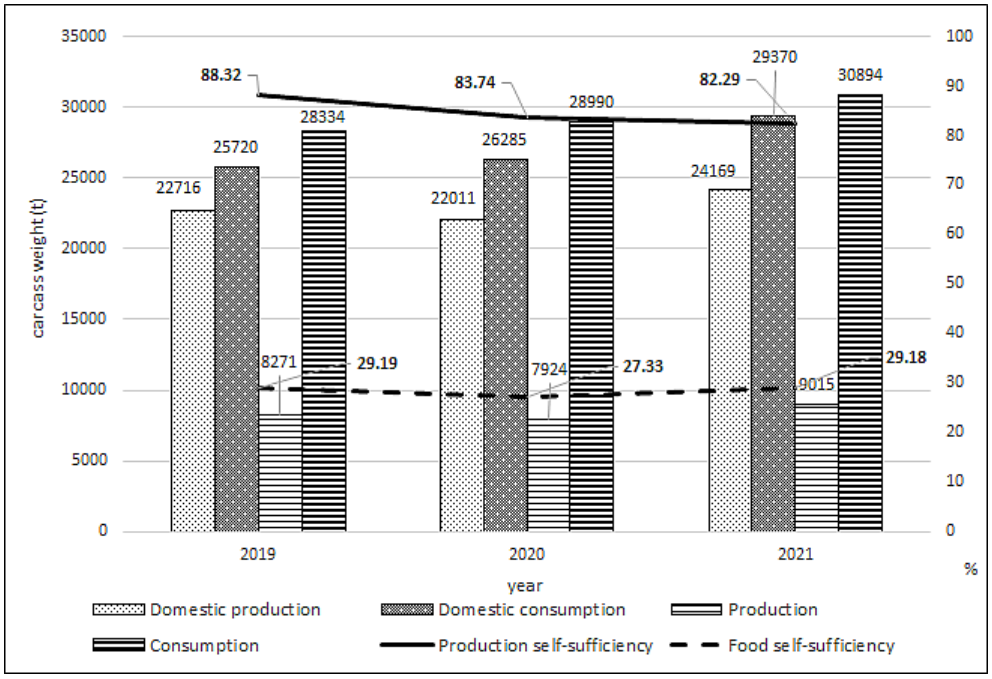
Figure 2: Production and food self-sufficiency of Slovakia in pork



Source: [7], own calculations

Next analysed commodity is beef and veal meat. The gross domestic production of beef and veal in the period 2019 to 2021 acquired a growing tendency. In 2021, it reached 24,169 t carcass weight, which is an increase compared to 2020 by 9.8% (by 2,158 t) and by 6.4% (by 1,453 t) in 2019 (Figure 3).

Figure 3: Production and food self-sufficiency of Slovakia in beef and veal



Source: [7], own calculations

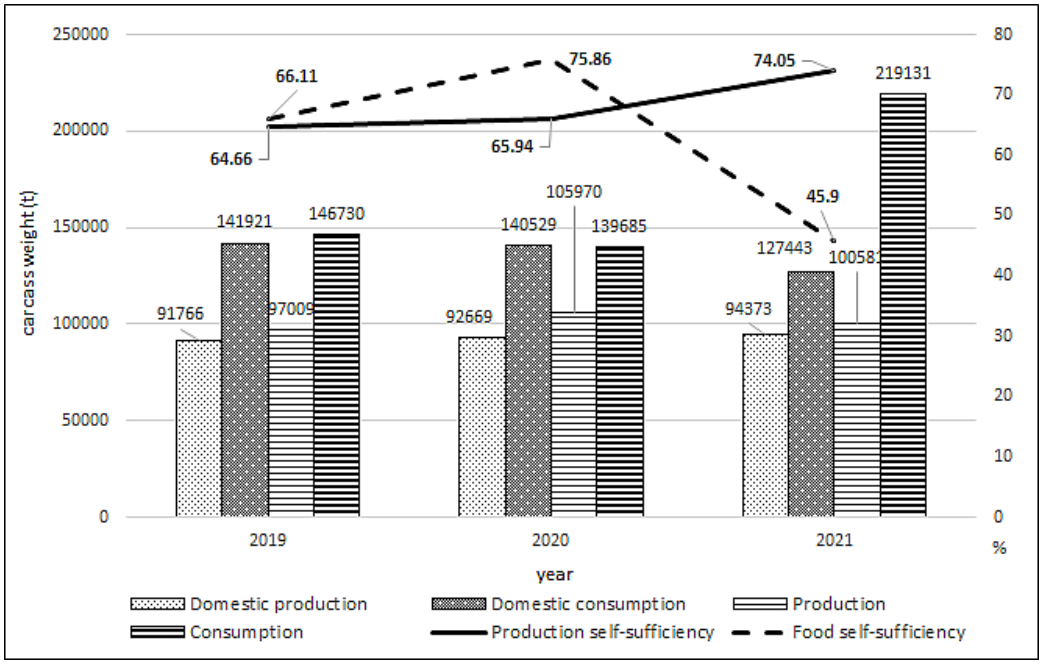
The domestic consumption of this meat in 2021 increased by 11.74% compared to 2020 and by 14.19% compared to 2019. The production self-sufficiency rate of Slovakia in the production of beef and veal reached 88.32% in 2019, 83.74% in 2020, and 2021 82.29%. These numbers indicate that we are lagging in gross beef and veal production and not covering domestic consumption.

Third analysed commodity is poultry meat.

In 2021, 94,373 t of poultry meat was produced in Slovakia, which represents an increase of 1,704 t (by 1.84%) compared to 2020 and 2,607 t (by 2.84%) compared to 2019 (Figure 4). The development of domestic consumption of poultry meat in the period from 2019 to 2021 had a downward trend. In 2021, it was recorded a decrease in consumption from 127,443 t of carcass weight by 13,086 t (by 10.27%) compared to 2020 and by 14,478 t (11.36%) compared to 2019.

In 2019, consumption was 1,392 t (0.99%) lower than in 2020. Slovakia's production self-sufficiency in poultry meat production is at the level of 64.66% in 2019, 65.94% in 2020 and 74.05% in 2021. The data show that, despite the decrease in consumption, domestic producers are unable to produce enough poultry meat.

Figure 4: Production and food self-sufficiency of Slovakia in poultry

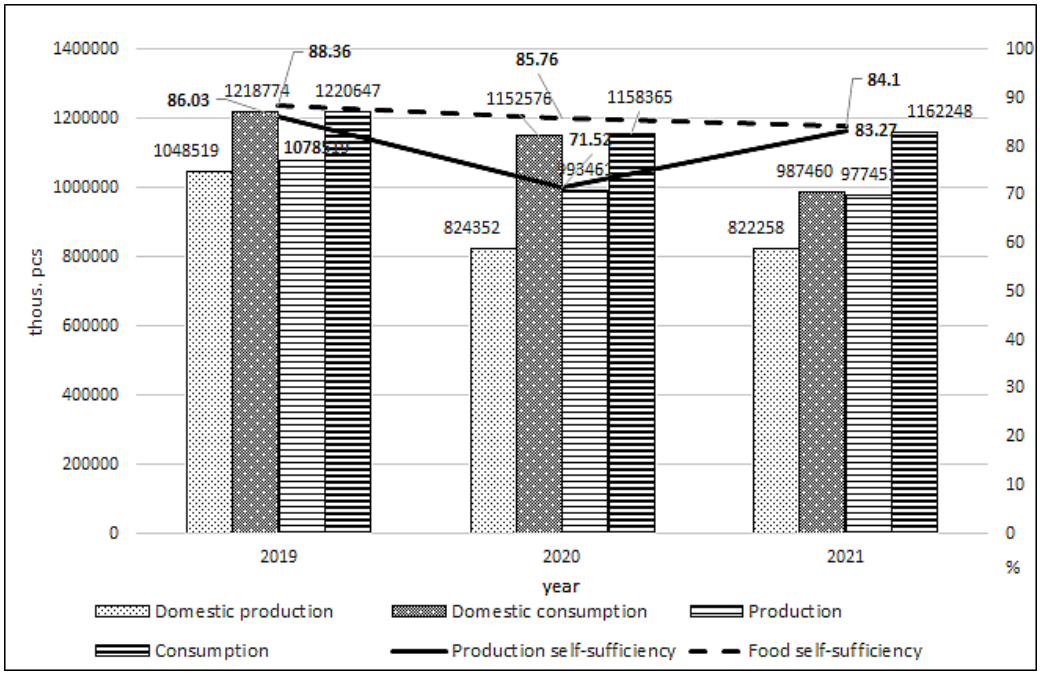


Source: [7], own calculations

Next analysed data are about the production and consumption of table eggs.

The gross domestic production of table eggs in the shell in the observed period of 2019 to 2021 had a decreasing trend (Figure 5). In 2019, 1,048,519 thousand pieces of eggs were produced in the Slovak Republic, which was by 226,261 thousand (by 27.52%) more than in 2021. If we start from the domestic consumption of table eggs in 2019 in the amount of 1,218,774 thousand pieces, Slovakia's self-sufficiency in egg production is at the level of 86.03%. In 2020, self-sufficiency in egg production reached 71.52%, and in 2021 it was 83.27%. Slovakia is not self-sufficient even in the production of table eggs.

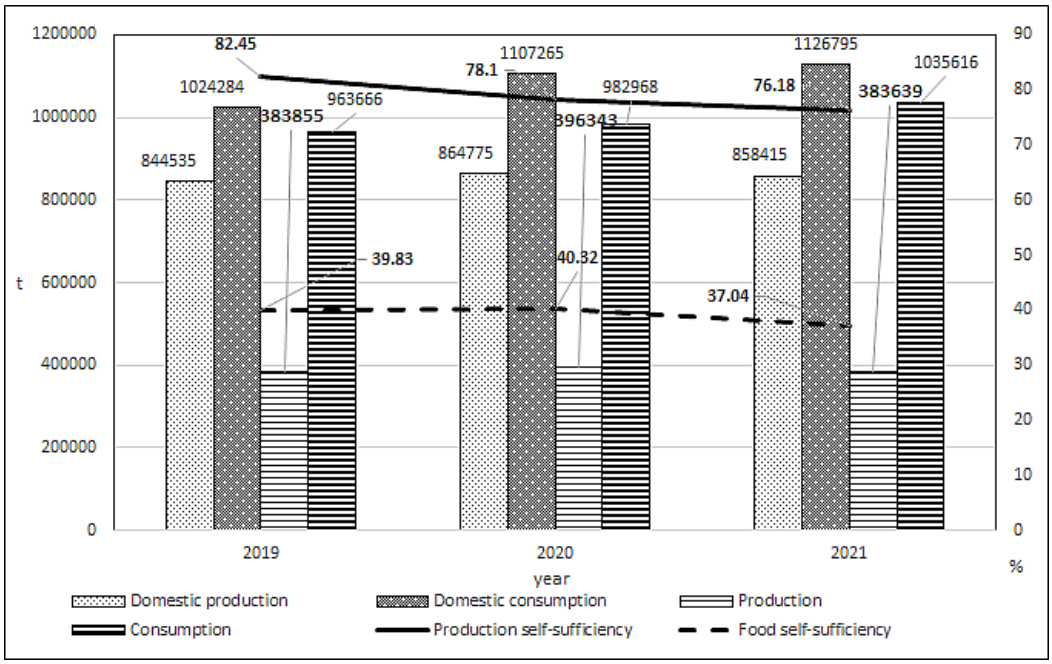
Figure 5: Production and food self-sufficiency of Slovakia in table eggs



Source: [7], own calculations

The last analysed commodity is cow's milk. The production of raw cow's milk in 2019 reached a value of 844,535 t, and its consumption was 1,024,284 t, which is slightly below the level of consumption (82.45%) (Figure 6). In 2020, milk production increased by 20,240 t compared to 2019, and consumption also increased by 82,981 t. Currently, the production of raw cow's milk is at the level of 76.18% self-sufficiency in Slovakia.

Figure 6: Production and food self-sufficiency of Slovakia in milk



Source: [7], own calculations

3.2 Food self-sufficiency in selected food products of animal production in Slovakia

The recommended annual food consumption of one adult in Slovakia is approximately as follows: up to 60 kilograms of meat of various kinds, 220 litres of milk and milk products, and 11 kilograms of eggs. Slovakia does not have the necessary level of food self-sufficiency. Even with relatively good production self-sufficiency, domestic consumption is not covered by food products. The biggest problems are in the processing industry, in which there are insufficient financial resources for reproduction, investing in modern technologies and supporting sales associations. In addition, the market shows high competition from imported products.

The situation is especially critical in the production of pork, where the results of production self-sufficiency (average over the last 3 years is 46.64%) and food self-sufficiency (average 30.23%) in individual verticals are known, and therefore measures must be taken to support the preservation of domestic animal production and processing industry.

In the production of beef, Slovakia achieves good production self-sufficiency (the average over the last 3 years is 86.45%), but this is not reflected in food self-sufficiency (average 28.57%), which results in problems in the processing industry, which is financially undervalued. The production of cow's milk copies the self-sufficiency in the production of beef. Over the last three years, production self-sufficiency is in the range from 82.45% (year 2019) to 76.18% (year 2021) and food self-sufficiency in the range from 40.32% (year 2020) to 37.04% (year 2021).

Self-sufficiency at the level of 60-70% is recorded for the commodity poultry meat; the average production self-sufficiency for the monitored period is 68.22% and 62.62% for food self-sufficiency. At the level of 85% and higher is the production of table eggs.

4. Conclusion

Until the 20th century, Slovakia had a predominantly rural character. It was common to see farm animals in every village backyard and small agricultural production was a part of families' lives. At the end of the 20th and the beginning of the 21st century, this situation changed radically.

Compared to other small open economies, the Slovak Republic has a low level of food self-sufficiency, which continues to decrease relatively quickly. Reversing Slovakia's downward trend in food self-sufficiency should be a priority. Better protection is needed for domestic farmers who produce quality food, but they are not financially subsidized enough like similar ones in other EU countries. The Concept of Development of Slovak Agriculture for 2013 – 2020 [10] aimed to increase production of agricultural commodities to 80% of consumption.

Currently, it is already possible to evaluate the implemented measures to slow down the spread of the Covid-19 epidemic, which significantly limited free trade. An increase in the prices of pork and other foodstuffs can be currently seeing. This is also about food products, where the production of the Slovak Republic does not cover own consumption. Meat, fruit, eggs, and vegetables can be identified as potentially deficient foods. The reason is that even the current main importers to Slovakia do not show high surplus production in these foods. With low surpluses, it can happen at any time that they will not be willing to export as much food as Slovakia would need, and especially in times of crisis, there could be supply shocks, and thus short-term high price volatility of these foods.

In the current conditions, ensuring enough food for the population is a big challenge for agriculture and food producers:

- Due to the increasing world population of the Earth, the demands on agricultural production are increasing in terms of securing food resources.

- To improve food affordability in 2022, EU member states may implement reduced rates of value added tax and economic operators to limit sharp increases in retail prices.
- One of the issues that needs to be addressed from a global perspective and criteria for people's access to food is the reduction of food waste.
- According to the FAO, up to a third of the food produced worldwide is wasted or spoiled, amounting to approximately 1.3 billion tons of food annually.
- By 2030, the European Commission proposes to reduce food waste by 50%.
- The development of agriculture will have to respect current environmental challenges with an emphasis on soil, water, and diversity.

Acknowledgements

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References

[1] Brankov, T., Matkovski, B., Jeremić, M., & Đurić, I. (2021). Food Self-Sufficiency of the SEE Countries; Is the Region Prepared for a Future Crisis? *Sustainability*, *13*(16), 8747. doi: https://doi.org/10.3390/su13168747

[2] FoodDrinkEurope. (2022). Retrieved from https://www.fooddrinkeurope.eu/

[3] Holotová, M., Horská, E., & Nagyová, Ľ. (2021). Changing patterns of sustainable food consumption regarding environmental and social impact-insights from Slovakia. *Frontiers in Sustainable Food Systems*, *5*, 703827.

[4] Kaufmann, L., Mayer, A., Matej, S., Kalt, G., Lauk, C., Theurl, M. C., & Erb, K. H. (2022). Regional self-sufficiency: A multi-dimensional analysis relating agricultural production and consumption in the European Union. *Sustainable Production and Consumption*, *34*, 12-25. doi: https://doi.org/10.1016/j.spc.2022.08.014

[5] Menconi, M. E., Giordano, S., & Grohmann, D. (2022). Revisiting global food production and consumption patterns by developing resilient food systems for local communities. *Land Use Policy*, *119*, 106210. https://doi.org/10.1016/j.landusepol.2022.106210

[6] Serenčéš, R., & Gálik, J. (2019). Development of the pork market in the Slovak Republic. International Science Days 2018: *Towards Productive and Sustainable Global Agriculture and Food Resources*, Conference Proceedings. SUA: Nitra, 69-75 (In Slovak).

[7] Situational and outlook reports of commodities. NPPC-VÚEPP (National Agricultural and Food Centre - **Research Institute of Agriculture and Food Economics).** Retrieved from https://www.vuepp.sk/04_komodity.htm

[8] Skylare, E. (2019). *Food Makes Youth Climate Superheroes*. Retrieved from https://www.norden.org/en/news/food-makes-youth-climate-superheroes

[9] Slovak agriculture and food industry after the corona crisis. (2020). (In Slovak). Retrieved from https://sk.euractiv.eu/wp-content/uploads/sites/8/special-report/EA-SPECIAL-072020-Slovenske%CC%81-pol%CC%8Cnohospoda%CC%81rstvo-a-potravina%CC%81rstvo-po-koronakri%CC%81ze.pdf

[10] The Concept of Development of Slovak Agriculture for 2013 – 2020. (In Slovak). Retrieved from https://www.enviroportal.sk/lesnictvo/koncepcia-rozvoja-podohospodarstva-sr-na-roky-2013-2020

[11] Vicente-Vicente, J. L., Doernberg, A., Zasada, I., Ludlow, D., Staszek, D., Bushell, J., ... & Piorr, A. (2021). Exploring alternative pathways toward more sustainable regional food systems by foodshed assessment–city region examples from Vienna and Bristol. *Environmental Science & Policy*, *124*, 401-412.

[12] VÚEPP (Research Institute of Agriculture and Food Economics). (2020). *Annual report 2020*. (In Slovak). Retrieved from http://www.nppc.sk/index.php/sk/o-nas/dokumenty

Stremlining the Production Process of Agricultural Enterprises as a Form of Responsible Business Strategy

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Abstract

The presented article provides an insight into the creation of a corporate responsible strategy based on the transformation and streamlining of processes in agricultural enterprises in the Slovak Republic. The process approach to corporate social responsibility represents a new approach to the CSR strategy, instead of the classic understanding of CSR, which is understood as ethical or ecological. The research was provided by a questionnaire survey among agricultural entities in the Slovak Republic. As the process approach of the CSR strategy is not known to agricultural enterprises in the Slovak Republic, it is important to continue the research in the future. The presented article serves as a basis for the application of the process approach in a selected agricultural enterprise to increase the productivity of the enterprise and achieve sustainable business and added value.

Key words: process mapping, six sigma, continuous improvement

JEL code: O01, Q13, Q15

1. Introduction

Today, socially responsible business is the basic philosophy of business in every sector. This is evidenced by the efforts of the Global Agenda 2030, European Union policies and national policies that promote a sustainable approach to business and the environment. Agriculture, as the primary sector, should constantly look for new solutions and approaches to socially responsible business. Socially responsible business takes many forms. The most basic approaches to the CSR are ecology and ethics, however we can approach the issue of the CSR also in terms of streamlining processes and continuous improvement. The presented article deals with socially responsible business of agricultural enterprises in the Slovak Republic within the continuous improvement of production processes. For the purposes of the article, we have divided the problem into the use of six sigma, process mapping and continuous improvement. In examining the six sigma, we focused on waste - transport, inventory, motion, waiting, over-production, over-processing, defects and unutilized talent and its reduction in the production process of agricultural enterprises. We examined process mapping in terms of knowledge of the concept of process mapping and its application in agricultural processes. Continuous improvement as a form of long-term planning and business management. In the article we present the results of nationwide research in the Slovak Republic and proposals for further research in the field of research.

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2. Theoretical background

Socially responsible business is an important part of a sustainable corporate strategy. Agricultural research over the last half-century has contributed many components to sustainable productivity, but its focus in the future will be more on systems, interactions among components, and the impact of the activity on the broader environment and community. Agriculture production cost and production system sustainability are key factors to sustain food production for the growing human race. Achieving zero food, agricultural, and industrial wastes can eliminate environmental burdens and pave the way for closed-loop production (Salleh,2021). European agriculture and their respective farms have moderate sustainability where the subsidies from Common Agricultural Policy have a positive impact (Santos, 2020). Local environmental conditions determine the needs and potentials for increasing sustainability of agricultural practices. However, the potential for implementation also depends on socio-economic factors, as farmers need to adopt innovative farming practices, and consumer demand affects the economic feasibility (Scherer, 2018). Companies that used continuous improvement are less likely to have product recalls than companies that do not (Scott, 2009). It is possible to approach corporate social responsibility strategy from different angles, usually through environmental and ethical measures, but it is also possible to use a process approach. The process approach to CSR contains continuous improvement, process mapping and use of Lean Six Sigma. Continuous process improvement can be seen as a managerial and operational strategy but has equally important implications for how manufacturing processes are run, and demands deploying systematic methods to (continuously) search for performance improvements (Oliveira, 2011). Lean, Six Sigma and Lean Six Sigma initiatives have been adopted by different industry and service sectors to improve companies' performance and competitiveness; however, adoption in the food industry is still very low (Costa, 2020). Implementation of six sigma and continuous improvement implementation in the sector is still growing. The use of six sigma was found to reduce costs and increase productivity. Human factors and the food industry characteristics were identified as the main barriers to implementing these initiatives (Costa, 2018). Lean Six Sigma is a hybrid initiative that identifies customer desires, eliminates wastes and reduces variability (Costa, 2021). Six Sigma and continuous improvement used in corporate social responsible business strategy need a strong foundation to build on. Process mapping is an opportunity for business to build this foundation. Business process reengineering is identified as one of the most important solutions for organizational improvements in all performance measures of business processes. However, high failure rates of 70% are reported about using it the most important reason that caused the failure is the focus on the process itself; regardless of the surrounding environment, and the knowledge of the organization. The other reasons are due to the lack of tools to determine the causes of the inconsistencies and inefficiencies (AbdEllatif, 2018). Process maps are covering the wide and diverse spectrum of business process flexibility concepts and relationships (Mejri, 2016). Process map enables coherently integrating two essential dimensions of any organization: the management, with clear responsibility for coordinating the work system and the functional areas, being in charge with executing specialized operations, according to relevant rules, regulations, and procedures (Fleacă, 2016). The global challenges of today are many, and one of the most concerning aspects relates to food production for an increasing global population. The sustainability of doing 'more of the same thing' is being increasingly called into question. Several sustainable business model frameworks have been presented in recent years to address these challenges, but our knowledge is limited about the change processes of the agricultural sector (Barth, 2021). Innovation within the development of sustainable business models has become a hot topic but it is affected by a high failure rate due to a lack of reliable and efficient methods (He, 2021). Process tools are the solution for the sustainability and corporate social responsibility of agro-businesses. Even so, the process approach is not a standard way for building CSR strategy, it is combining the opportunity to fix business processes, become more efficient and build a strong and sustainable business model.

3. Materials and Methods

Sufficient data had to be collected for the research. The research involved agricultural enterprises from the Slovak Republic, which we divided according to the number of employees into small, medium, and large. The questionnaire contains questions from the three logical units of the presented article. The first set of questions concerned the use of six sigma on farms. The second set of questions represents questions about process mapping and the use of process mapping in agricultural production, and the third set of questions consisted of questions about the continuous improvement of production processes. An important factor for the research was the collection of a sufficient amount of data and their subsequent comparison. For the needs of the article, the answers of 25 agricultural subjects were collected. 2 large, 10 medium and 13 small agricultural entities. The basic assumptions in the research were: agricultural companies in the Slovak Republic do not use process improvement as a part of CSR strategy, process improvement is ensured by the standard activity in the company and agricultural companies are open to develop skills of six sigma and process mapping.

4. Research results and discussion

The process approach to corporate social responsibility is an innovative approach. In the Slovak Republic, many agricultural businesses still do not have formally written strategy of corporate social responsibility. A process approach to corporate social responsibility provides the company not only with the advantage of sustainable business and values, but also streamlining existing processes, higher profitability and use of assets. In this part of the research, we will focus on the results related to a questionnaire survey among agricultural companies in Slovakia. Process approach in developing strategy of corporate social responsibility is not used by 92% of agricultural businesses. It should be mentioned that 57% of these entities did not even have a formally established corporate social responsibility strategy. Only 16% of the surveyed entities know and can define what the process approach of corporate social responsibility strategy means. The responses confirm that the process approach is not widespread and used among farmers. According to them, the main reason why companies do not use the process approach is the high financial demands and the insufficient amount of information about the implementation of the process procedure in agricultural companies.

Process improvement is the basis of long-term business success. Farm management should therefore at least consider using process approaches. Process mapping is not a simple task, it is even usually necessary to use the services of a professional consultant to start a process mapping project. Process efficiency will increase in most cases. Of the surveyed farm managers, however, in the case of our research, only 20% know the concept of process mapping. Those managers who do not know the concept of process mapping also in 40% never encountered the concept of continuous improvement and did not consider work processes in the company important for long-term success. Most of the interviewed managers answered positively when asked if they would welcome training in the areas of process approach to corporate social responsibility, six sigma and process mapping. Respondents who do not consider work processes in the company to be important saw a negative attitude in the interest in information about the process approach to socially responsible business. Managers who were interested in education in this area would most often choose the form of an online seminar, presentation at a conference, or an information portal with the possibility of consulting an expert. Continuous improvement in a company can be understood from two points of view. The farm may have a formally developed strategy for continuous improvement or continuous improvement may result from business processes and management activities without further specification. 40% of the surveyed entities had a formally created plan, they were medium and large entities in terms of the number of employees. Small farm entrepreneurs did not consider the creation of a formal plan necessary. However, 88% of respondents consider

continuous improvement to be necessary and equally necessary in the field of agriculture. Most managers considered socially responsible business to be a long-term management tool, which, according to them, is related to continuous improvement and interest in long-term goals. Finally, we were interested in the attitude to the implementation of six sigma-quality management. Respondents surveyed agreed in more than 90% that in terms of waste, which is categorized by the six-sigma theory, the most important is the reduction of waste defects, over-production, and transport. These types of waste also have the greatest influence on the strategy of corporate social responsibility of agricultural companies. Respondents agreed that a procedural approach to socially responsible business is a benefit for agricultural holdings not only in terms of standard motives for building a CSR strategy, but also that streamlining processes contributes to business profitability and better business management.

5. Conclusion

Before examining the attitude of Slovak farmers towards the procedural approach of the socially responsible business strategy, we set three assumptions. All assumptions for the research were confirmed. Agricultural companies in Slovak republic do not use process improvement as a part of CSR strategy, process improvement is mostly ensured by the standard activity in the company and agricultural companies are open to develop skills of six sigma and process mapping. Research has shown that farmers' interest in a process approach exists, not only in terms of the benefits that process approach brings to the CSR strategy but also in terms of better management of procedures and processes on farms. The research provided a basis for examining this issue in the future. Further research will be needed to better understand the implementation of the process approach to the farm. propose to create a strategy of socially responsible business for an agricultural enterprise, which will be based on mapping the processes in the company, based on which the strategy of Six Sigma implementation will be built. All actions will be combined with the existing strategy of corporate social responsibility of the agricultural business. Based on the implementation of the processes, the data of key performance indicators, reduction of the number of injuries in the workplace, reduction of waste defined by the Six Sigma theory and economic efficiency will be evaluated. Following the implementation of the process CSR, a plan for continuous process improvement will be established, which will need to be monitored for at least two years. Based on the obtained research data, it will be possible to compare the existing research that the presented article brings with the implementation of the theory in the agricultural business.

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References

1. AbdEllatif, Mahmoud; Farhan, Marwa Salah; Shehata, Naglaa Saeed. (2018). Overcoming business process reengineering obstacles using ontology-based knowledge map methodology. Future Computing and Informatics Journal 3. Issue 1. Pp 7-28.
2. Barth, Henrik; Ulvenblad, Pia; Ulvenblad, Per-Ola; Maya Hoveskog. (2021). Unpacking sustainable business models in the Swedish agricultural sector– the challenges of technological, social and organisational innovation. Journal of Cleaner Production 304.
3. Costa, Luana Bonome Message; Filho, Moacir Godinho; Fredendall, Lawrence D.; Ganga, Gilberto Miller Devós. (2021). Lean six sigma in the food industry: Construct development and measurement validation. International Journal of Production Economics 231.
4. Costa, Luana Bonome Message; Filho, Moacir Godinho; Fredendall, Lawrence D.; Ganga, Gilberto Miller Devós. (2020). The effect of Lean Six Sigma practices on food industry

performance: Implications of the Sector's experience and typical characteristics. Food Control 112.

5. Costa, Luana Bonome Message; Filho, Moacir Godinho; Fredendall, Lawrence D.; Paredes, Fernando José Gómez. (2018). Lean, six sigma and lean six sigma in the food industry: A systematic literature review, Trends in Food Science & Technology 82. Pp 122-133.
6. Dos Santos, Maria José Palma Lampreia; Ahmad, Nawaz. (2020). Sustainability of European agricultural holdings. Journal of the Saudi Society of Agricultural Sciences 19. Issue 5, Pp 358-364.
7. He, Jiantong; Ortiz, Jaime. (2021). Sustainable business modeling: The need for innovative design thinking. Journal of Cleaner Production 298.
8. Francis, Charles, A.; Madden, J. Patrick. (1993). Designing the future: sustainable agriculture in the US Agriculture. Ecosystems & Environment 46. Issues 1–4. Pp 123- 134.
9. Elena Fleacă, Bogdan Fleacă. (2016). The Business Process Management Map – an Effective Means for Managing the Enterprise Value Chain. Procedia Technology 22. Pp 954-960.
10. Mejri, Asma; Ghannouchi, Sonia Ayachi; Martinho, Ricardo. (2016). Representing Business Process Flexibility using Concept Maps. Procedia Computer Science 100. Pp 1260-1268,
11. Salleh, Siti Zuliana; et. al. (2021). Recycling food, agricultural, and industrial wastes as pore-forming agents for sustainable porous ceramic production: A review. Journal of Cleaner Production 306.
12. Scherer, L.A.; Verburg, P.H., Schulp, C.J.E. (2018). Opportunities for sustainable intensification in European agriculture. Global Environmental Change 48, Pp 43-55.
13. Scott, Bradley S.; Wilcock, Anne E.; Kanetkar, Vinay. (2009). A survey of structured continuous improvement programs in the Canadian food sector. Food Control 20. Issue 3. Pp 209-217.
14. Sriprapakhan, Preecha; Artkla, Ritchard; Nuanual, Santipong; Maneechot, Pisit. (2021). Economic and ecological assessment of integrated agricultural bio-energy and conventional agricultural energy frameworks for agriculture sustainability. Journal of the Saudi Society of Agricultural Sciences 20. Issue 4. Pages 227-234.
15. Oliveira, J.C. (2011). Plant and Equipment. Continuous Process Improvement and Optimization. Encyclopedia of Dairy Sciences. Academic Press, Pp 263-272.

The Impact of European Union Legislation on the Strategies of Agricultural Enterprises in the Slovak Republic

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Abstract

The article deals with the issue of the common agricultural policy of the European Union and its connection to the long-term goals for 2030 in the field of sustainability. The goals and policy of the European Union are conceived in the article from the point of view of Slovak farmers. The article uses qualitative research in the field of CAP and a questionnaire survey among Slovak agricultural farmers. Research in this area helps to understand how farmers perceive the European Union's sustainable policy and which CAP challenges are greatest. Research also brings together information on the European Union's sustainable policy and its objectives for the future.

Key words: sustainability, CAP, European union

JEL code: Q18, Q56

1. Introduction

Nowadays, agricultural enterprises face several challenges. One of these challenges is the long-term pressure on farmers in the European Union to develop and promote business strategies that are sustainable and in line with the European Union's long-term common agricultural policy. Farmers have a difficult role to play in planning business activities and transforming long-term business processes into sustainable options. European Union legislation initiates farmers to continually improve sustainable agricultural production in three areas - environmental, economic, and social. The European Union prioritises changing the direction of agricultural production as well as consumption. In the presented article we will deal individually with all three areas of sustainable policy and the view of farmers from the Slovak Republic. To meet the long-term goals of the European Union, it is important that farmers understand the regulations and projects correctly and the goals of meeting these projects are achievable. The role of the European Union and research in the field of the sustainable common agricultural policy is therefore to create adequate ways of communicating and linking the various objectives that can be applied to small, medium, and large agricultural enterprises.

2. Theoretical background

Population and consumption growth causes a 50% greater demand for food and fiber in the next 35 years (Schiefer, 2016). Demands from society drive the agricultural sector to change in two ways. On the one hand, global consumption patterns, human population increase and competing demands for land area require further intensification and increased productivity on agricultural

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land. On the other hand, increased awareness of consumers about environmental impacts of their behaviour together with a number of events connected to food safety as a result of high-intensive agriculture, demands for a move to more sustainable agriculture and a change in consumption patterns (Delbaere, 2014). Over the last 30 years, the European Union has significantly reformed its Common Agricultural Policy by introducing direct payments to farmers and reducing price support levels (Gohin, 2020). The Common Agricultural Policy of the European Union (CAP) is one of the oldest and most controversial of the EU policies (Kiryluk-Dryjska, 2019). The global targets for 2030 focus on achieving sustainability. Within the CAP, the European Union has created three groups of interest - economic, environmental, and social. Agriculture not only provides for farmers and their families across the EU, but also sustains society as a whole through a number of essential services. In particular, agriculture contributes to society by providing food and other essential materials for citizens, acting as the economic backbone of rural communities. The common agricultural policy (CAP) ensures that farmers can continue to provide these services on a long-term basis by pushing for the economic sustainability of agriculture. In turn, the economic measures of the CAP contain socially inclusive provisions, such as supports for small farmers and redistributive payments (European Commission, 2021). The common agricultural policy (CAP) has three clear environmental goals, each of which are echoed in the European Green Deal and Farm to Fork strategy: tackling climate change, protecting natural resources; enhancing biodiversity. Each of these goals are supported by the CAP's promotion of organic farming and the responsible management of inputs like pesticides and fertilisers. The CAP aims to reach its environmental goals in a way that is socially and economically sustainable for farmers, rural communities, and the EU as a whole (European Commission, 2021). Agriculture is a key driver of biodiversity losses and a major contributor to land-use changes that accelerate climate change and its impacts. With about €59 billion/year, or nearly 40% of the European Union's (EU) budget, the Common Agricultural Policy (CAP) is a case study of global interest as to how subsidies for the farming sector are designed and implemented (Pe'er, 2020). CAP's green component not only positively affects the environmental quality in the long term but also generates positive spillovers that have been hitherto underestimated (Czyżewski, 2020). An important policy question for many governments is how the current set of agricultural policies affects both productivity growth and environmental performance of the sector (Lankoski, 2020), but also, how farms can adopt new challenges. European agriculture and their respective farms have moderate sustainability where the subsidies from Common Agricultural Policy have a positive impact on (Santos, 2020). Without the ability to deliver a stable and rewarding income, agriculture would not be able to supply its essential products and services for society. The common agricultural policy (CAP) therefore includes several measures to ensure the economic viability of farms. The economic consequences of the changing environment have become increasingly apparent across Europe through the disruption brought by unstable weather conditions, such as droughts and floods, resulting in lower yields and falls in farm income. Therefore, the actions of the CAP that safeguard the environment are also in place to protect the long-term economic viability of agriculture (European Commission, 2021). Economical part of sustainable policy is in general dealing with implementing a fair system of income support, equality in the agri-food supply chain, green direct payments, rural development, bioeconomy, and innovations. European Union legislation in all three areas gives farmers the opportunity to become greener and more socially responsible with regard to financial support for farming initiatives and entrepreneurship.

3. Materials and Methods

To determine the current state of research, it was necessary to examine theoretical knowledge and legislation in the field of sustainability of the common agricultural policy. For the needs of the research, we chose the method of a questionnaire survey among agricultural enterprises in the Slovak Republic. A total of 25 agricultural companies participated in the questionnaire survey - 2 large, 10 medium and 13 small. The questionnaire is divided according to the units of the sustainable common agricultural policy - ecological, social, and economic part. In the research, we worked with the basic

assumptions, which are: biggest challenge for agricultural businesses of Common Agricultural Policy for a sustainable agriculture is environmental sustainability, farms are ready to face the challenges of European Union sustainability legislation, EU policy challenges are enshrined in a long- term farm plan of agricultural enterprises in Slovak republic. At the end of the research, we confirmed or refuted these assumptions.

4. Research results and discussion

In the questionnaire survey, we were primarily interested in the attitude of farmers towards a sustainable common agricultural policy and its individual groups. Of the managers surveyed, 84% said they do understand requirements of the EU's sustainable policy. 80% consider the economic area, 16% the ecological area and only 4% the social area to be the most important area of a sustainable CAP. We can state that the division is also caused by the direct connection of the policy to farmers and their business activities. Farmers had the lowest knowledge of the social area of a sustainable CAP, but subsidies, green payments and support for young farmers were among their core business activities. 60% farmers consider the environmental area of a sustainable CAP to be the most complex and challenging to meet. In the environmental field, they perceive education by the European Union as insufficient. Surveyed farmers would welcome more online ways to learn how to adapt environmental goals and transform conventional production to sustainable. Of the farmers surveyed, 20% agreed that they have long sought to transform the conventional type of their production into organic. It is a long-term plan that will contribute to improving the energy use of the farm, limiting pesticides, streamlining the company's water management and water quality, and increasing biodiversity. Majority does not plan for production to become organic, however, with correct education farmers stated they understand importance of sustainability and would like to contribute on sustainable production goals of European Union. Long term plans and operations of farmers depends mainly on financial support. 80% of farmers consider the financial side of supporting the sustainability of agriculture to be important, especially in long-term planning. Long-term planning is carried out on farms mainly in the interest of purchasing new equipment, machinery, cattle and increasing crop production. The profitability of long-term decisions is more important for farmers than their commitment to sustainability. However, all farmers surveyed consider important to provide financial support for rural areas, which they believe have the greatest potential to contribute to sustainable targets of common agricultural policy. The social area of sustainable policy The CAP deals with projects in several areas. In recent years, the surveyed farmers have been involved in the field of information campaigns and farm visits. Sustainable policy also supports TV futures on agriculture, audio-visual and media acts and apps for smart phones and tablets. None of this area has been addressed by farmers in recent years. The social area is committed to the production of food and raw materials that come from net agricultural production, so it is important in the CAP area to reduce the use of pesticides and fertilizers in production. Farmers said in our research that only 20% reduce the use of pesticides and fertilizers in their production. However, they consider it necessary to promote agriculture and the perception of agriculture in the eyes of mainly young people and students. All farmers have committed themselves to developing activities in the field of educating young people in the future. Overall, we can say that the farmers who participated in the questionnaire survey have a positive view of the sustainability of agriculture. They face various challenges in implementing European Union policy, but support the idea of sustainability and, above all, education.

5. Conclusion

In this article, we examined the sustainable policy of the European Union and how this policy is perceived by farmers in the Slovak Republic. It was important to provide a theoretical basis for sustainable policy and its main areas, which the policy aims to comply with. The main areas for the European Union's sustainable policy are economic, environmental, and social. The research showed

two of assumptions were met. Biggest challenge for agricultural businesses of Common Agricultural Policy for a sustainable agriculture is environmental sustainability. Farms are ready to face the challenges of European Union sustainability legislation, however they are struggling with ecological part of the policy. The assumption that EU policy challenges are enshrined in a long-term farm plan of agricultural enterprises in the Slovak Republic has not been confirmed. Farms have shown difficulty in strategic planning and drawing up plans related to business sustainability and meeting the European Union's sustainability objectives. The research provided the basis for a closer examination of the economic, environmental, and social spheres of the sustainable common agricultural policy. To meet the 2030 targets, it is important that stakeholders take part in the debate and jointly contribute to the sustainability of agriculture and food security in the future.

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References

1. Czyżewski, Bazyli; Trojanek, Radosław; Dzikuć, Maciej; Czyżewski, Andrzej. (2020). Cost-effectiveness of the common agricultural policy and environmental policy in country districts: Spatial spillovers of pollution, bio-uniformity and green schemes in Poland. Science of The Total Environment 726.
2. Delbaere, Ben; Mikos, Veronika; Pulleman, Mirjam. (2014). European Policy Review: Functional agrobiodiversity supporting sustainable agriculture. Journal for Nature Conservation 22. Issue 3. Pp 193-194.
3. Gohin, Alexandre; Zheng, Yu. (2020). Reforming the European Common Agricultural Policy: From price & income support to risk management. Journal of Policy Modeling 42. Issue 3. Pp 712-727.
4. https://ec.europa.eu/info/food-farming-fisheries/sustainability/social sustainability/socially-sustainable-cap_en
5. https://ec.europa.eu/info/food-farming-fisheries/sustainability/environmental-sustainability/cap-and-environment_en
6. https://ec.europa.eu/info/food-farming-fisheries/sustainability/economic-sustainability/cap-measures_en
7. Kiryluk-Dryjska, Ewa; Baer-Nawrocka, Agnieszka. (2019). Reforms of the Common Agricultural Policy of the EU: Expected results and their social acceptance. Journal of Policy Modeling 41. Issue 4. Pages 607-622.
8. Lankoski, Jussi; Thiem, Alrik. (2020). Linkages between agricultural policies, productivity and environmental sustainability. Ecological Economics 178.
9. Pe'er, Guy; Lakner, Sebastian. (2020). The EU's Common Agricultural Policy Could Be Spent Much More Efficiently to Address Challenges for Farmers, Climate, and Biodiversity, One Earth 3. Issue 2. Pp 173-175.
10. Santos, Maria José Palma Lampreia Dos; Ahmad, Nawaz. (2020). Sustainability of European agricultural holdings. Journal of the Saudi Society of Agricultural Sciences 19. Issue 5. Pp 358-364.
11. Schiefer, Jasmin; Lair, Georg J.; Blum, Winfried E.H.; (2016). Potential and limits of land and soil for sustainable intensification of European agriculture. Agriculture, Ecosystems & Environment 230. Pp 283-293.

Sustainable, Resilient and Fair Food Systems: A Contribution from Spain

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Abstract

There is no magic and simple answer to the climate change challenge, but rather a bundle of solutions, all necessary. Agriculture and food are both victims and causes, and our specific responsibility as scientists is to help mobilize the opportunities that technological progress offers us to produce more with less and to produce better. The difficulty is how to mutually converge the need to produce to feed the population with the maintenance of a living rural environment with decent living conditions. There is no green agriculture in red numbers. Nor will there be an agroecological transition without the active participation of all the actors in the food chain, starting with farmers and ranchers.

The fields of work are multiple. From Spain, we want to address one, particularly important for us, that of irrigation, in which research, innovation and technology can contribute to responding to the water challenge. In Spain, the modernization of irrigated land has allowed, in a decade, for example, the hectares of localized irrigation to exceed 2 million hectares. But much more is being done and has still to be done.

Technology allows us to act from the water supply side, not only with desalination plants and possible technological improvements to reduce their cost, but also (amongst others) with the storage of said water; with the Managed Aquifer Recharge or with the reuse of regenerated water.

From the demand side, in addition to the already more "traditional" technological improvement in irrigation, it is worth mentioning (among others) the management of deficit irrigation; genetic improvement in search of species and varieties less demanding in water for irrigation or even for dry land; research into cultivation techniques such as conservation agriculture and no-tillage; the improvement of the soil organic matter content that increases its water retention capacity; the search for crop rotations…

But for the new opportunities offered by agriculture 2.0 to become a reality, it is necessary to strengthen the ties between research and the agricultural world. On the one hand, researchers must be more attentive to the real needs of farmers and ranchers and, on the other, a powerful agricultural extension must accompany the latter in the process of adopting and learning about innovations.

All this requires that public policies assume these tasks as priorities. The current CAP, in particular with the Operational Research Groups, has taken steps in the right direction but there is still much to be done, especially in terms of strengthening farm advisory services. In the new Strategic Plans of the CAP for the years 2023-2027 (at least in the Spanish Plan), these priorities are reflected. As they are addressed in the second Pillar of the CAP, for rural development, managed in our country by the regional governments, everything will depend on their effective commitment.

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Keywords: *Climate change, Irrigation, Technology*

JEL Classification: *O32, O38, Q18, Q25*

1. Introduction

Climate change puts the presence of human beings on our earth at risk. The challenge is colossal and there is no magic and simple answer but rather a bundle of solutions, all necessary. Agriculture and food are both victims and causes of climate change and our responsibility is to be part of the solution.

As consumers, we must modify our diets towards greater sustainability. From Spain, we are fortunate to historically contradict the Mediterranean diet, declared Intangible Cultural Heritage of Humanity. As citizens , we must promote a circular economy and transform waste into a new source of resources. But our greatest responsibility as scientists is to help mobilize the tremendous opportunities that technological progress offers us to produce more with less and produce better.

Europe wants to assume the world leadership of the agenda for the adaptation and mitigation of climate change. Today's difficulties, such as what we do not hesitate to call the war in Ukraine, cannot divert our attention from strategic challenges. There even has to be a spur to these changes.

The difficulty of the challenge we are facing is how to make not only compatible but mutually convergent the need to produce to feed the population (the primary responsibility of agriculture), with the importance of maintaining a living rural environment with living conditions for its inhabitants. (and in the first place the farmers) worthy. There is no green agriculture in red numbers. Nor will there be an agroecological transition without the active participation of all the actors in the food chain, starting with farmers and ranchers.

The fields of work are multiple. From Spain, in this symposium, we want to address one, particularly important for us, that of irrigation, in which research, innovation and technology contribute to responding to the challenge of water. We have used the word “contributes” precisely because we are aware, at the same time, of the decisive importance of this contribution, but that it is not enough by itself to respond to this challenge. In our conclusion section, we will expand the discussion to include some of the additional elements that we feel are necessary.

We do not claim to be exhaustive. When talking about technology and irrigation, the first thing that comes to mind is irrigation techniques, especially drip irrigation. For this reason, we are going to focus our purpose on other technological contributions, both on the side of anticipation of droughts (section 3.1) and on the supply side (section 3.2) as well as on the demand for water (section 3.3).

2. Data and Methods

Our contribution is built around the long experience of the two signatories in the monitoring and knowledge of Spanish agriculture and public policies focused on agricultural activity and the rural world in Europe and Spain.

It has been completed with a bibliographic review, as well as with meetings of a very active nucleus within the association to which they belong, the National Association of Agricultural Engineers. In

addition, a happy coincidence in time has been able to count on the preparatory work and documents of the V National Congress of Agricultural Engineers, held from September 26 to 28, 2022.

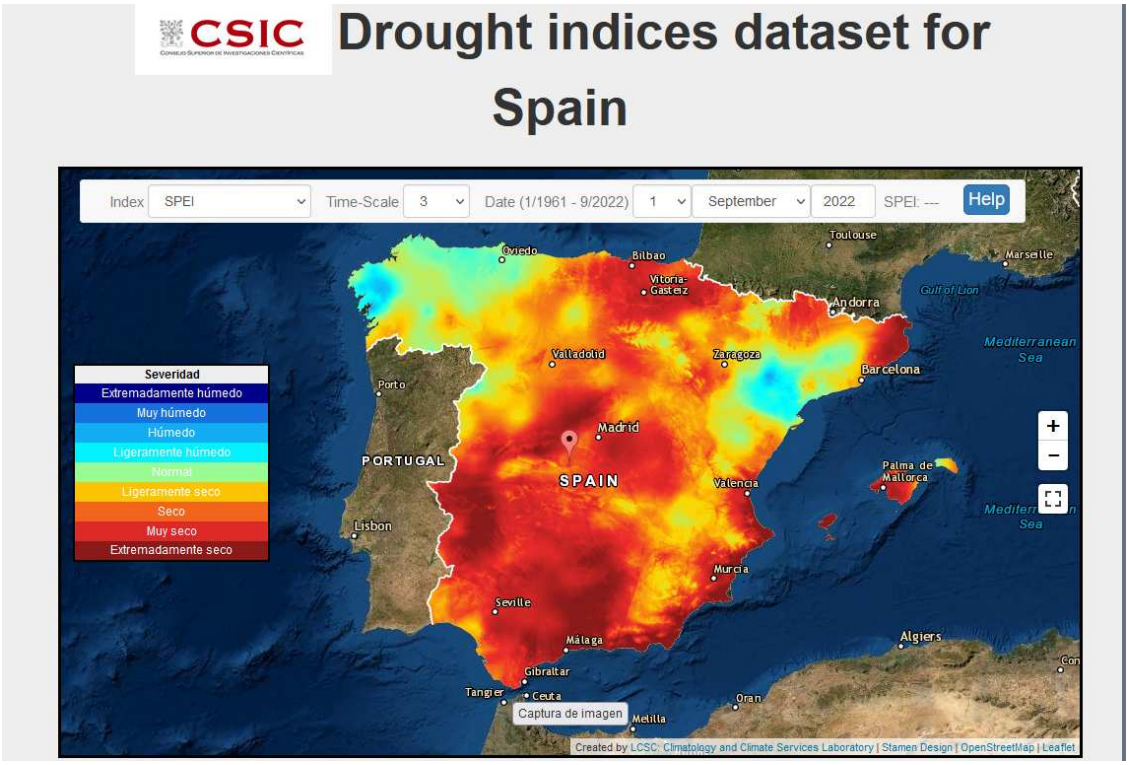
Fuente: https://congresoagronomos.es/v-congreso-nacional-de-ingenieros-agronomos/

3. Tecnology, a necessary condition

In Spain, the modernization of irrigation has allowed gravity risks to fall from more than one million hectares to 890,000 in a decade, sprinkler risks from 497,000 to 565,000, and localized irrigation from 1.6 million to more than 2. million hectares. In addition to a change in irrigation methods towards lower consumption practices, these figures reflect an increase in the total irrigated area of more than 400,000 hectares. Without a true technological revolution, this evolution would not have been possible.

3.1 The technology to anticipate

Technology allows us to anticipate possible drought situations. The Higher Council for Scientific Research (CSIC), in collaboration with the Aragonese Foundation for Research (ARAID), and the State Meteorological Agency (AEMET), has developed an online and open monitor that provides updated information about the degree of severity of meteorological droughts throughout the national territory.



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3.2 Technology and water supply

Technology allows us to act in different ways from the water supply side. The best known have to do with desalination plants, the successive technological improvements that have led to the reduction of their operating cost; the sustainable management of desalination waste, in the first place brine, transforming a problem into a new source of raw material (Mavukkandy et al, 2019; Elsaid et al, 2020)) and the increasing use of renewable energies, solar and wind mainly for its operation (Gude , Nirmalakhandan , and Deng, 2010; Sharon and Reddy, 2015; Sohani et al, 2022). At the University of Malaga, a research project is being developed to desalinate seawater using energy obtained through photovoltaic panels installed on reservoirs .

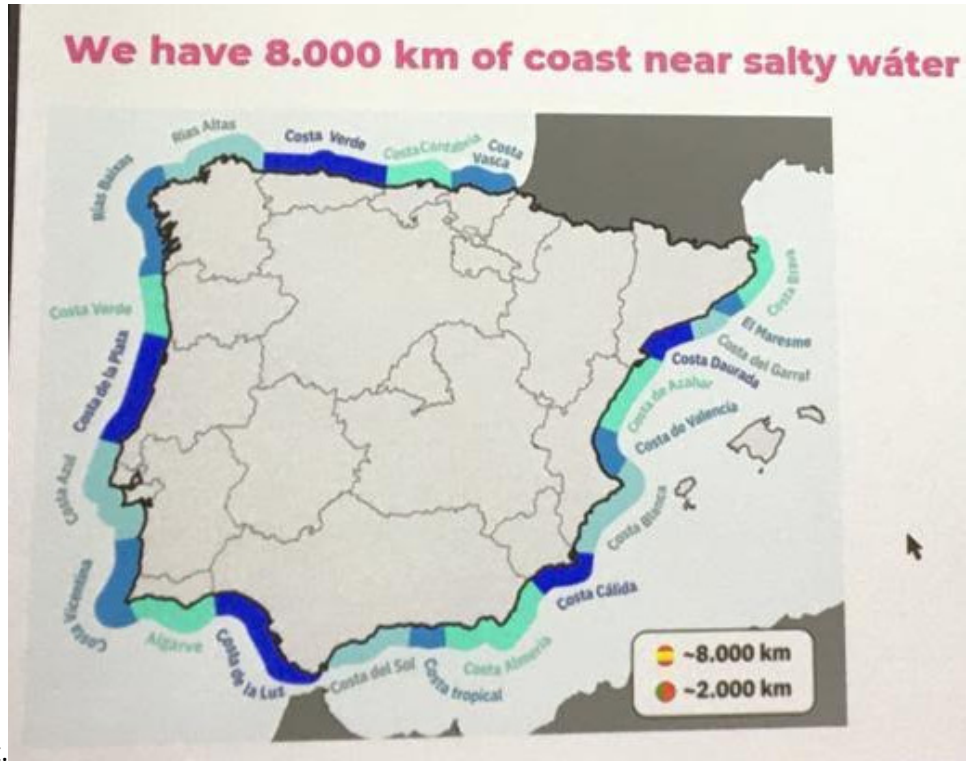
Storage in swamps

Nowadays, it is even possible to economically store desalinated or regenerated water in reservoirs located near the coast. The newest experience in this field is the Salto de Chira pumped-reversible hydroelectric plant.

The project takes advantage of the existence of two large reservoirs (the Chira and Soria dams) located in the interior of the island of Gran Canaria to build between them a 200 MW pumped-storage hydroelectric plant (equivalent to approximately 36% of the peak of demand from Gran Canaria) and 3.5 GWh of storage. The project includes a seawater desalination station and associated marine works, as well as the necessary facilities for its connection to the transport network. The project will always

guarantee the necessary flow in the reservoirs through the desalination plant. It allows responding to two different challenges existing in the Canary Islands, those of energy and hydraulic supply. The energy produced and the desalinated water produced at times when there is not enough demand is stored in the upper reservoir.

This technological leap opens up new opportunities in a country like Spain with 8,000 kilometres of coastline and several reservoirs such as La Vinuela (Malaga) located near the coast.



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Recharge and reuse of wastewater

The Managed Aquifer Recharge (MAR) is not a new technique (Dillon et al, 2019) but it has undergone considerable evolution in these almost 65 years. In a recent study on the "Los arenales" aquifer, Henao et al (2022) conclude that this technology "can effectively alleviate the impacts of toilet scarcity and drought, providing an adaptation solution to climate change worldwide." Perdikaki, Makropoulos and Kallioras (2022) reach the same conclusion studying the case of Greece.

The reuse of wastewater, once regenerated, is another veteran technique (Asano and Levine, 1996; Melgarejo, J. (2009; Morales, Gil Meseguer and Gómez Espín, 2014) but the current drive for the circular economy has given it new wings in the European Union (Jeffrey, Yang and Judd, 2022; Bellver Domingo, 2022; Oller-Alberola et al, 2022) and in the rest of the world (Nguyen et al, 2022).

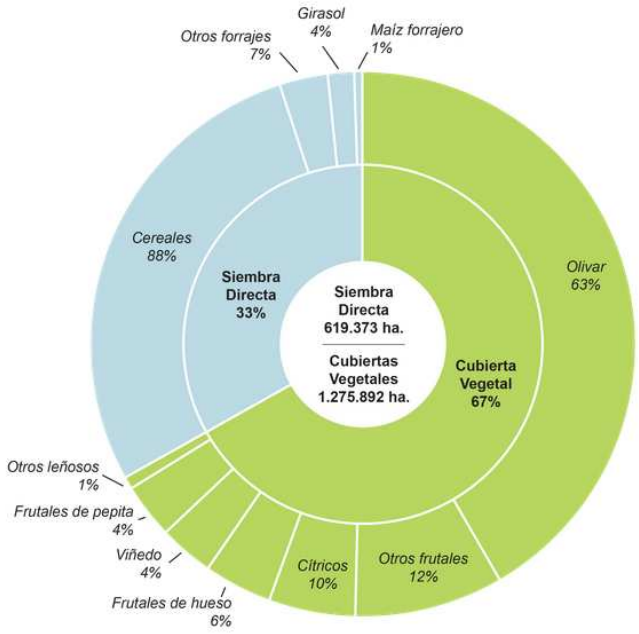
3.3 Technology and demand for water

From the demand side, in addition to the already more "traditional" path of technological improvement in irrigation, it is worth mentioning how much agronomic science can contribute with, for example, advances in the management of deficit irrigation; research into cultivation techniques such as conservation agriculture and no-tillage; the improvement of the organic matter content of the soil that increases its water retention capacity; the search for crop rotations... To all this must be added, among others, varietal improvement in search of species and varieties that are less demanding in terms of water for irrigation or, even, for dry land.

Agronomic science

Deficit irrigation seeks to maximize the productivity of crop water instead of maximizing the harvest per unit of land (Ferreres and Soriano, 2007). Among the most recent contributions of Spanish researchers in this regard, we could perhaps highlight the doctoral theses of Gutiérrez Gordillo (2022) on almond cultivation, Vita Serman (2022) on olive groves or Martín García (2022) on almond trees.

The FAO has precisely defined what should be understood by “conservation agriculture” and its three principles: crop diversification, minimal soil movement and permanent soil cover. In our country, the Spanish Association of Living Soil Conservation Agriculture (AEACSV) is particularly active. As this association points out on its website, " in Spain, with just over 8% of the total area of arable crops under Direct Sowing and 25.7% of the total area of woody crops with Vegetal Covers, there is at the head of Europe in terms of area under Conservation Agriculture, with a total area of around 1.9 million ha (year 2015)”.



Distribución de las técnicas de Agricultura de Conservación en el año 2015. FUENTE: MAPAMA, (2015). Encuesta Nacional de Superficies y Rendimientos. Análisis de las Técnicas de Mantenimiento del Suelo y Métodos de Siembra en España.

Source: AEACSV

The increase in organic matter in the soil increases resistance to drought. It helps individual mineral soil particles form stable aggregates, thus improving soil structure and facilitating tillage. It favors good porosity, thus improving aeration and water penetration and, therefore, increasing water retention capacity. Among the most recent works, we could highlight those by Marcos et al (2022) on legumes and Gabriel et al (2022) on corn cultivation

All these aspects (conservation agriculture, plant covers in woody crops and the increase in the organic matter content of the soil) have entered through the front door of the Eco-schemes that will be applied in Spain from January 1, 2023, as foreseen in the Spanish Strategic Plan for the application of the CAP (PEPAC). The option finally adopted in our country consists of trying to promote, with these Eco-schemes, agricultural practices that are both beneficial for the environment and for the farmer, practices already developed by the best farmers in the country and whose generalization would represent progress. towards an eco-responsible agriculture.

Many European projects in which Spanish agronomists have participated have supported these developments. Among them, the CLIMAGRI project could be highlighted, for example, which investigates “good agricultural practices to mitigate climate change and adapt irrigated crops to its effects”.

Varietal research

Varietal research, without a doubt, is also part of the solution in its two aspects, both in terms of reducing the water needs of irrigated crops and improving the seeds available for rainfed agriculture.

It is true that, in Europe, all varietal improvement based on genetic improvement has encountered an unfavorable regulatory framework. genetics related to an application that could be gently described as “prudent” of the precautionary principle. However, the Communication of the Commission on said principle (EC, 2000) incorporates among its principles that of “proportionality” which it clearly defines as follows: “Proportionality means tailoring measures to the chosen level of protection. Risk can rarely be reduced to zero, but incomplete risk assessments may greatly reduce the range of options open to risk managers. A total ban may not be a proportional response to a potential risk in all cases. However, in certain cases, it is the sole possible response to a given risk.”

Everything seems to indicate that, at least with regard to CRISPR gene editing techniques, the situation could evolve in the coming months. The future Spanish European Presidency for the second half of 2023 has already announced that advancing on this issue is going to be one of its priorities.

The principle of "equivalence in substance", applied in the United States, has not been enough to convince a large part of public opinion and political decision-makers in Europe, but this new technique resolves several of the reservations put forward with respect to the first wave of genetic engineering, such as antibiotic markers and the mixing of genes from different species. Therefore, there can be no doubt that the CRIPSPE technique deserves a specific evaluation, based on its own merits.

4. Technology is not a sufficient condition

But for the new opportunities offered by agriculture 2.0 to become a reality, it is necessary to strengthen the ties between research and the agricultural world. On the one hand, researchers must

be more attentive to the real needs of farmers and ranchers and, on the other, a powerful agricultural extension must accompany the latter in the process of adopting and learning about innovations.

All this is not possible without public policies that do not assume these tasks as priorities. The current CAP, in particular with the Operational Research Groups, has taken steps in the right direction, but there is still a lot to do on both sides.

From the field of research, the research career is still essentially based on the publications made in the so-called "impact scientific journals". From the point of view of said career, the time invested in listening to the sector, in disseminating the results and in the extension is not very “profitable”. A first timid step in the right direction has been taken with the creation of the “sexenios” of dissemination, but the road ahead is still long.

From the field of public policies, the CAP currently in force made an important qualitative leap, especially in terms of strengthening farm advisory services. In the new Strategic Plans of the CAP for the years 2023-2027 (at least in the Spanish Plan), these priorities are reflected but, being located in the second Pillar of the CAP for rural development managed by the regional governments in our country, everything will depend on the effective commitment of the different Autonomous Communities.

5. Conclusion

In this contribution, we wanted to address the challenge of building sustainable and resilient food systems using water and irrigation management as the common thread, which is so important in our country.

The necessarily limited nature of this contribution has led us to approach the problem only from a quantitative point of view. We are aware that the problem of improving water quality also deserves specific treatment.

We are also aware that the sustainable management of water resources requires a range of solutions, from the transposition of the Community Directives still pending to a general awareness, from the political leaders of the different administrations to public opinion in general, going through all actors in the food chain.

Assuming our part of the necessary social commitment, as agricultural scientists, we have focused on our great specific responsibility that no one can assume in our place: our contribution from the field of technological progress. There is much that we can do and even more that we must do.

References

Asano, T. and Levine, A.D. (1996): Wastewater reclamation, recycling and reuse: past, present, and future - *Water science and technology* *Elsevier* https://www.researchgate.net/file.PostFileLoader.html?id=578365be96b7e438a8373c98&assetKey=AS%3A382594530201600%401468229052703

Bellver Domingo, A. (2022): *Nuevas herramientas para promover la reutilización del agua regenerada: Un enfoque basado en la Economía Circular y el Pago por los Servicios Ambientales* Institut Interuniversitari de Desenvolupament Local https://roderic.uv.es/handle/10550/81444
Dillon, P., Stuyfzand, P., Grischek, T. et al. (2019): Sixty years of global progress in managed aquifer recharge. *Hydrogeol J* **27**, 1–30 https://doi.org/10.1007/s10040-018-1841-z

Elsaid, K.; Sayed, E.T.; Yousef, B.A.A.; Rabaia, M.K.H.; Abdelkareem, M.A.; [bcd]A.G. Olabi, A.G. (2020): Recent progress on the utilization of waste heat for desalination: A review *Energy Conversion and Management Volume 221* https://doi.org/10.1016/j.enconman.2020.113105

European Commission (EC, 2000): *Communication from the Commission on the precautionary principle* COM (2000)1f https://eur-lex.europa.eu/legal-content/ES/ALL/?uri=celex%3A52000DC0001

Fereres, E.; Soriano, M.A. (2007): Deficit irrigation for reducing agricultural water use *Journal of experimental botany, 58, 147-158* https://academic.oup.com/jxb/article/58/2/147/534071

Gabriel, J. L., Martín-Lammerding, D., Allende-Montalbán, R., Delgado, M. del M., & Rodríguez-Martín, J. A. (2022). Análisis de la producción de maíz en España. ACI Avances En *Ciencias E Ingenierías, 14(1).* https://doi.org/10.18272/aci.v14i1.2468

Gude, V.G.; Nirmalakhandan, N.; Deng, S. (2010): Renewable and sustainable approaches for desalination *Renewable and Sustainable Energy Reviews Volume 14, Issue 9*, Pages 2641-2654 https://doi.org/10.1016/j.rser.2010.06.008

Gutiérrez Gordillo, S. (2022): *New Approaches to Hydrosustainable Almonds ProductionAgronomical, Physiological and Quality Effects* https://dialnet.unirioja.es/servlet/dctes?codigo=307564

Henao Casas, J.D.; Fernández Escalante, E.; Ayuga, F. (2022): Alleviating drought and water scarcity in the Mediterranean region through managed aquifer recharge. *Hydrogeol J 30, 1685–1699* https://doi.org/10.1007/s10040-022-02513-5

Jeffrey, P. ; Yang, Z.; Judd, S.J. (2022): The status of potable water reuse implementation *Water Research Volume 214* https://doi.org/10.1016/j.watres.2022.118198

Marcos, M.; Sánchez, V.; Zornoza, R. Introducción de leguminosas como cultivo asociado para mejorar la calidad del suelo. En: *Proceedings of the 10th Workshop on Agri-Food Research for young researchers*. WIA.2021. Cartagena: Universidad Politécnica de Cartagena, 2022. Pp. 79-82.

Martín García, R. (2022). *Morphological and physiological adaptation of pepper rootstocks tolerant to hydric stress under controlled irrigation strategies* Universitat Politècnica de València. http://hdl.handle.net/10251/185377

Mavukkandy, M.O.; Chabib, C.M.; Mustafa , I.; Ghaferi, A.A.; AlMarzooqi, F. (2019):

Brine management in desalination industry: From waste to resources generation *Desalination Volume 472* https://doi.org/10.1016/j.desal.2019.114187

Melgarejo, J. (2009): Efectos ambientales y económicos de la reutilización del agua en España C l m . e c o n o m í a. N u m. 1 5, p p . 2 4 5 - 2 70 http://www.clmeconomia.jccm.es/pdfclm/melgarejo_clm_15.pdf

Morales, A.; Gil Meseguer, E.; Gómez Espín, J.M. (2014): Las aguas residuales regeneradas como recurso para los regadíos de la Demarcación Hidrográfica del Segura (España) *Boletín de la Asociación de Geógrafos Españoles N.º 64 - 2014, págs. 151-175*

Nguyen, M.D. ; Thomas, M.; Surapaneni, A. ; Moon, E.M. ; Milne, N.A. (2022): Beneficial reuse of water treatment sludge in the context of circular economy *Environmental Technology & Innovation Volume 28* https://doi.org/10.1016/j.eti.2022.102651

Oller-Alberola, I; Polo-López, M.I.; Malato-Rodríguez, S. and Nahim-Granados, S. (2022): Tratamiento solar de aguas en la Plataforma Solar de Almería (CIEMAT, España): Integración de tecnologías para la regeneración de aguas residuales y producción fotocatalítica de hidrogeno Ing-NOVA, 1(1), enero/2022, p. 121-135 https://revistas.unicartagena.edu.co/index.php/ing-nova/article/download/3731/3077

Perdikaki, M.; Makropoulos , C. and Kallioras, A. (2022): Participatory groundwater modeling for managed aquifer recharge as a tool for water resources management of a coastal aquifer in Greece *Hydrogeology Journal volume 30*, pages 37–58 https://link.springer.com/article/10.1007/s10040-021-02427-8

Sharon, H. and Reddy, K.S. (2015): A review of solar energy driven desalination technologies *Renewable and Sustainable Energy Reviews Volume 41, Pages 1080-1118* https://doi.org/10.1016/j.rser.2014.09.002

Sohani, A.; Delfani, F.; Chimeh, A.F.; Hoseinzadeh, S.; Panchal, H. (2022): A conceptual optimum design for a high-efficiency solar-assisted desalination system based on economic, exergy, energy, and environmental (4E) criteria *Sustainable Energy Technologies and Assessments Volume 52, Part B*, https://doi.org/10.1016/j.seta.2022.102053

Vita Serman, A. F. (2022): *Deficit irrigation strategies and water productivity in high-density olive orchards located in continental climates and fully dependent on irrigation*. https://helvia.uco.es/bitstream/handle/10396/23102/2022000002465.pdf?sequence=1&isAllowed=y

Theoretical and methodological approaches to the investigation of the implementation of new food strategy in agri-food-related businesses

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Abstract

The strategy of the European Union, Farm to Fork, represents a significant advance in the making of European food policy. The Farm to Fork strategy focuses on creating a healthy, fair, and environmentally-friendly food system in the EU. The main objectives of the strategy are the improvement of sustainable food production and sustainable food consumption, sustainable food processing and distribution, and food loss and waste prevention. However, the success of the strategy will depend on the application of specific policy actions of the 27 EU member countries. To ensure food security, nutrition, and public health, several countries started to use front-of-pack labelling known as Nutri-Score. It provides information about the overall nutritional quality of the products when purchasing. This paper is focused on the implementation of the strategy in agri-food-related businesses. To obtain the primary data, a questionnaire survey was applied. In total, 329 agri-food-related businesses participated. We analyzed the application of the Farm to Fork strategy concerning health nutrition, ecology, sustainability and innovations in 3 selected sectors of agro-businesses. According to the findings, more than 93% of selected businesses perceive the issue of ecology and carry out various activities such as the protection of air, water, nature, and recycling. Moreover, we found out that 74% of participating companies use innovations in their businesses (innovative packaging technology, new forms of customer service, innovative technologies and recipes, offering innovative products, entertainment and educational activities). Finally, we were evaluating opinions about the Nutri- Score labelling. From the results, it is evident that in each industry, more than 50% of companies do not deal with this topic.

Keywords: *Agriculture, Farm to Fork Strategy, Food Supply Chain, Green Deal, Sustainability*

JEL Classification: *Q00, Q01, Q10, Q18*

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1. Introduction

Agriculture is a significant sector of the European economy. It is currently known that food is closely associated with agriculture, trade, health, development, and the environment. Consumers choose what food to eat, and it is a right of everyone to have access to healthy, safe and nutritious food, consistent with the right to adequate food (FAO, 2022). They are more interested in environmental, health, social and ethical topics, and they seek value in food more than ever before. Consumers are looking for fresh food, and less processed and should have the power to select sustainable foods (European Commission, 2020a). Additionally, improving the sustainability of food systems is one of the world's most important concerns, along with connected problems such as biodiversity loss, climate change, food security, malnutrition, and soil degradation. According to Barling, Lang and Caraher (2002), Mason and Lang (2017), Willett, Rockström, Loken, Springmann, Lang, Vermeulen and Murray (2019), any comprehensive reform of the food system must necessarily address these problems. There have been requests for (better) integrated solutions to these problems during the past 20 years (Bazzan, Daugbjerg and Tosun, 2022). To give an example, The United Nations established the 2030 Agenda for Sustainable Development, which comprises 17 sustainable development goals (SDGs). The SDGs emphasize the desire to eradicate hunger and support sustainable agriculture, better nutrition, and food security (Nilsson, Allison, William, Dey, Halpern and Mccauley, 2016, Nilsson and Persson, 2017). Similarly, the European Commission released the Farm to Fork (F2F) strategy which is instrumental in working toward the SDGs (Purnhagen, Clemens, Eriksson, Fresco, Tosun, Qaim and Zilberman, .2021, Arabska, 2021). The F2F strategy is the fundamental element of the European Green Deal, which sets out how to make Europe the first climate-neutral continent by 2050 (European Commission, 2019). According to European Commission (2020a), the F2F strategy supports the transition toward a sustainable food system by reducing reliance on pesticides and antimicrobials, reducing nutrient losses, promoting organic farming, improving animal welfare, reversing obesity trends, reducing food waste, and reversing biodiversity loss.

1.1 Theoretical approaches to the Farm to Fork Strategy

The European Union's F2F strategy, introduced in 2020, strives for a thorough sustainability transition of the European agrifood sector (Reinhardt, 2022). As argued by Hawkes (2017), an efficient sustainable food system requires policy coherence across several targets (including agriculture and health). According to Benton and Bailey (2019), a sustainable food system redefines efficiency to mean that food systems deliver profits, healthy diets, and a healthy world. Schebesta and Candel (2020) declare that the Strategies' proposal defines a major shift in the EU food and agriculture industry, and for that reason, it has been the topic of broad debate. König and Araújo-Soares (2021) point out that the F2F strategy acknowledges the need for extensive changes throughout the food chain, from the producer (farm) to the consumer (fork), to lessen the impact of the food system on the environment. As a result, the strategy focuses on a variety of stakeholders, such as farmers, as well as manufacturing companies, retailers, and individual users. It lists targets that must be met by 2030. In conclusion, it is necessary to add that for the strategy to be effective, the stakeholders' behaviour needs to change.

As reported by Mowlds (2020), the F2F strategy represents a chance to boost lifestyles, health, and the environment. The F2F strategy concentrates on the stewardship of the environment, and also the outcomes for food security and human health in the EU agricultural sector. The focus is on the four fields for improvement namely: sustainable food production, sustainable food consumption, sustainable food processing and distribution, and the last one is the prevention of food loss and waste (Beckman, Ivanic and Jelliffe, 2021). The F2F strategy is connected to The Biodiversity strategy. As argued by EUROPARC Federation (2022), these two strategies are interlinked and the complementarity

between biodiversity and agriculture is thus particularly significant. Moreover, European Commission (2022b) explains the connection between the F2F strategy and the Common Agricultural Policy (CAP) which enforces sustainability in agriculture and rural regions across the EU, with the target of making sure that forestry and agriculture in the EU are socially, economically, and environmentally sustainable. Moreover, the goals set out in the F2F will be accomplished mostly through reforms of existing policies, including the EU's CAP (Bazzan, Daugbjerg and Tosun, 2022). Mowlds (2020) points out that the interdependencies between sectors (such as health and agriculture) must be taken into account in policy and decision-making processes due to the complexity of the food system. More specifically, as reported by the European Commission (2022a), the main qualitative target of the F2F strategy is to speed up the transformation of the food system to one that is sustainable and should ensure:

- neutral or positive effect on the environment,
- help to mitigate climate change and adapt to its effects,
- preservation of biodiversity,
- ensure food security, nutrition and public health, and ensure that everyone has access to sufficient, safe, nutritious, sustainable food,
- preserve food affordable while generating fairer economic returns, support the competitiveness of the EU supply sector and support fair trade.

To fulfil the goal that deals with food security, nutrition and public health, the five-colour Nutri-Score labelling can help. The Nutri-Score label on the front of food packaging provides the consumer with readable and easy-to-understand information about the overall nutritional quality of the products when purchasing. The consumer can compare products and direct his choice to foods with favourable nutritional quality and thus contribute to a healthier lifestyle. The European Union plans to introduce a unified nutritional system of food labelling from 2023 (Pro Nutri-score Aliancia, 2021). The main objective of Nutri-Score is to influence consumer purchasing habits in order to encourage people to make easier, healthier decisions. Consumers can tell how healthy a product is by looking at a front-of-pack ranking score from A to E (Adifo, 2021).

The quantitative targets of the F2F strategy include, for example, the reduction of pollution by using 50% less chemical pesticides by 2030, a reduction of 20% in fertilizer usage, and a minimum 50% reduction in nutrient losses (Montanarella and Panagos, 2021, Wesseler, 2022). More objectives of the F2F strategy contain that by 2030, 25% of EU agricultural land must be used for organic farming and to bring back at least 10% of agricultural areas under high-diversity landscape features (EUROPARC Federation, 2022). According to Drapáková and Koreň (2021), for Slovakia to meet this target of the F2F strategy, it would have to increase the area of eco-farms by almost 300 thousand hectares. In 2021, organic farms in Slovakia covered 10.3% of agricultural land, while the European Union average is 8.5%. Compared to 2020, the area of organic farms increased by 20%. Up to two-thirds of ecological land consists of permanent grasslands. Major findings of Cortignani, Buttinelli and Dono (2022) indicated an improvement in the environmental sustainability of agricultural production in the context of lower usage of the chemical. Referring to the views of Purnhagen et al. (2022), innovative techniques, including biotechnology, may lead to an increase in sustainability and organic farming will be promoted.

Taking into consideration the agri-food supply chain, according to the European Commission (2021) the aim of the F2F strategy is to enhance the cooperation of primary producers, improve their position within the food supply chain and increase the transparency of the market. As reported by European Commission (2020b) and Arabska (2021), building a strong and adaptable food system that can function in any environment and ensure that citizens have access to a sufficient amount of affordable food is crucial and it’s getting the more important subject, especially when we faced the COVID-19

pandemic. Similarly, Dudek and Spiewak (2022), Galanakis, Rizou, Aldawoud, Ucak and Rowan (2021), Bochtis, Benos, Lampridi, Marinoudi, Pearson and Sørensen, (2020), Ellison and Kalaitzandonakes (2020) identify that the food supply chain and the food industry were disrupted by the COVID-19 pandemic all over the world. These claims are also supported by Giudice, Caffera and Morone (2020), Aday and Aday (2020), Mehra, Kumar, Kumar and Kumar (2021) who declare that the COVID-19 pandemic transformed the whole functioning of the food system from producers, processors, foodservice operators, logistics, and retailers to final consumers worldwide. It has also highlighted the interdependence of our global boundaries, supply chains, consumer behaviours, and ecosystems. European Commission (2020a) appeals that our food system is in peril and has to become more robust and sustainable. Research done by Ellison & Kalaitzandonakes (2020) was dealing with food waste on all levels of the food supply chain during the COVID-19 pandemic. Based on the results it can be concluded that in some cases, severe food shortages were obtained. In other cases, food could not reach final consumers and it was wasted. Moreover, the food waste grew for some supply chain actors, namely producers connected to the food service sector who were forced to abruptly close. On the other hand, processors and grocery retailers, have not experienced such a rise in overall food waste. Additionally, Riccaboni, Neri, Trovarelli, and Pulselli (2021) declare that research and innovation are crucial factors in expediting the shift to food systems that are sustainable, wholesome, and inclusive from primary production to consumption. All things considered, Moschitz, Muller, Kretzschmar, Haller, de Porras, Pfeifer and Stolz (2021) claim that for implementing the F2F strategy, the 27 specific policy actions integrating existing and new policy instruments ensuring the sustainable transition is deployed in all levels of the EU food system have to be applied.

2. Data and Methods

The main objective of this paper was to identify the implementation of the strategy Farm to Fork in agri-food-related companies. We focused on 3 sectors of agro-businesses and then compared the implementation of the Farm to Fork strategy. The research was based on primary data obtained from an online questionnaire survey in 2022. Overall, 329 agri-food-related businesses participated. We were finding out the field of business, the number of employees and the territorial operation of the participating companies. Questions regarding sustainability, ecology, innovation, and healthy nutrition were used to determine the level of involvement in the new strategy of agri-food-related businesses. Table 1 represents the identification characteristics of participating companies. To conclude, more than 29% of participating companies were catering facilities and restaurants. Moreover, approximately 20% was represented by retail and 17% of companies were dealing with agricultural primary production. More than 80% of participating businesses had between 1-49 employees and they mostly operate their business locally (59%).

Table 1: Characteristics of the participating companies

Variables	Categories	Frequency (%)
Business field	food distribution	3.34%
	primary agricultural production	17.32%
	retail	20.36%
	wholesale	4.86%
	food storage	1.21%

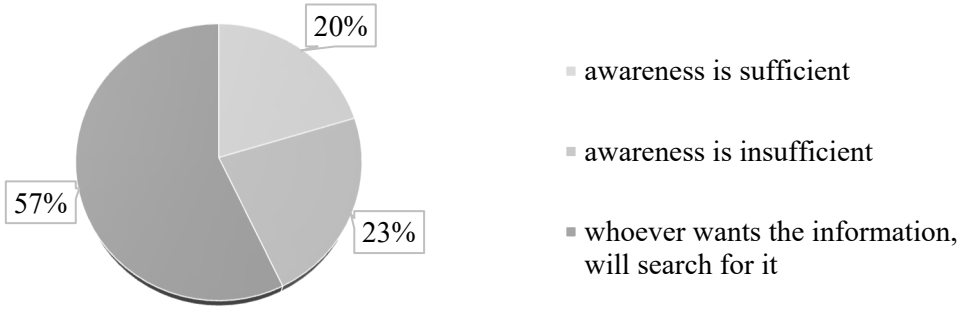
	processing of agricultural products and food production	6.07%
	gastronomy	29.48%
	food production	6.68%
	combination of several activities	10.63%
Number of employees	10-49	30.09%
	50-249	9.11%
	More than 250	4.25%
Territorial area of operation	Local	59.27%
	Regional	20.36%
	National	8.81%
	International	11.55%

Source: author's calculations

3. Results

Nowadays, the concept of sustainability, climate change and ecology is largely discussed issue. At the beginning of the questionnaire survey, companies were asked to answer the question dealing with the awareness of sustainability, environmental protection and topics related to climate protection. According to the results, it can be concluded that 23% of participating companies consider the awareness of sustainability and related topics insufficient. On the other hand, only 20% of answers were positive and companies consider the amount of information on sustainability, environment, and climate to be sufficient. More than 57% of the answers stated that whoever wants the information, will search (Figure 1).

Figure 1: Awareness of the topic of sustainability in production and consumption, environmental protection and other topics related to climate protection



Source: author's calculations

The next question provides an interesting comparison. We were investigating the level of involvement in healthy nutrition of retail, catering facilities and restaurants and agricultural primary production companies. Results revealed that companies operating in retail (73.13%) and gastronomy (72.16%) consider healthy nutrition as a serious issue and develop different activities (for instance the

production and offer of healthy food products, for special nutrition e.g. for diabetics, gluten-free and lactose-free food, vegetarian or vegan products). On the other hand, businesses operating in agricultural primary production (70.17%) do not consider the topic of healthy nutrition to be important. When it comes to the issue of ecology, all of the investigating sectors expressed a positive opinion (usage of environmentally appropriate technologies in production and logistics (such as the protection of air, water, the surrounding nature, welfare and recycling waste).

Innovations could represent a crucial factor in expediting the shift to sustainable and healthy food systems. The next question was focused on using innovations in business, in several ways, such as innovations in the form of communication with customers, innovative packaging technology, new forms of customer service, innovative technologies and recipes, offering innovative products, entertainment and educational activities for, for example, children, families, and others (playgrounds, educational trail, wellness, outdoor fitness). Our results demonstrate that most of the participating companies use innovations. More than 80% of gastronomy facilities declare that they use innovations. Approximately 60% of participating companies in retail use innovations and 80% in agricultural primary production.

The final question was dealing with the Nutri-Score labelling on products. The main objective of this label is to determine a product's healthfulness by looking at the front-of-pack ranking score, which ranges from A to E and informs the consumer. We were asking the participating companies their level of knowledge about the label. From the results, it is evident that in each business, more than 50% of companies do not deal with this topic. On the contrary, 38% of catering facilities and restaurants support or partially support this labelling according to how it affects health. In retail, more than 36% of participating companies support Nutri-Score labelling. Finally, 37% of companies in agricultural primary production support front-of-pack labelling. 2% of companies in the catering a restaurant sector thought that Nutri-Score labelling is discriminatory for some products.

Table 2: Knowledge about the food traffic light, or the Nutri-Score initiative

	Partial support	Significantly Support	This labelling is discriminatory	We do not deal with this issue
Gastronomy	28.86%	10.30%	2.06%	58.76%
Retail	22.38%	14.92%	5.97%	56.71%
Primary agricultural production	21.05%	17.54%	7.01%	54.38%

Source: author's calculations

4. Discussion

Based on the results of the questionnaire survey, it is evident that only 20% of responses were favorable, and businesses believe that the available data on sustainability, the environment, and climate are sufficient. A study by Favi et al. (2017) examined how 52 Italian enterprises view and are aware of environmental sustainability challenges. 52% of answers indicated that sustainability offers a chance for product and service innovation. Only 6% of the sample uses sustainability for marketing purposes, while 37% of respondents only use it to fulfill requirements and standards. The remaining 5% of respondents never think about sustainability in their everyday activities. Furthermore, participating businesses had to state which environmentally sustainable activities are carried out in

their businesses. Most businesses carry out activities that are connected with illumination and heating efficiency, plant efficiency, biomass exploitation, certification and development of environmentally friendly products (recyclable materials, efficient engines, etc.). Finally, Alves, Ferreira and Araújo (2018) investigated the perception and awareness of sustainability in businesses in Brazil. The findings demonstrate the disparity between large and small businesses. In the context of sustainability, the results show a lower level of awareness of the effects of activities in small businesses.

The next research question was dealing with the Nutri-Score label on the front-of-pack of food and beverages. The Nutri-Score system in Slovakia is voluntary. Based on our results, it can be concluded that the selected companies do not consider the food nutrition labelling system Nutri-Score as a serious issue. The Pro NutriScore Alliance was established only in 2021 in Slovakia. The main object of Alliance is to support the nutritional labelling of products by the Nutri-Score and inform consumers. The food producer registers and documents necessary documents and can use the Nutri-Score labelling system. Slovak consumers may already encounter the Nutri-Score label on food products of several companies (Pro Nutri-Score Aliancia, 2021). According to Mialon, Julia and Hercberg (2018), the front-of-pack nutrition labelling system, known as Nutri-Score, was acknowledged by the French government in 2017. More than 70 companies adopted the usage of labelling voluntarily in 2018. The available research done by Public Health France in 2020 shows that from 2017 the figure has risen to 500 companies that adopted the front-of-pack nutrition labelling. The survey also finds out that 93% of French participants considered the Nutri-Score labelling useful for knowing the nutritional quality of products. Over 57% of participants knew the Nutri-Score logo and had changed one or more purchasing habits (Southey, 2021). Furthermore, other countries like Germany, Spain, Portugal, Austria, Belgium, and the Netherlands have chosen the voluntary implementation of the Nutri-Score system (Adifo, 2021). In Germany, 116 German companies with 236 brands have already registered to use this nutrition label in 2021 (BMEL, 2022).

When taking into consideration the usage of innovations in selected businesses, the results showed that most of the companies use innovations in different forms. As stated by Knickel, Brunori, Rand and Proost (2009), Van der Ploeg, Bouma, Rip, Rijkenberg, Ventura, and Wiskerke (2004), innovations in the agro-food industry typically entail much more than just technology, it includes marketing, management, organization, and design. Innovations are the result of fresh approaches and various modes of thoughts. Research done by Riccaboni et al. (2021) describes the importance of innovations. Agribusinesses have a significant potential to invent within their capabilities for a practical transition to sustainability, which might eventually become a market-focused competitive force. Additionally, innovations in the agri-food industry that are focused on sustainability could address a wide range of topics, from technical ones that optimize breeding and agricultural practices to those that target consumers by promoting sustainable food paradigms and policymakers by supporting public-private initiatives. Research by Moravčíková, Tkáč and Mušinská (2021) analyzes characteristics and factors that influence the innovative performance of Slovak in 99 agro-food firms. Moreover, the study is dealing with the types of innovations as well as issues that can affect how well they are implemented and evaluated. According to the results, up to 77% of respondents, considered innovation as a crucial factor in increasing a company's competitiveness. Approximately about 75% of respondents claimed to have implemented innovations over the previous five years. More than 33% of respondents indicated technical innovation. Innovations in products and services, such as brand-new ones or upgrades to already-existing ones, were put into practice by 26% of respondents, while innovations in marketing strategies and organizational procedures were announced by 15% of respondents. According to the findings, 89% of respondents believe that the rise in product quality is the most crucial element for innovations. The need to reduce costs for the business and boost its competitiveness are additional significant factors for 86% of respondents. The expansion of products or services was viewed

as an important element by 75% of the businesses contacted. On the other hand, the overwhelming majority of respondents (91%) agreed that a lack of funds is the main obstacle to implementing innovation. Donaldson (2022) proves innovation in form of digital devices aimed at ensuring food integrity and the control of supply chains are shown to reconstitute infrastructures of qualification by which the qualities of foodstuffs are established as they move through the processes of the supply chain, from production to consumption. As stated by Freidberg (2013), innovations in form of digitalization represent a possibility to increase information in the food sector. Moreover, according to Carolan (2018), innovations can form consumer behaviour. Finally, research carried out by Van Rijswijk and Frewer (2011) was analysing the traceability of food systems as a new trend in innovations. Based on the findings, there is a need for a variety of information regarding food and the production processes involved. However, for traceability to have a real impact on consumers, the information that is supplied to consumers must be accurate, reliable, and clear.

5. Conclusion

The Farm to Fork strategy provides a bold plan for European agriculture and the food sector. The fundamental targets of the strategy are to improve sustainable food production and consumption, sustainable food distribution, and the prevention of food loss and waste. The aim of this paper was to identify the application of the Farm to Fork strategy in selected companies. We focused on health nutrition, ecology, sustainability and innovations in 3 selected sectors. Our results showed that more than 93% of selected businesses perceive the issue of ecology and carry out various activities such as the protection of air, water, nature, and recycling. Additionally, 74% of participating companies use innovations in their businesses (innovative packaging technology, new forms of customer service, innovative technologies and recipes, offering innovative products, entertainment, and educational activities). Lastly, we were evaluating opinions about the Nutri-Score labelling. Based on the results, it is evident that in each industry, more than 50% of companies do not deal with this topic.

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References

[19] Aday, S., & Aday, M. S. (2020). Impact of COVID-19 on the food supply chain. *Food Quality and Safety*, 4(4), 11-24. doi.org/10.1093/ fqsafe/fyaa024

[20] Adifo. (2021). *Three years ago, France introduced Nutri-Score. What is the current situation in the different countries across Europe? And what about its future?* Retrieved August 30, 2022, from https://www.adifo.com/en/news/three-years-ago-france-introduced-nutri-score-what-current-situation-different-countries

[21] Alves, W., Ferreira, P., & Araújo, M. (2018). Sustainability awareness in Brazilian mining corporations: The case of Paraíba state. Environment, Development and Sustainability, 20(1), 41-63.

[22] Arabska, E. (2021). From farm to fork: Human health and well-being through sustainable agri-food systems. *Journal of Life Economics, 8*(1), 11-27. doi:10.15637/jlecon.8.1.02

[23] Barling, D., Lang, T., & Caraher, M. (2002). Joined–up food policy? The trials of governance, public policy and the food system. *Social Policy & Administration, 36*(6), 556-574. doi:10.1111/1467-9515.t01-1-00304

[24] Bazzan, G., Daugbjerg, C., & Tosun, J. (2022). Attaining policy integration through the integration of new policy instruments: The case of the Farm to Fork Strategy. *Applied Economic Perspectives and Policy*. doi: 10.1002/aepp.13235

[25] Beckman, J., Ivanic, M., & Jelliffe, J. (2021). Market impacts of Farm to Fork: Reducing agricultural input usage. *Applied Economic Perspectives and Policy*. doi: 10.1002/aepp.13176

[26] Benton, T. G., & Bailey, R. (2019). The paradox of productivity: agricultural productivity promotes food system inefficiency. *Global Sustainability*. 2. doi: 10.1017/sus.2019.3

[27] BMEL. (2022). *Klöckner: First sound barrier broken with the Nutri-Score*. Retrieved August 30, 2022, from https://www.bmel.de/SharedDocs/Pressemitteilungen/DE/2021/20-erste-schallmauer-nutri-score-durchbrochen.html

[28] Bochtis, D., Benos, L., Lampridi, M., Marinoudi, V., Pearson, S., & Sørensen, C. G. (2020). Agricultural workforce crisis in light of the COVID-19 pandemic. *Sustainability*. 12(19), 8212. doi: 10.3390/su12198212

[29] Carolan, M. (2018). Big data and food retail: Nudging out citizens by creating dependent consumers. *Geoforum*, *90*, 142-150.

[30] Cortignani, R., Buttinelli, R., & Dono, G. (2022). Farm to Fork strategy and restrictions on the use of chemical inputs: Impacts on the various types of farming and territories of Italy. *Science of The Total Environment*, *810*, 152259. doi: 10.1016/j.scitotenv.2021.152259

[31] Donaldson, A. (2022). Digital from farm to fork: Infrastructures of quality and control in food supply chains. *Journal of Rural Studies*, *91*, 228-235.

[32] Drapáková, D., & Koreň, M. (2021). *Ekologické poľnohospodárstvo v Únii a na Slovensku (INFOGRAFIKA).* Retrieved August 22, 2022, from: https://euractiv.sk/section/ekonomika-a-euro/infographic/ekologicke-polnohospodarstvo-v-unii-a-na-slovensku/

[33] Dudek, M., & Śpiewak, R. (2022). Effects of the COVID-19 Pandemic on Sustainable Food Systems: Lessons Learned for Public Policies? The Case of Poland. *Agriculture*, *12*(1), 61. doi: 10.3390/agriculture12010061

[34] Ellison, B., & Kalaitzandonakes, M. (2020). Food Waste and Covid-19: Impacts along the supply chain. *Farmdoc Daily*, 10, 164.

[35] EUROPARC Federation. (2022). *EU Farm to Fork.* Retrieved August 22, 2022, from: https://www.europarc.org/european-policy/farm-to-fork-protectes-areas/

[36] European Commission. (2019). *The European Green Deal sets out how to make Europe the first climate-neutral continent by 2050, boosting the economy, improving people's health and quality of life, caring for nature, and leaving no one behind*. Retrieved August 22, 2022, from: https://ec.europa.eu/commission/presscorner/detail/en/ip_19_6691

[37] European Commission. (2020a). *Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions: A Farm to Fork Strategy for a Fair, Healthy and Environmentally-Friendly Food System: COM(2020) 381 Final. Brussels:* European Commission. Retrieved August 22, 2022, from: https://eur-lex.europa.eu/resource.html?uri=cellar:ea0f9f73-9ab2-11ea-9d2d-01aa75ed71a1.0001.02/DOC_1&format=PDF

[38] European Commission. (2020b). *Farm to Fork: For fair, healthy and environmentally-friendly food system - #EUGreenDeal.* Retrieved August 22, 2022, from: https://food.ec.europa.eu/system/files/2020-05/f2f_action-plan_2020_strategy-info_en.pdf

[39] European Commission. (2021). *ENRD workshop - The Farm to Fork Strategy and cooperation in the agri-food supply chain Launch of the Forum on Best Practices in the Agri-Food Supply Chain*. Retrieved August 22, 2022, from: https://enrd.ec.europa.eu/sites/default/files/enrd_f2f_ws_agenda_20211201.pdf

[40] European Commission. (2022a). *Farm to Fork strategy for a fair, healthy and environmentally-friendly food system.* Retrieved August 22, 2022, from: https://food.ec.europa.eu/horizontal-topics/farm-fork-strategy_en

[41] European Commission. (2022b). *Sustainable food production*. Retrieved August 22, 2022, from: https://food.ec.europa.eu/horizontal-topics/farm-fork-strategy/sustainable-food-production_en

[42] FAO. (2022). *The Right to Food*. Retrieved August 22, 2022, from: https://www.fao.org/right-to-food/background/qa-on-right-to-food/en/

[43] Favi, C., Germani, M., Gregori, F., Mandolini, M., Marconi, M., Marilungo, E. & Rossi, M. (2017). Environmental sustainability awareness in product design practices: A survey of italian companies. In *International Design Engineering Technical Conferences and Computers and Information in Engineering Conference* (Vol. 58165, p. V004T05A040). American Society of Mechanical Engineers.

[44] Freidberg, S. (2013). Calculating sustainability in supply chain capitalism. *Economy and Society*, *42*(4), 571-596.

[45] Galanakis, C. M., Rizou, M., Aldawoud, T. M., Ucak, I., & Rowan, N. J. (2021). Innovations and technology disruptions in the food sector within the COVID-19 pandemic and post-lockdown era. *Trends in Food Science & Technology,* 110, 193-200.

[46] Giudice, F., Caferra, R., & Morone, P. (2020). COVID-19, the food system and the circular economy: Challenges and opportunities. *Sustainability*, *12*(19), 7939. doi: 10.3390/su12197939

[47] Hawkes, C. (2017). *Policy coherence across the food system for nutrition: from challenge to opportunity?* Retrieved August 22, 2022, from: https://ecdpm.org/great-insights/sustainable-food-systems/policy-coherence-across-food-system-nutrition-challenge-opportunity/

[48] Knickel, K., Brunori, G., Rand, S., & Proost, J. (2009). *Towards a better conceptual framework for innovation processes in agriculture and rural development: from linear models to systemic approaches.* Journal of Agricultural Education and Extension, 15(2), 131-146.

[49] König, L. M., & Araújo-Soares, V. (2021). Will the Farm to Fork strategy be effective in changing food consumption behavior? A health psychology perspective. *Applied Economic Perspectives and Policy*. doi: 10.1002/aepp.13220

[50] Mason, P., & Lang, T. (2017). *Sustainable diets: how ecological nutrition can transform consumption and the food system.* Routledge

[51] Mehra, R., Kumar, H., Kumar, N., & Kumar, S. (2021). Impact of COVID-19 Pandemic on Food Supply Chain (FSC) and Human Health. *Integrated Management-Standing up for a Sustainable World*. Eureka Publications, 311-9.

[52] Mialon, M., Julia, C., & Hercberg, S. (2018). The policy dystopia model adapted to the food industry: the example of the Nutri-Score saga in France. *World Nutrition*, 9(2), 109-120.

[53] Montanarella, L., & Panagos, P. (2021). The relevance of sustainable soil management within the European Green Deal. *Land use policy*, *100*, 104950. doi: 10.1016/j.landusepol.2020.104950

[54] Moravčíková, D., Tkáč, F.,& Mušinská, K. (2021). Selected Aspects and Determinants of the Slovak Agro-Food Companies' Innovativeness. *Frontiers Sustainable Food System*, doi:10.3389/fsufs.2021.720730

[55] Moschitz, H., Muller, A., Kretzschmar, U., Haller, L., de Porras, M., Pfeifer, C., ... & Stolz, H. (2021). How can the EU Farm to Fork strategy deliver on its organic promises? Some critical reflections. *EuroChoices*, *20*(1), 30-36. doi: 10.1111/1746-692X.12294

[56] Mowlds, S. (2020). The EU's farm to fork strategy: Missing links for transformation. *Acta Innovations*. doi:10.32933/ActaInnovations.36.2

[57] Nilsson, G., Allison, E. H., William, W. L., Dey, M. M., Halpern, S., & Mccauley, D. J. (2016). *SDG interactions.* Nilsson, Griggs.

[58] Nilsson, M., & Persson, Å. (2017). Policy note: Lessons from environmental policy integration for the implementation of the 2030 Agenda. *Environmental Science & Policy, 78(*36–39), doi: 10.1016/j.envsci.2017.09.003

[59] Pro Nutri-Score Aliancia. (2021). *Pro Nutri-Score Aliancia podporuje zjednodušené nutričné označenie potravín a nápojov.* Retrieved August 22, 2022, from: https://www.nutriscoreslovakia.sk/wp-content/uploads/2021/04/TS_ProNutriScoreAliancia_210428.pdf

[60] Purnhagen, K. P., Clemens, S., Eriksson, D., Fresco, L. O., Tosun, J., Qaim, M., & Zilberman, D. (2021). Europe's farm to fork strategy and its commitment to biotechnology and organic farming: Conflicting or complementary goals?. *Trends in plant science, 26*(6), 600-606. doi: 10.1016/j.tplants.2021.03.012

[61] Reinhardt, T. (2022). The farm to fork strategy and the digital transformation of the agrifood sector—An assessment from the perspective of innovation systems. *Applied Economic Perspectives and Policy*. doi: 10.1002/aepp.13246

[62] Riccaboni, A., Neri, E., Trovarelli, F., & Pulselli, R. M. (2021). Sustainability-oriented research and innovation in 'farm to fork'value chains. *Current Opinion in Food Science*, *42*, 102-112. doi:10.1016/j.cofs.2021.04.006

[63] Schebesta, H., & Candel, J. J. (2020). Game-changing potential of the EU's Farm to Fork Strategy. *Nature Food*, *1*(10), 586-588.

[64] Southey, F. (2021). *Is Nutri-Score working in France? The results are in*… Retrieved August 30, 2022, from https://www.foodnavigator.com/Article/2021/03/05/Is-Nutri-Score-working-in-France-The-results-are-in

[65] Van der Ploeg, J. D., Bouma, J., Rip, A., Rijkenberg, F. H. J., Ventura, F., & Wiskerke, J. S. C. (2004). On Regimes, Novelties, Niches and Co-Production. In J. D. Prof.dr.ir. Ploeg, & J. S. C. Dr.ir. Wiskerke (Eds.), *Seeds of Transition : Essays on novelty production, niches ans regimes in agriculture*, European Perspecctives on Rural Development, 1-30. Retrieved August 30, 2022, from: https://edepot.wur.nl/337404

[66] Van Rijswijk, W., & Frewer, L. J. (2012). Consumer needs and requirements for food and ingredient traceability information. *International Journal of Consumer Studies*, 36(3), 282-290.

[67] Wesseler, J. (2022). The EU's farm-to-fork strategy: An assessment from the perspective of agricultural economics. *Applied Economic Perspectives and Policy*. doi: 10.1002/aepp.13239

[68] Willett, W., Rockström, J., Loken, B., Springmann, M., Lang, T., Vermeulen, S., & Murray, C. J. (2019). Food in the Anthropocene: the EAT–Lancet Commission on healthy diets from sustainable food systems. *The Lancet*, *393*(10170), 447-492. doi: 10.1016/S0140-6736(18)31788-4

Global food crisis and its causes: the EU's response domestically and globally

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Abstract

In 2022, a global food crisis broke out due to three main factors. The first is climate change, which is related to the harvest, other measures related to the COVID-19 pandemic, which have disrupted the supply chain, and the last decisive one is the ongoing war in Ukraine. These factors primarily caused shortages in the supply of cereals, which we will focus on in our research. The main goal of paper is to evaluate the development of purchase, sales and consumer prices of selected cereals and cereal products in the Slovak Republic. We focus on the prices of food wheat, food rye, wheat-rye bread, fat roll and semi-coarse wheat flour for the period January - July 2022. Based on the research results is evident that the purchase prices of wheat had mostly a rising trend, and they grew the most in April 2022. In May 2022, the price of food wheat had reached its maximum, up to EUR 362.33 per ton. The growing price of food also caused the growth of consumer prices of wheat products. Compared to January 2022, all examined consumer prices were higher in July 2022, the price of selected semi-coarse wheat flour grew the most, by almost 50% during analysed period.

Keywords: *global food crisis, grain, inflation, price*

JEL Classification: *Q02, Q11*

1. Introduction

Wars and violent conflicts are a frequent cause of food crises. Even now, we are witnessing the global food crisis, which has fully erupted precisely as a result of the ongoing war in Ukraine. More serious problems with food supplies began already in 2020, when disruptions in the supply chain caused by measures against the spread of the COVID-19 disease were a frequent phenomenon (Esfandabadi, Ranjbari & Scagnelli, 2022). The situation was further aggravated by climate changes, which have had a significant negative impact on agricultural production for several years. The world suffered from economic shocks and economic slowdowns (Yu, Hu, Tong, Xia & Ran, 2022).

Ukraine is an important producer of wheat; it is its fifth largest exporter (Benton et al., 2022). However, Russia's military operations have caused the interruption of a large part of wheat exports, as the export routes are blocked. 20 million tons of cereals are due to the war blocked in ports (Ahmed, Blight, Ford & McMullan, 2022). Even now, when the blockade is over, occur serious problems with wheat supply. The countries of Africa and the Middle East, which depend on Ukrainian wheat, suffer the most (Balma, Heidland, Jävervall, Mahlkow, Mukasa et al., 2022|). Africa is the most endangered continent by hunger. According to the Food and Agriculture Organization of the United Nations [FAO] (2022), in 2021, 702-828 million people worldwide suffered from hunger, that is, approximately one tenth of the world's population was undernourished. The greatest prevalence of malnutrition was in Africa, up to 20.2%. The lack

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of wheat pushes its price up. The price of wheat on world markets has increased by more than 40% since the beginning of 2022 (Macrobond, 2022).

The countries of European Union, suffer from global food crisis, too. The war in Ukraine caused price shocks for food and fertilizers. The price of fertilizers has doubled from December 2019 to May 2022. Fertilizers are important inputs to agricultural production, so the jump in fertilizer prices was also reflected in the prices of agricultural products (Haller, 2022).

The European Union as well as the governments of its member states are facing two global problems, which are food security and food availability. It is trying to introduce measures aimed at ensuring the availability of food to citizens, especially the most vulnerable groups. Common agricultural policy is provided in the EU and thanks to that, food shortages do not threat the member states, but the low-income families suffer under food inflation. The European Union can take the following measures against inflation: facilitate advance payments to address cash flow challenges; allow temporary derogations on some requirements, such as set-aside land; adopt a crisis framework to provide further support. Also, the member states themselves can do the following things: reduce VAT rates; encourage retailers to keep prices down; use dedicated EU funds to help the most deprived (European Council & Council of the European Union, 2022).

The Slovak Republic is a small country, both in Europe and globally. Slovakia's agri-food foreign trade does not have an important position for these countries. It is therefore important for the Slovak Republic to engage in international trade (Látečková, Trnková, Palkovič & Holúbek, 2021). So, it is not surprising that Slovakia is hit by the embargo of Russian agri-food products (Kašťáková, Žatko & Jarossová, 2022). Slovakia feels the negative impact of the war through commodity supplies from Russia and Ukraine. We mean gas, oil or cereals. Their prices are rising and grain production in Ukraine will be lower. Food prices are growing the fastest in Slovakia and thus contribute the most significantly to inflation. Despite the partial decline in the prices of food commodities in the world Economic and monetary development markets after reaching an agreement on the export of commodities from Ukraine, there are pressures on the growth of food prices enormous. They are supported by other input prices such as for example, fertilizers, fuels, energy and, finally, the weather. (National Bank of Slovakia [NBS], 2022). The inflation rate in Slovakia reached 14% in August 2022, increased by 0.8% month-on-month. The prices of bread and cereals increased by 1.5%. As for food prices, they are more expensive by 21.6% compared to August 2021, while the prices of bread and cereals have increased the most, by 24.5%. Currently, food is the second largest item of expenditure after housing and energy (Statistical Office of Slovak Republic [ŠÚ SR], 2022).

2. Data and Methods

The aim of the paper is to evaluate the development of purchase, sales and consumer prices of selected cereals and cereal products in the Slovak Republic. To reach this main goal, we analyze the average monthly prices of cereals and cereal products in Slovakia for the period January – July 2022. We divide our research into three parts. In the first part we examine the purchase prices of grain. Two commodities were chosen for the research – food wheat and food rye and the values are featured in euros per ton. The second part is devoted to sales prices of cereal products and we analyze there the prices of wheat-rye bread and fat roll. The prices are given in euros per 100 kg. In the final part of research, we evaluate the consumer prices of final products and we focus on four products – semi-coarse wheat flour, bread, cereal bread and fat roll. In this part, the prices are given in euros per kilogram and for fat roll, they were recalculated from price per 40 grams to 1 kilogram. The values originate from the data of the Agricultural Payment Agency [APA] - Agrarian market information of Slovakia [ATIS], which periodically report information about situation on the agricultural markets.

By analyzing the data, the time series method is used. Time series can be defined as a certain grouping of the elements of some statistical sign based on chronological order.

The time series are appropriately ordered only when they three conditions:

- the possibility of comparing data over time, i.e., the time periods must be of the same length,
- spatial comparability of data,
- the possibility of comparison based on content (Kirchgässner, Wolters & Hassler, 2013).

Indicators:

- Absolute increase – tells us how the given values change compared to the previous time period, we can express it using the difference between the value of the current and the previous period.

$$\Delta\ y_t = y_t - y_{t-1}\ , t = 2,3, \dots , n \tag{1}$$

where:

y_t value in date t

y_{t-1} value in previous date

t date

n number of dates

The average absolute increase is an arithmetic mean of the absolute increase.

$$\overline{\Delta} = \frac{1}{n-1} \sum_{t=2}^{n} \Delta y_t = \frac{y_n - y_1}{n-1} \tag{2}$$

where:

y_n value in date n

y_1 value in date 1

- Growth coefficient – represents a multiple of the average growth of the given element compared to the previous period.

$$k_t = \frac{y_t}{y_{t-1}},\ t = 2, 3, \dots, n \tag{3}$$

where:

y_t value in date t

y_{t-1} value in previous date

The average growth coefficient can be expressed as the geometric mean of the growth coefficient.

$$\overline{k} = \sqrt[n-1]{k_2 k_3 \dots k_n} = \sqrt[n-1]{\frac{y_n}{y_1}} \tag{4}$$

where:

$k_{2,3}$ growth coefficients in dates 2 and 3

k_n growth coefficient in date n Litschmannová (2010)

A linear trend line is a part of graphs created in our research. Trend can be defined as a change over a period of time. Trend line represents a line which show us a pattern or trend on a graph. Trend lines can be also used to make predictions of the future. We distinguish three types of trend line, a trend line with positive slope, a trend line with negative slope and a horizontal trend line. A trend line with a positive slope indicates a positive relationship between the variables, so when one variable increases, the other increases, too. When a trend line has a negative slope, it indicates a negative relationship between the two variables. When one goes up, the other goes down, and vice versa. A horizontal trend indicates a constant relationship between the two variables. No matter which direction one goes, the other stays the same (Kirchgässner et al., 2013).

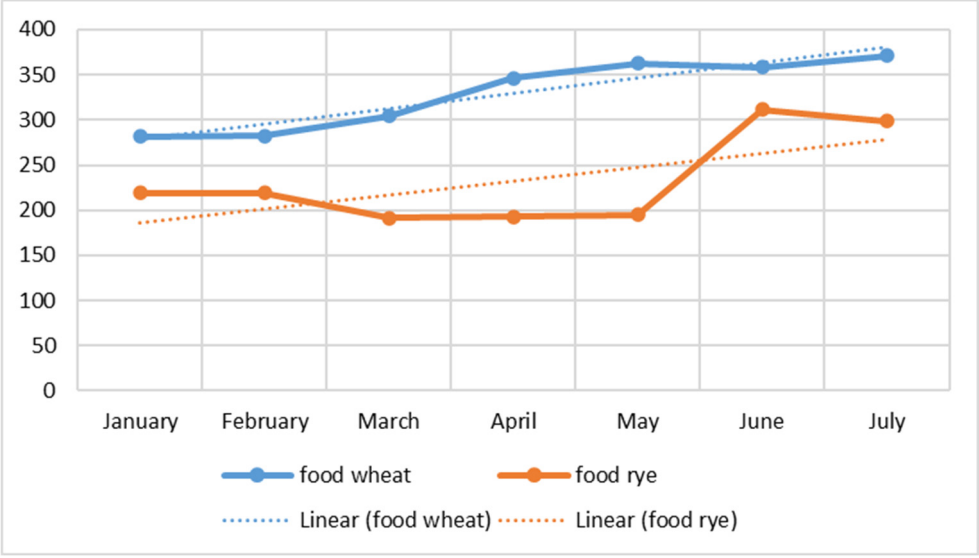
3. Results and Discussion

In our research we examine the development of purchase, sales and consumer prices of selected grains and cereal products in Slovakia in the period January – July 2022.

3.1 Purchase prices of selected grains

We begin with the first stage of the product vertical of grains, which are products of primary agricultural production. We selected two products which average monthly prices are available for public in the reports of the APA - ATIS. These products are food wheat and food rye. We have chosen these two grains because they are very important for nutrition of Slovak population. On the shelves in supermarkets in Slovakia, wheat and rye products are the most common. The average monthly purchase prices for food wheat and food rye are shown in the graph below.

Figure 1: Purchase prices of selected grains in Slovakia January – July 2022 (EUR/t)



Source: ATIS, own processing

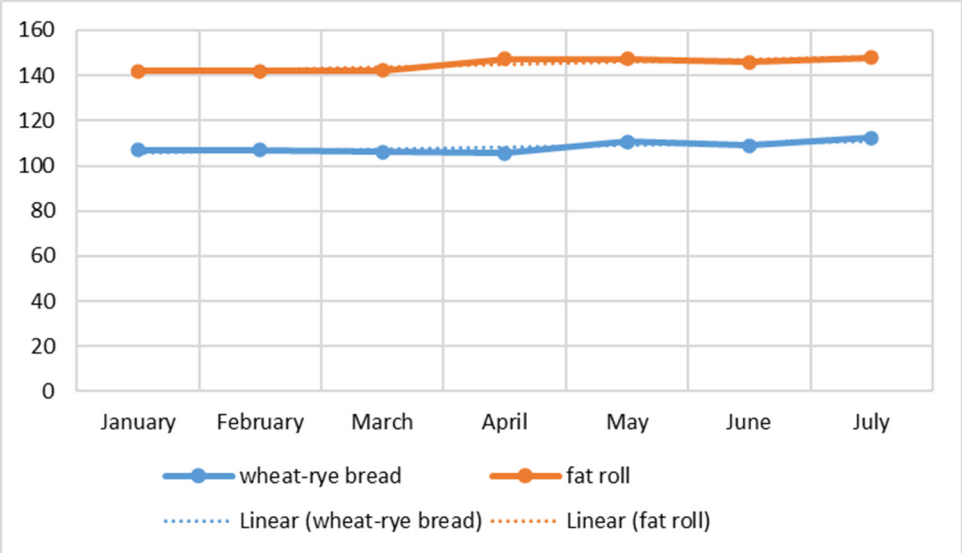
The trend lines shown in the graph show that the purchase prices of both food wheat and food rye in Slovakia followed an upward trend during the period January – July 2022, while the slope of the linear trend line was very similar for both commodities examined. The growth rate of both wheat and rye prices was around 5%, which can be assessed as a significant rise. The price of rye grew slightly faster than the price of wheat. While on average the price of wheat rose by 4.7% month-on-month, for rye this increase was 5.3%.
However, if we look at price developments in individual months, we see a significant difference between commodities. The development of the price of wheat did not experience such significant fluctuations during the period considered as in the evolution of the price of rye. We can also see the differences between the trend in price developments during the months of February-July, that is, since the outbreak of the war in Ukraine. While the price of wheat rose significantly in the months of February – May, the price of rye, on the contrary, fell by 27.78 EUR/t in March and remained at a relatively constant level during April and May, the increase in the price of rye during this period was only minimal. However, the price of wheat recorded the largest month-on-month increase in April, up to 42.35 EUR/t. In June, the situation turned around. The price of wheat fell for the only time in the period under review and a jump of 116.82 EUR/t was recorded in the price of rye. In the last examined month, the trends twisted again, while the price of wheat rose to 371.16 EUR/t, the price of rye decreased to 298.97 EUR/t. The price of food wheat was in July the highest of all examined months.

3.2 Sales prices of selected cereal products

After we have analysed the prices of primary agricultural products, we continue to examine the next stage of cereal products vertical, which are products intended for sale by retail undertakings. So, we examine the sales prices of these products. We have chosen wheat-rye bread and fat roll because these are sold to the retailers in huge amounts.

In the following graph are displayed the sales prices of wheat-rye bread and fat roll in Slovakia in January – July 2022.

Figure 2: Sales prices of selected cereal products in Slovakia January – July 2022 (EUR/100kg)



Source: ATIS, own processing

In contrast to the purchase prices of selected grains, the sales prices of cereal products did not change dramatically at all over the period considered. The prices of both wheat-rye bread and fat roll had a slight upward trend. The average month-on-month price increase during the months under review was minimal. On average, the price of wheat-rye bread increased by only 0.84% month-on-month, and with the price of a roll, this growth was even smaller, only 0.69%. The wholesale price of the roll was around EUR 25/100kg higher than the price of wheat-rye bread during the period considered.

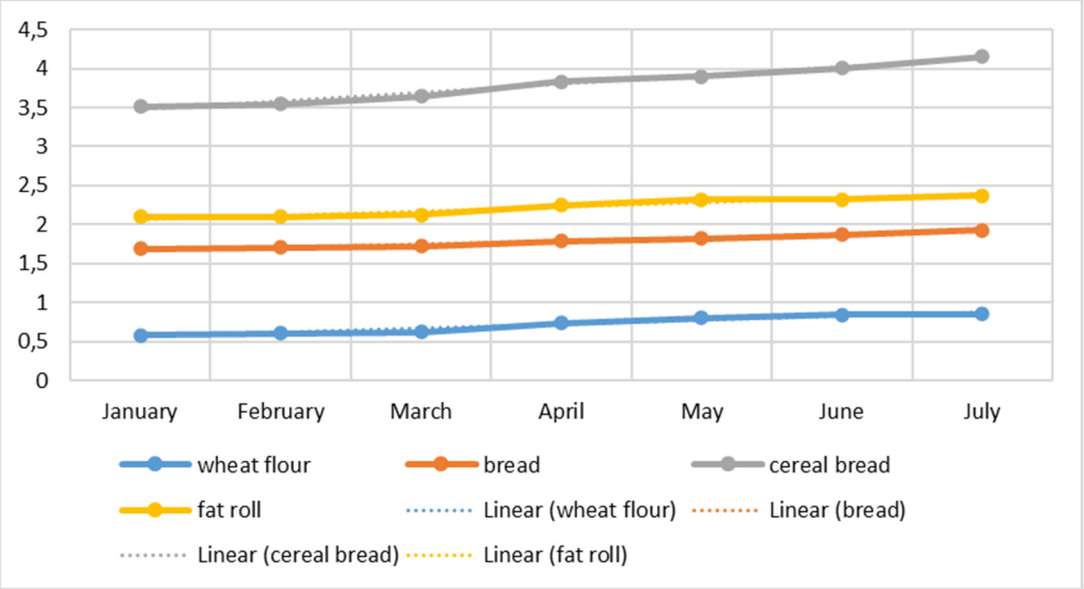
The price of the roll did not change in February compared to the previous month, but after the outbreak of the war in Ukraine, it increased slightly by EUR 0.25/100 kg. The crisis did not fully manifest itself in the price of the roll until April, when it jumped by EUR 5/100 kg. In May, the price of the roll remained at a constant level. In June, a reduction of 1.5 euros was noted. It held at a constant level, and in July the price increased by 2.25 euros. In July, 100 kg of fat roll costed 148 euros.

The development of the price of wheat-rye bread had a different course. Even in the period before the war, its price rose slightly by 0.21 euros compared to the previous month. Interestingly, however, in March the price even decreased by more than 1 euro, and in April this decline continued, albeit to a lesser extent. In May, when the price of the roll stabilized, on the contrary, the price of wheat-rye bread soared by almost 5 euros. In both June and July, the development of the price of wheat-rye bread followed the same course as the development of the price of the roll. In July 2022, retailers were able to buy 100 kg of wheat-rye bread for 112.39 euros, which is 5.51 euros more than at the beginning of the year.

3.3 Consumer prices of bread and pastry

Finally, we will look at the evolution of the prices of final grain products. We will examine the consumer prices of four selected products, which often appear in the consumer basket of Slovak residents. These include semi-coarse wheat flour, bread, cereal bread, and fat roll. Data on their average monthly prices are shown in the graph.

Figure 3: Consumer prices of bread and pastry in Slovakia January – July 2022 (EUR/kg)



Source: ATIS, own processing

The graph shows that all items of bread and pastries selected by us had a slight upward trend during the reporting period. The prices of semi-wheat flour, bread and wholemeal bread were constantly increasing. The prices of fat roll either increased by leaps and bounds during the period under review. All prices rose most strongly compared to the previous month in April, when the food crisis took full effect. On the other hand, prices increased at least in February, in the period before the outbreak of the war in Ukraine.

If we look at the price development of individual items, we find that during the months of January - July 2022, the price of flour rose most significantly, up to three times compared to the other foods analysed. The average month-on-month increase in the price of flour was 6.6%. In absolute terms, the price of flour increased by EUR 0.27/kg in July compared to January, a 47% increase. Most significantly, its price rose in April, by 0.11 euros. In July 2022, consumers were able to buy a package of semi-wheat flour for 0.85 euros.

As for the other items examined, wholemeal bread showed the second largest price increase. On average, its price increased by 2.8% month-on-month. Overall, it increased by EUR 0.62/kg compared to January in July. In July, 1 kg of wholemeal bread cost 4.16 euros/kg.

An even smaller increase was shown by the price of bread, averaging 2.2% per month. Also, the April price jump was lower than the previous two items, the price increased by 0.06 EUR/kg at that time. In July, the price of bread stabilised at 1.93 EUR/kg, which is 14% higher than in January.

The price of the fat roll was the least sensitive to the events of the last year. Over the period under review, it grew by an average month-on-month increase by 2.1%. In February and June, even its price did not rise at all, but remained at a constant level. In April, however, the price of the roll reacted more strongly to the war in Ukraine than the price of bread, at that time the price of the fat roll increased by EUR 0.13/kg. The price increase for the entire period under review amounted to EUR 0.28, in relative terms 13%. and during July 2022, consumers were able to buy kg of rolls for 2.38 euros.

3.4 Discussion

On the previous graphs, we could observe a significant increase in the prices of primary agricultural commodities, namely food grade wheat and food grade rye. Peter Močko, chairman of the Slovak Millers Association in the report made by Hilbertová (2022), states that wheat prices in Slovakia are determined by export prices. It is the stock exchanges that determine the price. The high rise in world prices can be attributed to the reduction in grain supply on the world market, mainly due to the mainly due to the war in Ukraine and the related temporary stoppage of wheat exports from Ukraine and Russia and due to the ban on wheat exports from India. The lack of grain supply combined with high demand is pushing up prices.

At the same time, the Food Chamber (2022) notes that Russia is a large importer of fertilizers to Slovakia, especially urea and phosphorous fertilizers, the price of which has increased significantly in the recent period. If the conflict were to last for a longer period, a problem may arise when establishing a new crop, and substitutes will have to be sought, mainly in phosphoric fertilizers.

It is noteworthy, however, that the food crisis did not affect the wholesale prices of wheat-rye bread and fat rolls, nor the consumer prices of baked goods to such a significant degree as the prices of grain. The only exception is the price of flour, which grew even more than grain prices on average month-on-month during the monitored period. In a report made by Hricišinová (2022), Vlada Debnárová, secretary of the Association of Cereal Growers, explains that the costs of buying grain make up only a third of the consumer prices of bread. The rest is made up

mainly of costs for energy, transport, packaging, and other costs, as well as the trade margin of retailers. It is precisely the high trade margin that justifies the much higher growth of retail bakery prices than wholesale prices. Debnárová further states that in the case of flour, grain costs account for up to 70% of its price, and thus the rise in grain prices accelerates the rise in flour prices much more than other grain products.

The uncertainty of future market developments is extremely high. Inflationary pressures weigh on the financial situation households and companies (Saâdaoui, Jabeur & Goodell, 2022). The European Central Bank [ECB] plans a tightening of monetary policy on a global scale dampen consumer demand. Businesses continue to face higher costs and supply chain disruptions, although there are tentative signs of some easing of supply constraints. These factors significantly overshadow the outlook for development in the second half of 2022 and beyond. (Mota & Fernandes, 2022).

In its latest report on economic and monetary development, the NBS (2022) created two different scenarios - positive and negative – of how the macroeconomic situation in Slovakia could develop in the next year. In a positive scenario, energy prices would rise by 50% in 2023, which would affect the development of inflation. It would be at the level of 13.5% and the Slovak economy would avoid recession. Moderate 0.5% economic growth would continue. However, the negative scenario that can occur with a lack of natural gas assumes an inflation rate of up to 22%, which would cause a significant decrease in consumer wealth. As a result, a recession would occur, GDP would fall by more than 4%.

4. Conclusion

We are currently living in turbulent times when it is difficult to predict the future. Institutions at both national and international level face major challenges. In addition to ongoing climate change, they also have to deal with the consequences of pandemic measures and deal with the impact of the Russian-Ukrainian conflict on world markets. One of the most serious consequences of recent events is the food crisis. The world is suffering from food shortages and rising food prices. Food shortages are a problem especially for the countries of Africa and the Middle East, as these countries are dependent on Ukrainian wheat, which is currently in short supply on the world market. The situation is aggravated by the Indian embargo on wheat exports. Thanks to its common agricultural policy, the European Union is protected from food shortages, but its member states are greatly concerned about rising food prices. The EU can take the following measures against inflation: facilitate advance payments to address cash flow challenges; allow temporary derogations on some requirements, such as set-aside land; adopt a crisis framework to provide further support. The dramatic rise in the price level also affects the Slovak economy. We can observe a galloping food inflation. The inflation rate in Slovakia reached 14% in August 2022. Food is by 21,6 % more expensive than it was in August 2021. The prices of bread and cereals have increased the most, nearly by 25%.

The main goal of paper was to evaluate the development of purchase, sales and consumer prices of selected cereals and cereal products in the Slovak Republic. We focus on the prices of food wheat, food rye, wheat-rye bread, fat roll and semi-coarse wheat flour. We examined the average monthly data of individual commodities for the period January – July 2022. The data were drown of the Agricultural Payment Agency - Agrarian market information of Slovakia. We used the method of time series and for each commodity we added a linear trend line in the graph.

Prices of every commodities have been rising during January – July 2022 but the velocity of growth was very different. The purchase prices of both examined grains – food wheat and food rye were increasing on average month-on-month by about 5%. However, by food rye, there was

a bigger volatility than by food wheat. In July 2022 one tonne of food wheat could be bought for 371.16 euros and one tonne of food rye for 298,97 euros. The high growth of grain prices was caused mainly by the ongoing war in Ukraine. The exports from Ukraine and Russia are much lower than before the conflict and India has banned the export of wheat, so there is not enough supply on the world market what has pushed the prices upwards. The second factor is, that the prices of inputs have grown, namely the prices of energy, fuel and fertilizers. The sales prices of wheat-rye bread and fat roll were growing slowly in comparison to food wheat and food rye. On average, the price of wheat-rye bread increased by only 0.84% month-on-month, and the price of fat roll by only 0.69%. In July 2022, retailers were able to buy 100 kg of wheat-rye bread for 112.39 euros, and 100 kg of fat roll for 148 euros. The reason for slower growth is that grain prices make only 30% of total costs of bread and pastry. The consumer prices of bread, cereal bread and fat roll, these were growing every month on average by about 2%. However, the price of semi-coarse wheat flour was growing three times faster, by 6,6%. Total costs of wheat flour consist by 70% of the costs of wheat in comparison to bread and pastry and this is the reason for the greater increase.

It is very difficult to predict the future development of price level and experts have made more scenarios. As for Slovakia, there are two scenarios created by National Bank of Slovakia. In positive scenario the price of natural gas will grow by 50% and there will be a minimal economic growth but in the negative scenario will Slovak economy in 2023 turn into recession and the inflation rate will be more than 20%. Because almost every other prices depend on energy costs, it is recommended that Slovakia and also the European Union focus primarily on problems with gas and electricity supply.

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References

[1] Ahmed, K., Blight, G., Ford, L & McMullan, L. (2022). The Black Sea blockade: mapping the impact of war in Ukraine on the world's food supply – interactive. *The Guardian*. Retrieved September 24, 2022, from <https://www.theguardian.com/global-development/ng-interactive/2022/jun/09/the-black-sea-blockade-mapping-the-impact-of-war-in-ukraine-on-the-worlds-food-supply-interactive>

[2] Balma, L., Heidland, T., Jävervall, S., Mahlkow, H., Mukasa, A.N. & Woldemichael, A. (2022). Long-run impacts of the conflict in Ukraine on food security in Africa. *Econstor*, Ukraine Special 1. Available at: <http://hdl.handle.net/10419/251885>

[3] Benton, T. G., Froggatt, A. & Wellesley, L. (2022). The Ukraine war and threats to food and energy security: Cascading risks from rising prices and supply disruptions, Research Paper, London: Royal Institute of International Affairs. <https://doi.org/10.55317/9781784135225>

[4] Esfandabadi, Z.S., Ranjbari, M. & Scagnelli, S.D. (2022). The imbalance of food and biofuel markets amid Ukraine-Russia crisis: A systems thinking perspective. *Biofuel Research Journal*, 9(2), 1640 – 1647. <https://doi.org/10.18331/BRJ2022.9.2.5>

[5] European Council & Council of the European Union (2022). Infographic - How EU countries are addressing the global food crisis. Retrieved September 27, 2022, from <https://www.consilium.europa.eu/en/infographics/how-eu-countries-are-addressing-the-global-food-crisis/>

[6] European Council & Council of the European Union (2022). Food security and affordability. Retrieved September 24, 2022, from <https://www.consilium.europa.eu/en/policies/food-security-and-affordability/>

[7] Food and Agriculture Organization of the United Nations (2022). The state of food security and nutrition in the world 2022. Retrieved September 24, 2022, from <https://www.fao.org/3/cc0639en/online/sofi-2022/food-security-nutrition-indicators.html>

[8] Haller, A. (2022). Influence of Agricultural Chains on the Carbon Footprint in the Context of European Green Pact and Crises. *Agriculture*, 12(6). <https://doi.org/10.3390/agriculture12060751>

[9] Hilbertová, M. (2022). Pšenice máme dosť, svetovému trhu však nepomôžeme. *Retail Magazin.* Retrieved October 3 2022, from <https://www.retailmagazin.sk/produkt/potravinarsky-sortiment/6189-psenice-mame-dost-svetovemu-trhu-vsak-nepomozeme>

[10] Hricišinová, S. (2022). Priplatíme si za chlieb a cestoviny? Ceny pšenice lámu rekordy, ovplyvniť môžu aj slovenský trh. Retrieved October 3, 2022, from <https://spravy.rtvs.sk/2022/05/priplatime-si-za-chlieb-a-cestoviny-ceny-psenice-lamu-rekordy-ovplyvnit-mozu-aj-slovensky-trh/>

[11] Kašťáková, E., Žatko, M., & Jarossová, M. A. (2022). The impact of the Russian embargo on the development and specialization of agri-food trade between Slovakia and Russia. Potravinarstvo Slovak Journal of Food Sciences, 16, 590–602. <https://doi.org/10.5219/1779>

[12] Kemmerling, B. Schetter, C. & Wirkus, L. (2022). The logics of war and food (in)security. Global Food Security, 33, 1 - 8. <https://doi.org/10.1016/j.gfs.2022.100634>

[13] Kirchgässner, G., Wolters, J. & Hassler, U. (2013). Introduction to Modern Time Series Analysis. Berlin: Springer-Verlag, second edition, 318. ISBN: 978-3-642-33435-1. Retrieved September 24, 2022, from <https://books.google.sk/books?hl=sk&lr=&id=o7jWV67165QC&oi=fnd&pg=PR5&dq=time+series&ots=mqkf2WBa1r&sig=vkGrpjN2gR7Q3YQqXWxCGuMmrYM&redir_esc=y#v=onepage&q=time%20series&f=false>

[14] Látečková, A., Trnková, M., Palkovič, J., & Holúbek, I. (2021). Competitiveness of agri-food foreign trade in conditions of the Slovak Republic. Potravinarstvo Slovak Journal of Food Sciences, 15, 694–702. <https://doi.org/10.5219/1686>

[15] Litschmannová, M. (2010). Úvod do analýzy časových řad. 4 – 5. Retrieved October 1, 2022, from <https://homel.vsb.cz/~lit40/SMAD/Casove_rady.pdf>

[16] Macrobond (2022). Commodities, China lockdown and egg prices. Retrieved September 24, 2022, from <https://www.macrobond.com/charts-of-the-week/commodities-china-lockdown-and-egg-prices>

[17] Mota, P.R. & Fernandes, A.L.C. (2022). Is the ECB already following albeit implicitly an average inflation targeting strategy? *Research in Economics*, 76(3), 149 - 162. <https://doi.org/10.1016/j.rie.2022.07.006>

[18] Národná banka Slovenska (2022). Vojna a dopady na ekonomiku. Retrieved October 1, 2022, from <https://nbs.sk/vojna-a-dopady-na-ekonomiku/>

[19] Saâdaoui, F., Jabeur, S. B. & Goodell, J.W. (2022). Causality of geopolitical risk on food prices: Considering the Russo–Ukrainian conflict. *Finance Research Letters*, 49, 1 - 10. <https://doi.org/10.1016/j.frl.2022.103103>

[20] Slovenská poľnohospodárska a potravinárska komora (2022). Dopady vojny na slovenské agropotravinárstvo. Retrieved October 3, 2022, from <https://www.sppk.sk/clanok/4332>

[21] Štatistický úrad SR (2022). Inflation increased to 14% in August, rising continuously for the nineteenth consecutive month. *Inflation – consumer price indices in August 2022*. Retrieved September 24, 2022, from <https://slovak.statistics.sk/wps/portal/ext/products/informationmessages/inf_sprava_detail/ad8b916a-0872-4123-8de4-eb4a06486448/!ut/p/z1/tVLLkpswEPwaH0EDEiByAxIDG7wPWGyjSwps1hCbx4IC67-PSHxIUlnsHDIXSVXdM63pRgxtEavToTykvGzq9CTeCdO_PBk-tW3FArADDP7d5-jec5aqG2to8wPguJZHjACABq4GvuXFofmEMVgYsV_5VDMA_PsoBlhH8EzIhQ_vlAW38WcA7Bb96-DxJ-Ahii3BD33NCWzsBtq1-WvEENvVvOUFSpqsTwupP0pl_SKlR74AcWm6SmxzqHOpb7t0OC9g6HN-FGe6p5mp6KkE1FAloqhYovucSHlGUtAJ1QmhU_t2V-5RchN6c80vNr_tzTRv5sdA5gERwAWwjB5VyySu8zF8WIL_7Kg0CnQVQLkA5jJzTeYfGlwvpkKDDa5rBgo4BrpDrMwqedxVMsjYNDRQNRCHaegKNaZYW3WG6QGxLn_Ju7yTv3Ui7QXnbf9hAQsYx1E-NM3hlMu7plrA3yhF03O0_R2JEuGA8a4DioE2Q5mPKK6nXJxQ9I8GezD9bd5jIbX8-vrKLJHMpub5m1D5P6Ip5qjdylmJlbQpL6bWDdreRG2rWFRF8Vk6hp9CesanoXIyuuJa8h2U10OE/dz/d5/L2dBISEvZ0FBIS9nQSEh/>

[22] Yu, D., Hu, S., Tong, L., Xia, C. & Ran, P. (2022). Dynamics and Determinants of the Grain Yield Gap in Major Grain-Producing Areas: A Case Study in Hunan Province, China. *Foods*, 11(8). <https://doi.org/10.3390/foods11081122>

Consumer acceptability of insect flour as an ingredient in bakery products

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Abstract

Nowadays, the bakery market is affected by the current economic situation, the lack of cereals, the economic difficulty of growing crops and the global food crisis. In the recent period, there have been changes in consumer preferences for bakery products consumption, as well as changes in consumer lifestyles related to food consumption regarding the health, sustainability, and environmental protection. In the following years the bakery industry can be significantly affected by the production of fresh and durable bakery products from insect flour, the production of which is efficient, economically advantageous, and in addition, the consumption of insect flour, which is rich in nutritional components, positively affects consumers' health. The aim of the paper is to point out the acceptability of insect flour and bakery products made from insects by Slovak consumers, as well as to identify key motives and barriers to insect flour bakery products consumption. The aim of the paper was achieved by conducting a consumer survey, which was carried out in 2021 and 2022 in Slovakia (n=733 respondents). The collected data were evaluated and processed using mathematical and statistical methods. The research results showed that up to 70% of Slovak consumers are unaware of the existence of insect flour bakery products. On the other hand, 2.6% of Slovak consumers consumed insect flour bakery products. Furthermore, approximately 30% of consumers consider insect flour to be a suitable or acceptable substitute for classic flour, and 25% of Slovak consumers perceive insect flour as a possible alternative to classic flour in the future or as a long-term solution of bakery industry sustainability and drought problems. A positive finding was that 5.5% of consumers can imagine consuming insect flour bakery products in the future, and 37% of consumers would at least try these innovative foods. The main reasons for consuming are the health aspect, taste, and environment protection. The results further showed that more than half of Slovak consumers cannot imagine consuming insect flour bakery products in the future, and key barriers are habit of classic flour, fear of loss of appetite, or lack of information. The important motives for insect flour bakery products consumption are the taste and appearance similarity to bakery products made from classic flour and higher consumer awareness of insect bakery products consumption. Based on the results of the consumer study and the situation on the food market, it is desirable that Slovak consumers gradually become familiar with and informed about alternative eating and accept the possibility of consuming insect flour bakery products. The consumer study maps the current situation of consumer perception of insect flour bakery products in Slovakia and thus fills a research gap, because this issue has not yet been examined in Slovakia. Results

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of this study can be a suitable basis not only for the scientific and research sphere, but also for bakery businesses and experts in the field of public health and food legislation.

Keywords: *consumer, bakery products, consumer acceptability, consumer perception, insect flour*

JEL Classification: *Q13, M31, M39*

1. Introduction

Nowadays, the bakery market reflects the changes in the economic, social and legal institutions countries (Kostyuchenko, Kosovan, Shaposhnikov & Martirosyan, 2019. Bread and other bakery products are consumed throughout the world due to they are one of staple foods (Mafu, Ketnawa, Phongthai, Schönlechner & Rawdkuen, 2022). However, the current market for bakery products is significantly influenced by consumers' interest in healthy eating, pleasure and convenience in connection with their changing lifestyles, as well as aspects related to sustainability and environmental perspectives (Martínez-Monzó, García-Segovia & Albors-Garrigos, 2013; Strid, Hallström, Sonesson, Sjons, Winkvist & Bianchi, 2021). In connection with the new trends affecting the bakery products market, Mitelut, Popa, Popescu, and Popa (2021) emphasize that it is necessary to produce new innovative bakery products using various functional ingredients that will satisfy consumer demand for healthy foods. In this context, the enrichment of bakery products with other plant components with high nutritional value is becoming relevant (Martinez & Gomez, 2019). Nowadays, increasing consumer demands for health and sustainability can be fulfilled by legume flour as an ingredient in bakery products (Bresciani & Marti, 2019) or the use of oilseeds (flaxseed, chia, sunflower, pumpkin, sesame and poppyseed) in breads and other bakery products (De Lamo & Goméz, 2018). The enrichment of bakery products with defatted sunflower seed flour (Graso et al., 2019) and flaxseed flour (Codină, Istrate, Gontariu & Mironeasa, 2019) are other options to meet market requirements. In many studies, insect flour is mentioned as an ingredient for enriching wheat bread, and it is possible to use various edible flours, e.g.. mealworm, buffalo worm, cricket (Kowalski, Mikulec, Mickowska, Skotnicka & Mazurek, 2022; González, Garzón & Rosell, 2019).

Production of edible insect and insect flour is efficient, economical, eco-friendly, sustainable (Yazici & Ozer, 2021; Huis, Itterbeeck & Klunder, 2013). In addition, the consumption of insect flour is very healthy because this flour is rich in nutritional components, mainly proteins and is also good source of fatty acids. Insect flour improves the biological value of bread due to its high protein properties (Patel, Suleria & Rauf, 2019; Zielińska, Pankiewicz & Sujka, 2021; Papastavropoulou, Koupa, Kritikou, Kostakis & Proestos, 2021). The results of the study conducted by Kowalski et al. (2022) indicated the possibility of using insect flour for bread production, because the enrichment of bakery products with insect flour contributes more to the health of consumers compared to the wheat alternative. For this reason, it is possible to assume that in the following years the bakery industry can be significantly affected by the production of bakery products from insect flour.

In order to expand the use of insect flour as an ingredient in bakery products, consumer acceptability of edible insect is necessary. Key motivating factors for the consumption of insect-based food products are health considerations, high nutritional values, strong sustainability awareness, or information related to origin, production and safety (Wendin & Nyberg, 2021; Legendre, Jo, Han, Kim, Ryu, Jang & Kim, 2019; Palmieri, Perito, Macrì & Lupi, 2019; Barton, Richardson & McSweeney, 2020). On the other hand, studies conducted by Lammers, Ullmann and Fiebelkorn (2019); Sogari, Bogueva, and Marinova (2019), as well as Chang and Chen (2019) found that environmental and nutritional benefits would probably not have a positive effect on the consumption of insect-based products. In connection with the above, it is important to emphasize important psychological factors that influence consumer

acceptability of insect consumption (Wendin & Nyberg, 2021). Neophobia and disgust are considered as the two main psychological factors for the rejection of insects as food or as ingredient in food products (De Carvalho, Madureira & Pintado, 2019). Other factors determining the acceptability of insects as food are sensory attributes, especially the appearance of products containing insects, social and cultural norms and peer influence or increased awareness and knowledge about insects as food. The mentioned aspects should eliminate barriers related to fear of consumption and disgust (Wendin & Nyberg, 2021).

In the context of the mentioned the aim of the paper is to point out the acceptability of insect flour and bakery products made from insects by Slovak consumers and also to identify key motives and barriers to insect flour bakery products consumption. Therefore, research paper tries to answer the following research questions:

1. Is acceptable insect flour as ingredient in bakery products?

2. What are the key reasons for consumption and non-consumption of insect flour bakery products?

3. What are the key motives for consumer acceptability of insect flour as ingredient of bakery products and their consumption?

2. Data and Methods

A questionnaire survey was conducted to identify consumer acceptance of insect flour as a new ingredient in bakery products with an emphasis on its use as a future substitute for wheat flour, possible future consumption of these bakery products, as well as the key reasons for consumption and non-consumption of bakery products made from insect flour. The consumer survey was carried out using the snowball method on a sample of 733 respondents. The survey was conducted in 2021 and 2022 in the Slovak Republic. Consumers involved in the questionnaire survey were divided according to eight socio-demographic criteria (gender, age, number of members in the household, place of residence, education, economic status, monthly income of the respondent, monthly income of the household) (Table 1).

Table 1: Socio-demographic profile of the sample

Gender			**Residence**		
Male	260	35.5%	City	348	47.5%
Female	473	64.5%	Rural area	385	52.5%
Age			**Education**		
18-25 years	353	48.2%	Elementary education	28	3.8%
26-45 years	230	31.4%	Secondary education	317	43.2%
More than 45 years	150	20.5%	Higher education	388	52.9%
Number of members in household			**Economic activity**		
1 member	25	3.4%	Employed	312	42.6%
2 members	154	21.0%	Student	303	41.3%
3 members	205	28.0%	Self-employed	47	6.4%
4 members	257	35.1%	Unemployed	14	1.9%
5 members	65	8.9%	Retired	23	3.1%
6 members	21	2.9%	Maternity leave	23	3.1%
More than 6 members	6	0.8%	Other	11	1.5%
Monthly income of respondent			**Monthly income of household**		
Up to 500 €	313	42.7%	Up to 1,000 €	83	11.3%
501-1,000 €	242	33.0%	1,001-2,000 €	366	49.9%
1,001-1,500 €	133	18.1%	2,001-3,000 €	194	26.5%
1,501-2,000 €	30	4.1%	3,001-4,000 €	58	7.9%
More than 2,001€	15	2.0%	More than 4,001€	32	4.4%

Source: questionnaire survey

The main part of the questionnaire survey was to examine the key reasons for consumption and non-consumption of bakery products with the addition of insect flour. Consumers who would consume bakery products from insect flour in the future evaluated 6 possible reasons for consumption, namely moral aspect, health aspect, sustainability, environmental protection, taste and lifestyle. These reasons were rated on a Likert scale from 1 to 5, with 1 representing the least important reason for consumption and 5 representing the most important reason for consumption. Consumers involved in the questionnaire survey, who would not consume bakery products containing insect flour in the future, evaluated 7 potential reasons for non-consumption, namely habit of bakery products made from wheat flour, fear of loss of appetite, lack of information about insect bakery products, distrust of the new alternative diet, higher price, production process of insect flour and its products, absence of recipes for meals made from insect flour. These reasons were evaluated on a 5-point Likert scale, with 1 representing the least important reason for non-consumption and 5 representing the most important reason for non-consumption. In the research, we investigated differences in the assessment of the reasons for consumption/non-consumption of bakery products containing insect flour using the Friedman test and consequent post hoc pairwise multiple comparison test according to Nemenyi.

In addition to the aforementioned, the aim of the survey was to find out the main motives for the consumption of bakery products containing insect flour. Respondents evaluated 7 different motivational factors to consume these bakery products, namely taste as wheat flour, appearance as wheat flour, aroma as wheat flour, color as wheat flour, information about health aspect, information about production and information about sustainability and environmental protection. Potential motives were rated on a Likert scale from 1 to 5, with 1 representing the least significant motive and 5 the most significant motive. Based on the applied categorical analysis of the principal components, there were identified 2 latent components related to the identification of key motives for the future consumption of insect flour as a new ingredient in bakery products.

The data obtained by the questionnaire survey were evaluated using Microsoft Excel and statistically evaluated in the XLSTAT and IBMSPSS programs.

3. Results and Discussion

The results of the consumer survey showed that about 70 % of Slovak consumers have not heard about insect flour as novel ingredient in bakery products. Positive finding was that more than 25 % consumers ever heard about this flour as possible ingredient and even 2.6 % Slovaks consumed insect flour as ingredient in bakery products.

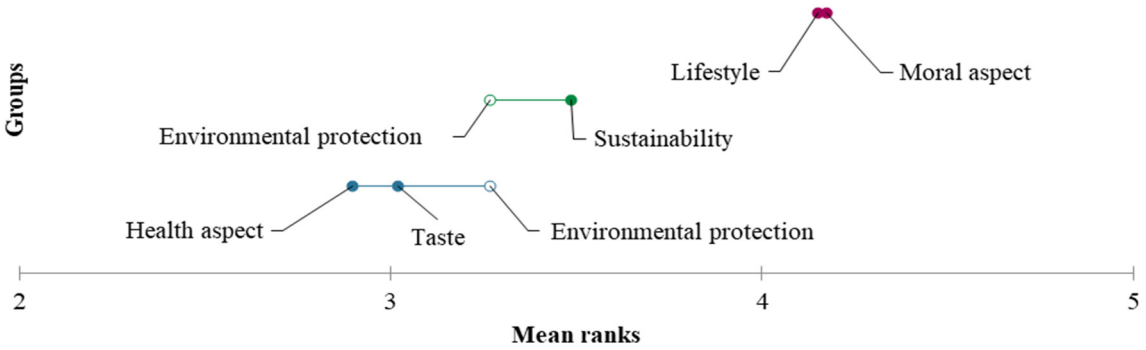
As already mentioned, that insect flour could by a real alternative to wheat flour in the future, the consumer survey was oriented on the consumer acceptability of insect flour as replacement of wheat flour. The results showed that 30 % Slovak consumers accept insect flour and think that this flour is very appropriate due to its properties. We also identified that 25 % perceive insect flour as a necessary ingredient in the bakery industry in the future considering health and sustainable aspects. On the other hand, 45 % of Slovak consumer do not accept insect flour as a novel ingredient.

Consumer research has also focused on possible consumption of insect flour as ingredient in bakery products. We found that 5.5 % consumers will consume insect flour and more than 35 % of Slovaks would try bakery products with insect flour. On the other hand, almost 60 % of Slovak consumer would not try and consume insect flour as ingredient in bakery products.

In the context of the possible consumption, we also identified key reasons for consumption and non-consumption of insect flour. Consumers who would consume bakery products containing insect flour rated possible reasons for consumption on a scale from 1 to 5, with 1 being the most important aspect

and 5 being the least important aspect. The results showed that bakery products with insect flour should be consumed due to health aspects, taste, environmental protection, sustainability, lifestyle, and moral aspect. Moreover, we also identified differences in evaluation of reasons using the applied Friedman test (p-value = <0.001). Subsequently, Nemenyi's method and Demsar plot pointed out the differences between evaluating reasons of insect flour consumption (Figure 1).

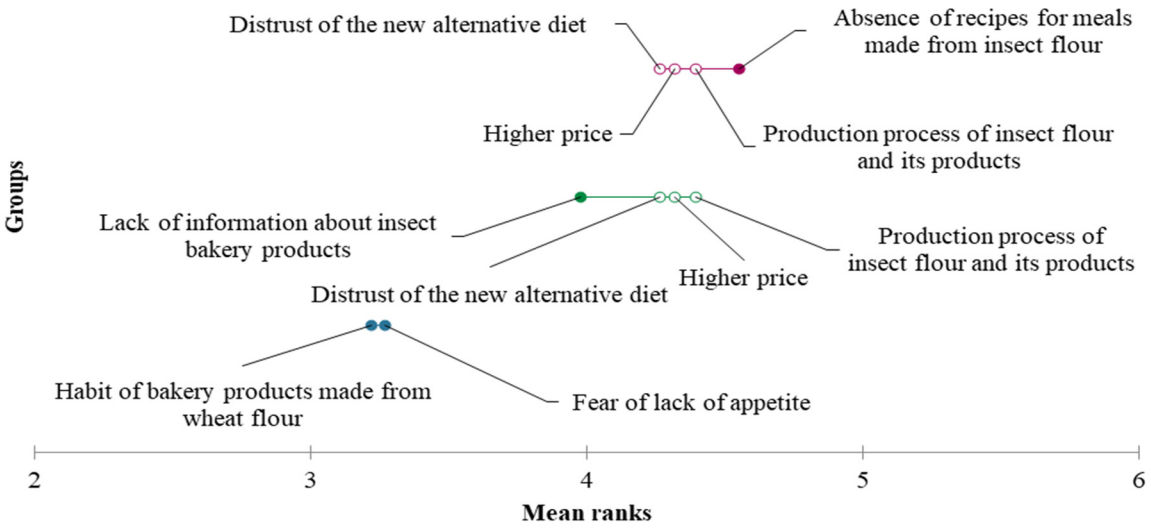
Figure 1: Reasons for consumption of bakery products from insect flour



Source: questionnaire survey

However, consumers who would not consume bakery products containing insect flour rated reasons for non-consumption on a scale from 1 to 5, with 1 being the most important aspect and 5 being the least important aspect. The results showed that there are some barriers for insect flour consumption and the key ones are habit for bakery products made from wheat flour, fear of loss of appetite, lack of information about insect flour, distrust in the new alternative diet, higher price, production process of insect flour and its bakery products, absence of recipes for meals made from insect flour. Differences in the evaluation of the reasons for non-consumption were confirmed by applying the Friedman test (p-value = <0.001). Consequent post hoc pairwise multiple comparison test according to Nemenyi pointed out the differences between evaluating reasons for non-consumption of bakery products from insect flour. These differences are shown by Demsar plot (Figure 2).

Figure 2: Reasons for non-consumption of bakery products from insect flour



Source: questionnaire survey

For the future acceptance of insect flour as an ingredient in bakery products, it is necessary to motivate consumers to consume it or at least to try it. Slovak consumers evaluate 7 possible motives for consumption. Based on the results it could be stated that key motives are taste and higher consumer awareness related to health effect and production. For a deeper analysis of the factors determining insect flour acceptability and consumption we used categorical principal component analysis and identified hidden relationships between the examined factors. We state the existence of two latent components namely "like a wheat flour" and "information". The first component includes taste, appearance, aroma, colour, and second one includes information about health aspect, production and sustainability and environmental protection (Table 2).

Table 2: Motives for consumption of bakery products from insect flour

	1.Component	*2.Component*
Appearance as wheat flour	**0,872**	0,408
Colour as wheat flour	**0,888**	0,390
Aroma as wheat flour	**0,838**	0,467
Taste as wheat flour	**0,711**	0,600
Information about health aspect of edible insect flour	0,452	**0,845**
Information about production of edible insect flour	0,412	**0,872**
Information about sustainability and environmental protection	0,390	**0,867**

Source: questionnaire survey

The results of a consumer study conducted in Slovakia showed that the consumption of insects as an ingredient in bakery products is not acceptable for Slovak consumers, as they do not know this innovative ingredient and its benefits. The results further showed that the majority of Slovak consumers would not consume insect flour, mainly due to lack of appetite and lack of information. On the other hand, consumers who would consume insect flour determined health, environmental aspect and taste as key reasons. The key motives for the acceptance of insects as food and their use in bakery products are mainly the similarity with wheat flour and increasing consumer awareness. Other consumer studies conducted in different countries also point to similar results. Burt, Kotao, Lopez, Koeppel, Goldstein, Samuel and Stopler (2019) found that it is acceptable for consumers to consume insects within food products where they are not directly visible and would provide high nutritional properties with good taste. Bogusz, Polak and Nowacka (2020) conducted consumer survey oriented to issues related to consumption of edible insects and products made with some insect-based ingredient, willingness and intention to consume them in the future, benefits, and risks of their consumption and its results showed that almost 70% of respondents are willing to consume products containing insects as one of the ingredients in the future, and approximately 80% of consumers would consume food products containing only insect protein. In this context, Mancini, Sogari, Menozzi, Nuvoloni, Torracca, Moruzzo, and Paci (2019) points to the fact that recently there has been a growing tendency to consume insects added in the form of powder or flour to many widely popular food products, especially bakery products and pasta. Bogusz et al. (2020) further identified that insufficient consumer awareness is one of the key reasons for consumers' lack of interest in consuming edible insects and foods containing edible insects. Increasing consumer awareness of environmental and nutritional benefits contribute to acceptance of consuming edible insects and insect-based food in the future (Sogari et al., 2019; Mancini et al., 2019). Due to the nutritional composition of edible insects and the environmental benefits, it is possible that insects will become the food of the future or a new food, and 60% of consumers involved in the study conducted by Bogusz et al. (2020) agree with this statement. However, the taste of bakery products containing insect flour will be an important motivating factor ,Awobusuyi, Pillay & Siwela 2020).

4. Conclusion

To conclude insect flour as a novel ingredient can affect the bakery industry in the future. Adding insect flour into bakery products brings many benefits. The production of insect flour is efficient, sustainable, and economic. Moreover, the consumption of insect flour positively affects consumers' health because is rich in nutritional components. However, the insect flour in our conditions do not have any tradition and consumers have the fear from consumption. Therefore, we conducted questionnaire survey related to consumer awareness of insect flour and we found that almost 3 % Slovaks have ever consumed edible insect flour, but more than 70 % of Slovak consumers have never heard about insect flour. The following finding was that for 30 % of Slovak consumers is insect flour acceptable and 25 % consumers perceive it as potential alternative ingredient in the future. More than 40 % of Slovak consumers would try insect flour bakery products due to aspects of health and sustainability. Almost 60 % of Slovak consumers will not consume insect flour bakery products and the key reasons are habit for bakery products made from wheat flour, fear of loss of appetite, or lack of information. Key motives for Slovak consumers are motive “like a wheat flour” and the second is motive of information. Based on the results of the consumer study and the situation on the food market, it is desirable that Slovak consumers gradually become familiar with and informed about alternative eating and accept the possibility of consuming insect flour bakery products. We also suggest eliminating barriers for insect flour bakery products consumption and also to appeal to food enterprises and initiate them to develop and produce bakery products with insect flour. In the future research it is necessary to monitor the developing situation on the market of insect flour bakery product, to monitor the developing situation on the market of insect flour bakery product, to examine current trends in insect flour consumption in other countries and also to monitor current legislative situation in the field of production and consumption of edible insects in the EU countries.

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References

[1] Awobusuyi, T. D., Pillay, K., & Siwela, M. (2020). Consumer acceptance of biscuits supplemented with a sorghum–insect meal. *Nutrients, 12*(4), 895. doi:10.3390/nu12040895

[2] Barton, A., Richardson, C. D., & McSweeney, M. B. (2020). Consumer attitudes toward entomophagy before and after evaluating cricket (*acheta domesticus*)-based protein powders. *Journal of Food Science, 85*(3), 781-788. doi:10.1111/1750-3841.15043

[3] Burt, K. G., Kotao, T., Lopez, I., Koeppel, J., Goldstein, A., Samuel, L., & Stopler, M. (2019). Acceptance of using cricket flour as a low carbohydrate, high protein, sustainable substitute for all-purpose flour in muffins. *Journal of Culinary Science & Technology, 18*(3), 201-213. doi:10.1080/15428052.2018.1563934

[4] Chang, H., Ma, C., & Chen, H. (2019). Climate change and consumer’s attitude toward Insect Food. *International Journal of Environmental Research and Public Health, 16*(9), 1606. doi:10.3390/ijerph16091606

[5] Codină, G. G., Istrate, A. M., Gontariu, I., & Mironeasa, S. (2019). Rheological properties of wheat–flaxseed composite flours assessed by Mixolab and their relation to quality features. *Foods, 8*(8), 333. doi:10.3390/foods8080333

[6] De Carvalho, N. M., Madureira, A. R., & Pintado, M. E. (2019). The potential of insects as food sources – a review. *Critical Reviews in Food Science and Nutrition, 60*(21), 3642-3652. doi:10.1080/10408398.2019.1703170

[7] De Lamo, B., & Gómez, M. (2018). Bread enrichment with oilseeds. A Review. *Foods, 7*(11), 191. doi:10.3390/foods7110191

[8] González, C. M., Garzón, R., & Rosell, C. M. (2019). Insects as ingredients for bakery goods. A comparison study of H. Illucens, A. Domestica and T. Molitor flours. *Innovative Food Science & Emerging Technologies, 51*, 205-210. doi:10.1016/j.ifset.2018.03.021

[9] Grasso, S., Omoarukhe, E., Wen, X., Papoutsis, K., & Methven, L. (2019). The use of upcycled defatted sunflower seed flour as a functional ingredient in biscuits. *Foods, 8*(8), 305. doi:10.3390/foods8080305

[10] Huis, A. V., Itterbeeck, V. J., & Klunder, H. (2013). *Edible insects: Future prospects for food and feed security*. Rome, Italy: Food and Agriculture Organization of the United Nations.

[11] Kostyuchenko, M., Kosovan, A., Shaposhnikov, I., & Martirosyan, V. (2019). The bakery products market in the Globalization Economy Conditions: Institutional changes and trends in the development of consumer behavior and competitive strategies. *Proceedings of the 2nd International Scientific Conference on New Industrialization: Global, National, Regional Dimension (SICNI 2018)*. doi:10.2991/sicni-18.2019.101

[12] Kowalski, S., Mikulec, A., Mickowska, B., Skotnicka, M., & Mazurek, A. (2022). Wheat bread supplementation with various edible insect flours. influence of chemical composition on nutritional and technological aspects. *LWT, 159*, 113220. doi:10.1016/j.lwt.2022.113220

[13] Lammers, P., Ullmann, L. M., & Fiebelkorn, F. (2019). Acceptance of insects as food in Germany: Is it about sensation seeking, sustainability consciousness, or food disgust? *Food Quality and Preference, 77*, 78-88. doi:10.1016/j.foodqual.2019.05.010

[14] Legendre, T. S., Jo, Y. H., Han, Y. S., Kim, Y. W., Ryu, J. P., Jang, S. J., & Kim, J. (2019). The impact of consumer familiarity on edible insect food product purchase and expected liking: The role of media trust and purchase activism. *Entomological Research, 49*(4), 158-164. doi:10.1111/1748-5967.12342

[15] Mafu, A., Ketnawa, S., Phongthai, S., Schönlechner, R., & Rawdkuen, S. (2022). Whole wheat bread enriched with cricket powder as an alternative protein. *Foods, 11*(14), 2142. doi:10.3390/foods11142142

[16] Mancini, S., Sogari, G., Menozzi, D., Nuvoloni, R., Torracca, B., Moruzzo, R., & Paci, G. (2019). Factors predicting the intention of eating an insect-based product. *Foods, 8*(7), 270. doi:10.3390/foods8070270

[17] Martinez, M. M., & Gomez, M. (2019). Current trends in the realm of baking: When indulgent Consumers Demand Healthy Sustainable Foods. *Foods, 8*(10), 518. doi:10.3390/foods8100518

[18] Martínez-Monzó, J., García-Segovia, P., & Albors-Garrigos, J. (2013). Trends and innovations in bread, bakery, and pastry. *Journal of Culinary Science & Technology, 11*(1), 56-65. doi:10.1080/15428052.2012.728980

[19] Mitelut, A. C., Popa, E. E., Popescu, P. A., & Popa, M. E. (2021). Trends of innovation in bread and bakery production. *Trends in Wheat and Bread Making,* 199-226. doi:10.1016/b978-0-12-821048-2.00007-6

[20] Palmieri, N., Perito, M. A., Macrì, M. C., & Lupi, C. (2019). Exploring consumers' willingness to eat insects in Italy. *British Food Journal, 121*(11), 2937-2950. doi:10.1108/bfj-03-2019-0170

[21] Papastavropoulou, K., Koupa, A., Kritikou, E., Kostakis, M., & Proestos, C. (2021). Edible insects: Benefits and potential risk for consumers and the Food Industry. *Biointerface Research in Applied Chemistry, 12*(4), 5131-5149. doi:10.33263/briac124.51315149

[22] Patel, S., Suleria, H. A., & Rauf, A. (2019). Edible insects as innovative foods: Nutritional and functional assessments. *Trends in Food Science & Technology, 86*, 352-359. doi:10.1016/j.tifs.2019.02.033

[23] Sogari, G., Bogueva, D., & Marinova, D. (2019). Australian consumers' response to insects as food. *Agriculture, 9*(5), 108. doi:10.3390/agriculture9050108

[24] Strid, A., Hallström, E., Sonesson, U., Sjons, J., Winkvist, A., & Bianchi, M. (2021). Sustainability Indicators for foods benefiting climate and health. *Sustainability, 13*(7), 3621. doi:10.3390/su13073621

[25] Wendin, K. M., & Nyberg, M. E. (2021). Factors influencing consumer perception and acceptability of insect-based foods. *Current Opinion in Food Science, 40*, 67-71. doi:10.1016/j.cofs.2021.01.007

[26] Yazici, G. N., & Ozer, M. S. (2021). Using edible insects in the production of cookies, Biscuits, and crackers: A Review. *The 2nd International Electronic Conference on Foods - "Future Foods and Food Technologies for a Sustainable World"*. doi:10.3390/foods2021-10974

[27] Zielińska, E., Pankiewicz, U., & Sujka, M. (2021). Nutritional, physiochemical, and biological value of muffins enriched with edible insects flour. *Antioxidants, 10*(7), 1122. doi:10.3390/antiox10071122

Food consumption in Ukraine: challenges and changes

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Abstract

The paper considers peculiarities of food consumption in Ukraine. Particular attention is devoted to assessing the impact of war with Russia on consumption of foodstuffs by the Ukrainian population. Data for 2004-2020 are employed in the paper, using the publications and website of State Statistics Service of Ukraine. The following indicators are chosen for this research: gross domestic product, income of the population, total money expenditure per household, money expenditure on food products per household, and consumption of food products per capita. Given the war situation in Ukraine, two periods are explored separately: the pre-war period (2004-2013) and the war period (2014-2020). The aims of our paper are as follows: 1) to examine specific features of food consumption in Ukraine, taking into account the war conflict in the country; 2) to estimate the impact of the chosen indicators (GDP and income of the population) on consumption of food products by Ukrainian inhabitants. The following statistical methods are applied in our research study: descriptive statistics and Pearson correlation coefficient. We analyze the dynamics of changes in GDP, income of the population, and money expenditure on food products. The obtained results show that the war with Russia led to a significant decline of these indicators. It is also found that there was a reduction in consumption of the majority of foodstuffs. As a result, during the war period, the actual rate of food consumption was substantially below the recommended norms, with the exception of few food products. Using the Pearson correlation coefficient, the levels of correlation between the chosen indicators (GDP and income of population) and consumption of foodstuffs are identified. Conclusions are made about changes occurred in food consumption in the pre-war and war periods in the country.

Keywords: *economic challenges, food consumption, Ukraine*

JEL Classification: *E21, F51, O10*

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1. Introduction

Since 2014, unprecedented Russian aggression has seen against Ukraine. Russia has started a war in Ukraine and occupied the Crimean peninsula and territories in the east and south of Ukraine in violation of all norms of international law. This war has a significant negative effect on the Ukrainian economy and the income level of the country's population. This situation is also exacerbated by the impact of the COVID-19 pandemic. Under these conditions it is necessary to ensure the stable functioning of the country's agri-food sector, which is important both for Ukraine and globally.

It should be noted that there are some studies, in which various aspects of food consumption and food security are considered in Ukraine and other countries, taking into account the mentioned war conflict. OECD (2022) analyses the influence of the Russia's war in Ukraine on international agricultural market. It is revealed that, as a result of this war, the substantial increase of food prices could be observed, which will have an unfavorable impact on global food security. Employing the MAGNET model, van Meijl et al. (2022) determine that the war in Ukraine can deteriorate food security worldwide in the medium-term period. This could be particularly related to low-income countries which are highly dependent on cereal imports from Ukraine. Also, the war can have a negative impact on poor people because of the growth of food prices. Hellegers (2022) evaluates consequences of Russia's invasion to Ukraine on the vulnerability of the global economy. Using the indicators of dependency and coping capacity, it is identified that the most significant unfavorable effects could be observed in the Middle-East and North Africa (MENA) region, as well as Sub-Saharan countries. To enhance the food security in vulnerable regions, the socio-economic aspects of the agricultural sector and open trade ought to be reconsidered. Similar results are obtained by Abay et al. (2022). They argue that the MENA region is expected to be in an especially vulnerable situation and to have trade and price shocks. This can happen due to the high food import dependence of the region.

According to the preliminary estimations by FAO (2022), as a result of the war, considerable damage was caused to the Ukrainian agricultural sector and related infrastructure. Household incomes decreased to a substantial extent, and the significant share of population can face higher levels of food insecurity and food consumption gap, especially in regions with active fighting. Mostenska et al. (2022) consider economic affordability of food for the Ukrainian population. Using the regression analysis, the close link between the indicators of food expenditures and the GDP level is determined. Based on correlation coefficients, the relationships between the consumption of foodstuffs and the level of per capita income are found. Kotykova et al. (2020) investigate peculiarities of food security in different types of Ukrainian households, paying attention to economic affordability and consumption level of food products. Using the obtained results, the most vulnerable groups of households are identified in terms of food security. Also, it is confirmed that economic affordability affects substantially the level and pattern of food consumption.

Vasylieva (2019) explores possibilities for the improvement of food security in Ukraine, with the aim to ensure the health and income levels of the country's inhabitants. The researcher elaborates aggregate evaluation of regional food consumption, which provides a possibility to enhance Ukraine's agricultural production and support its sustainable development. Seheda et al. (2019) assess the interaction between consumption of foodstuffs and chosen demographic indicators in Ukraine. Applying the Pearson´s correlation coefficient and linear regression, it is found that the worsening of food consumption leads to the deterioration of the country's demographic situation. The reverse impact between the demographic indicators and consumption of food products is also revealed.

At the same time, there is a lack of publications, in which peculiarities of food consumption of the Ukrainian population are compared in the pre-war and war periods. That is why we decided to prepare this publication. The aims of our paper are as follows:

- to examine specific features of food consumption in Ukraine, taking into account the war conflict in the country
- to estimate the impact of the chosen indicators (GDP and income of the population) on consumption of food products in the pre-war and war periods.

2. Data and Methods

Data for 2004-2020 were employed in the paper, based on the publications and website of State Statistics Service of Ukraine (www.ukrstat.gov.ua). Given the war situation in Ukraine, two periods were explored separately:

- the pre-war period: 2004-2013
- the war period: 2014-2020.

The following indicators were chosen for this research:

- gross domestic product (bln. US dollars)
- income of the population (bln. US dollars)
- total money expenditure per household (US dollars)
- money expenditure on food products per household (US dollars)
- consumption of food products per capita (kg, pieces).

Using the data on the resident population, gross domestic product (GDP) and income of the population were calculated per capita. For a better interpretation of the data, the respective indicators were recalculated from Ukrainian hryvnias (UAH) to US dollars (USD), employing information of the National Bank of Ukraine on the annual average official exchange rate between UAH and USD (www.bank.gov.ua).

The following statistical methods were applied in our research study:

- Descriptive statistics: it was used to characterize analyzed set of variables
- Pearson correlation coefficient: it was employed to investigate relationship between the chosen economic indicators and consumption of different food products.

The form of the Pearson´s correlation coefficient used in this paper can be calculated using the following equation:

$$\rho_{xy} = \frac{cov(X,Y)}{\sigma_X \sigma_Y} \quad (1)$$

where: cov(x,y) is the covariance between x and y

σ_X is the standard deviation of the variable X

σ_Y is the standard deviation of the variable Y.

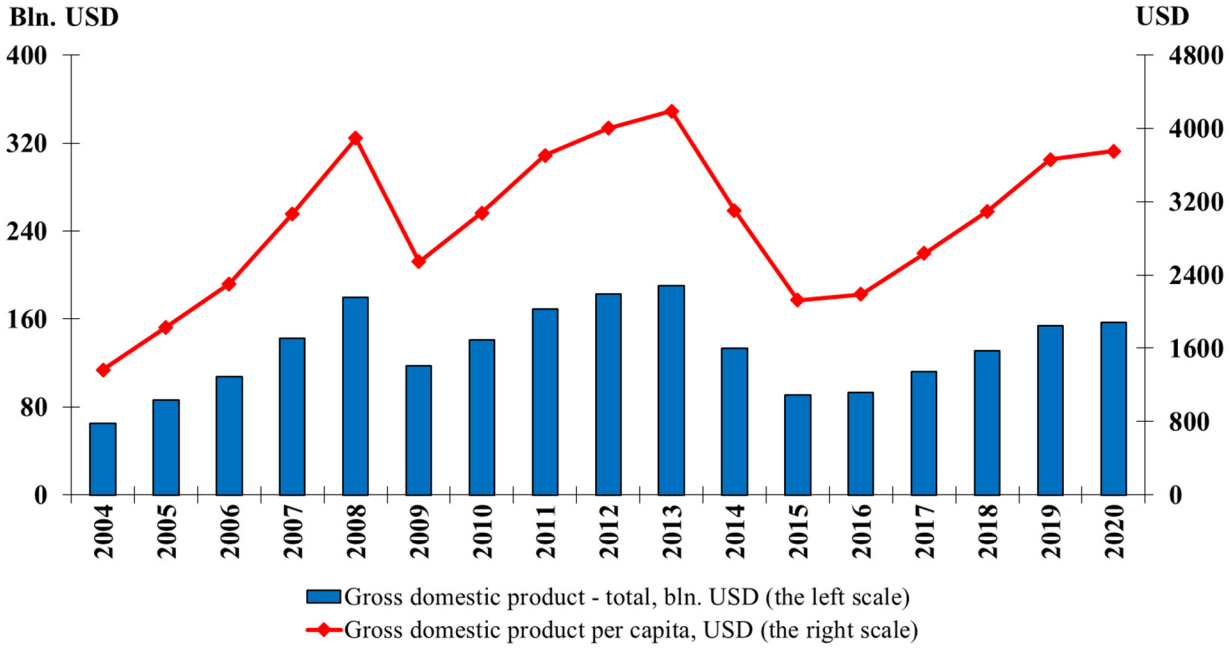
The correlation coefficient value close to 0 means weak or no relationship between variables. The value close to 1 means strong positive relationship – if the first variable increases, the second variable

grows too. The value close to -1 means strong negative relationship – if the first variable rises, the second one decreases. Correlation analysis is used to determine only the character of relationship between a pair of variables, but not to identify which the variable is the cause, and which one is the consequence.

3. Results and Discussion

The dynamics of changes of the country's GDP in 2004-2020 is given on Figure 1. It should be mentioned that there were several periods associated with changes in this indicator. During 2004-2008, there was its steady increase: from 64,9 bln. USD to 180,0 bln. USD. In 2009, the sharp reduction of the indicator occurred to 117.2 bln. USD (65.1% of the 2008 level), driven by the global financial crisis. In 2010-2013, there was a gradual recovery of the Ukrainian economy, and, as a result, GDP increased to 190,5 bln. USD. In 2014, due to the war conflict with Russia in the east of Ukraine, as well as the annexation of the Crimean peninsula, the country's economic situation deteriorated significantly. This also affected Ukraine's GDP, which contracted to 133,5 bln. USD (by 29.9% less in comparison with 2013). The decline of GDP has continued until 2016, in which its level was 91,0 bln. USD (by 52.2% less than in 2013). Later, the analyzed indicator slightly increased, and it grew to 156,6 bln. USD in 2020, which was by 17.8% less compared with 2013. GDP per capita was also calculated, and its changes coincided with the above-mentioned tendencies in GDP in total. In 2020, its value was equal to 3752 USD, or by 10.4% less than in 2013.

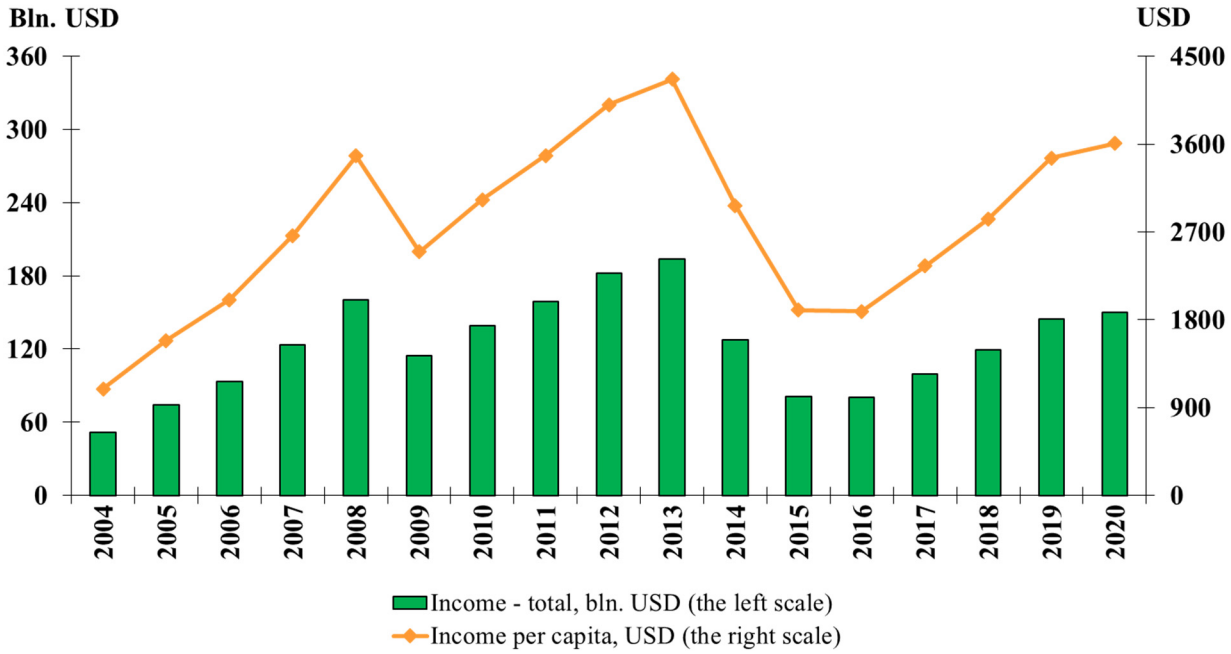
Figure 1: Gross domestic product of Ukraine



Source: authors' calculations based on data of State Statistics Service of Ukraine

Information about the income level of the Ukrainian population in 2004-2020 is presented on Figure 2. It can be seen that this indicator grew from 51,6 bln. USD to 160,5 bln. USD between 2004 and 2008. In 2009, its value decreased to 114,8 bln. USD (by 28,5% less compared with 2008). The population's income went up from 138,8 bln. USD in 2010 to 193,8 bln. USD in 2013 (or by 39,6%).

Figure 2: Income of the Ukrainian population

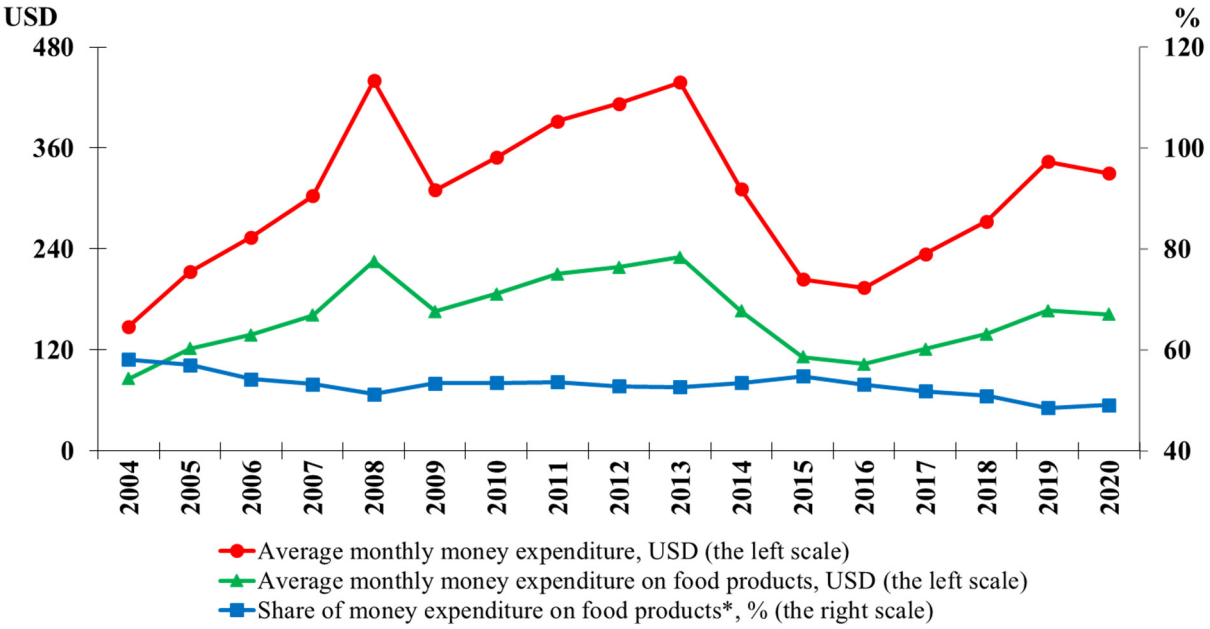


Source: authors' calculations based on data of State Statistics Service of Ukraine

Since the start of war in Ukraine, the income of the country's inhabitants has dropped substantially. For example, its value was 127,6 bln. USD in 2014 (or by 34.2% less than in 2013). This decline has continued until 2016, in which the indicator's value contracted to 80,3 bln. USD (or by 58,6% lower in comparison with 2013). There was a gradual increase of the income value in subsequent years. In 2020, the indicator was equal to 150,4 bln. USD (or 77,5% of its 2013 level). The same changes took place in regards to the calculated income per capita. In 2020, the value of this indicator was 3608 USD (84.6% of its level in 2013).

Similar tendencies took place for average monthly money expenditure and average monthly money expenditure spent on food products (Figure 3). These indicators had maximum values in 2008 and 2013 while their largest decrease occurred in 2009 and 2014-2016. In 2020, their values were 330 USD and 162 USD (75,3% and 70,4% of the 2013 level, correspondingly). These tendencies led to changes in the share of money expenditures on food products. The share went down from 58,1% in 2004 to 52,6% in 2013. While the indicator grew from 53,5% in 2014 to 54,8% in 2015, it reduced again from 53,1% to 49,1% between 2016 and 2020.

Figure 3: Average monthly money expenditure per household



* including eating-out, alcoholic beverages and tobacco

Source: authors' calculations based on data of State Statistics Service of Ukraine

Table 1 presents a comparison of food consumption per capita in the pre-war period (2004-2013) and the war period (2014-2020). The calculated indicators show a significant reduction in consumption of foodstuffs, with the exception of meat and meat products, as well as fruit, berries, nuts and grapes. To the most extent, the level of consumption decreased on potatoes (by 23,8%), fish and fish products (by 22,2%), and sugar (by 18,2%). By the way, this decline in food consumption was seen on products that were traditional for Ukrainian residents and played a significant role in their nutrition.

In order to have a more complete picture, we considered the consumption of animal food products by Ukrainian households, calculated as a percentage of the recommended rate (Figure 4). The general tendency for these products is that their consumption did not meet the minimum nutritional requirements, with the exception of fish and fish products in the pre-war period.

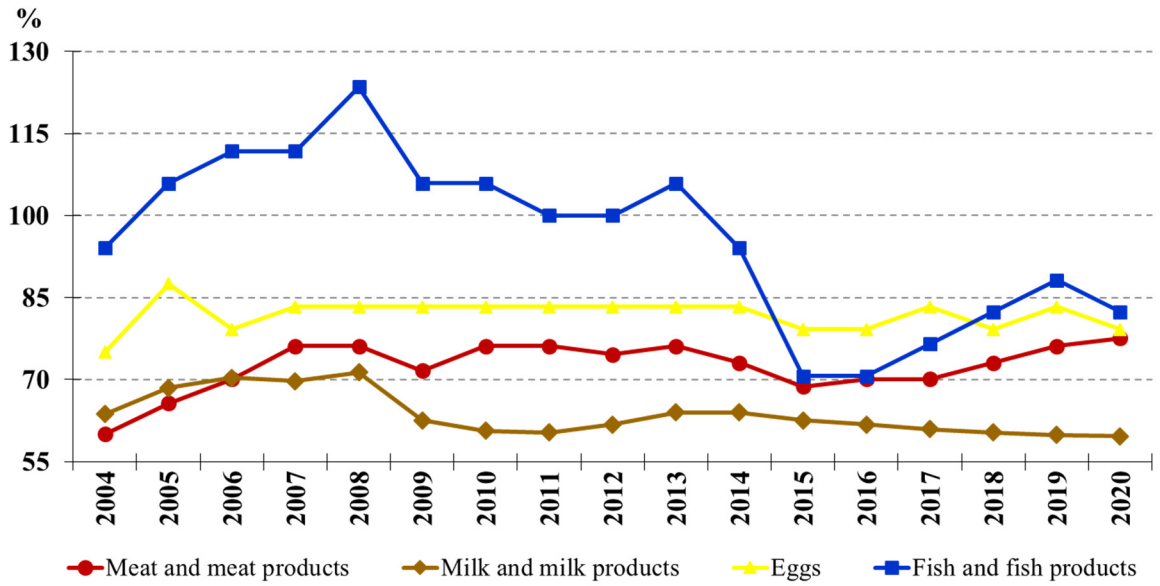
Table 1: Average monthly consumption of food products per capita, kg

	The pre-war period (2004-2013)	The war period (2014-2020)	The war period as % of the pre-war period
Meat and meat products	**4,8**	**4,9**	**102,1**
Milk and milk products	**20,7**	**19,4**	**93,7**
Eggs, pieces	**20**	**19**	**95,0**
Fish and fish products	**1,8**	**1,4**	**77,8**
Sugar	**3,3**	**2,7**	**81,8**
Sunflower-seed oil and other vegetable oils	**1,8**	**1,5**	**83,3**
Potatoes	**8,4**	**6,4**	**76,2**
Vegetables, melons and gourds	**9,4**	**8,8**	**93,6**
Fruit, berries, nuts and grapes	**3,5**	**3,6**	**102,9**
Bread and bakery products	**9,6**	**8,4**	**87,5**

Source: authors' calculations based on data of State Statistics Service of Ukraine

The maximum level of consumption as the percentage of recommended norms in the pre-war period was the following: meat and meat products – 68,7%, milk and milk products – 62,5%, eggs – 79,2%, and fish and fish products – 70,6%. During the war period, there was a slight increase in the consumption of meat and meat products while the opposite situation took place on milk and milk products. Mixed changes were observed on the consumption of eggs and fish and fish products. It can be seen that in 2020, the consumption level on meat and meat products was 77,6%, milk and milk products – 59,6%, eggs – 79,2%, and fish and fish products – 82,4% of the recommended level.

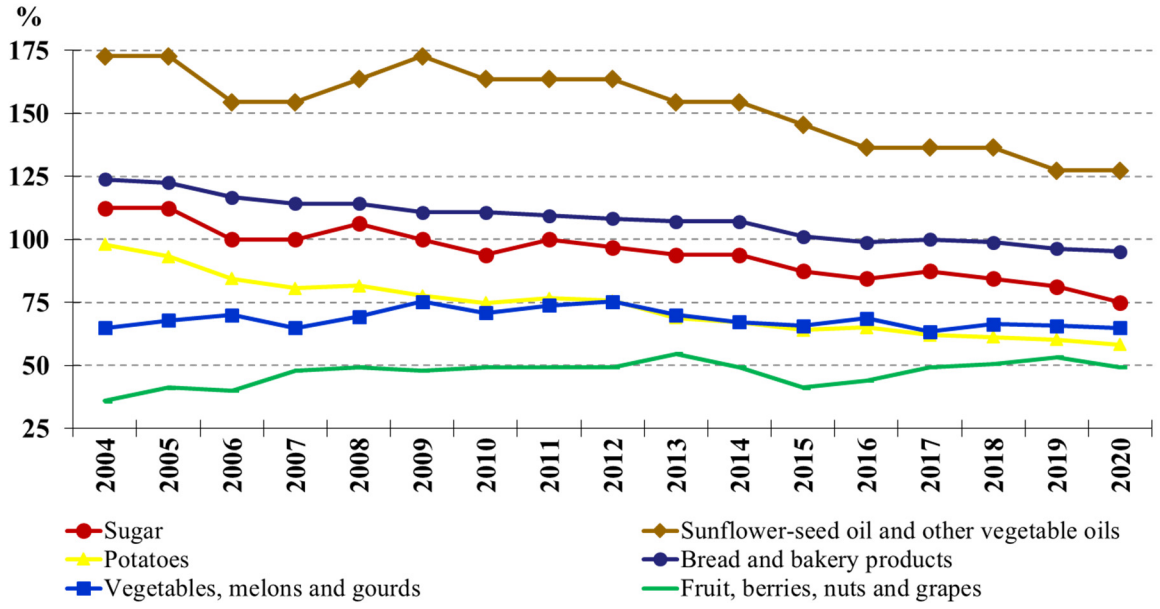
Figure 4: Consumption of animal food products by Ukrainian households (% of the recommended rate)



Source: authors' calculations based on data of State Statistics Service of Ukraine

The calculated results on consumption of plant food products (in the percentage of the recommended level) is given on Figure 5. In the pre-war period, their level on several products exceeded recommended rates, while it had a downward tendency. For instance, the consumption level of sunflower-seed oil and other vegetables oils, bread and bakery products, and sugar fell from 172,7%, 123,8%, and 112,5% in 2004 to 154,5%, 107,1%, and 93,8% in 2013, correspondingly. Besides, its significant decrease was observed on potatoes: from 98,1% to 68,9%. The mixed tendencies occurred on other products, and their consumption was at a low level, namely: fruit, berries, nuts and grapes – 36,0% in 2004 and 54,7% in 2013 and vegetables, melons and gourds – 64,9% in 2004 and 70,1% in 2013.

Figure 5: Consumption of plant food products by Ukrainian households (% of the recommended rate)



Source: authors' calculations based on data of State Statistics Service of Ukraine

The reduction in the consumption rate continued for the majority of plant foodstuffs during the war period. In 2020, while the consumption rate of sunflower-seed oil and other vegetables oils (127,3%) was still above the recommended level, its values for bread and bakery products and sugar were already below this level: 95,2% and 75,0%, respectively. In the same year, the lowest level of consumption was found on fruit, berries, nuts and grapes (49,3%), potatoes (58,3%), and vegetables, melons and gourds (64,9%).

In the pre-war period, the highest consumption increase was determined for foodstuffs that provide healthy and balanced nutrition (fruit, berries, nuts and grapes, meat and meat products, and fish and fish products). Ukrainian households had such opportunity owing to the growth of their income level. The smallest rise was identified for food products, which can harm people's health in case of excessive consumption (potatoes, sugar, and bread and bakery products).

The different situation on food consumption was observed during the war period. Due to the decrease of households' income, mixed changes were determined in its pattern. On the one hand, the largest decline was revealed in consumption of fish and fish products, as well as products consumed significantly by the Ukrainian population in the past (sunflower-seed oil and other vegetable oils and sugar). On the other hand, we found that households reduced their consumption of meat and meat products, vegetables, melons and gourds, and fruit, berries, nuts and grapes to the least extent. We consider the above-mentioned changes as the efforts of households to maintain balanced nutrition in limited income conditions.

In order to determine the impact of GDP on the food consumption pattern in the pre-war and war periods, the Pearson correlation coefficient (PCC) was calculated (Table 2).

Table 2: Pearson correlation coefficient: GDP and consumption of food products

	The pre-war period (2004-2013)		**The war period (2014-2020)**	
	PCC, value	**Interpretation**	**PCC, value**	**Interpretation**
Meat and meat products	0,888	strong positive correlation	0,972	very strong positive correlation
Milk and milk products	-0,178	negligible negative correlation	-0,529	moderate negative correlation
Eggs	0,405	weak positive correlation	0,282	negligible positive correlation
Fish and fish products	0,301	weak positive correlation	0,766	strong positive correlation
Sugar	-0,684	moderate negative correlation	-0,518	moderate negative correlation
Sunflower-seed oil and other vegetable oils	-0,536	moderate negative correlation	-0,482	weak negative correlation

Potatoes	-0,858	strong negative correlation	-0,651	moderate negative correlation
Vegetables, melons and gourds	0,475	weak positive correlation	-0,278	negligible negative correlation
Fruit, berries, nuts and grapes	0,909	very strong positive correlation	0,847	strong positive correlation
Bread and bakery products	-0,866	strong negative correlation	-0,365	weak negative correlation

Source: authors' calculations based on data of State Statistics Service of Ukraine

The research results show that in the pre-war period, the very strong positive correlation was determined between GDP and consumption of fruit, berries, nuts and grapes (0,909), and the strong positive correlation was found between this economic indicator and meat and meat products (0,888). At the same time, strong negative correlation was identified in the case of bread and bakery products (-0,866) and potatoes (-0,858). In the war period, the very strong positive correlation was observed regarding meat and meat products (0,972) while strong positive correlation was revealed in the case of fruit, berries, nuts and grapes (0,847) and fish and fish products (0,766). The very strong and strong negative correlations were not found during this period.

Using the Pearson correlation coefficient, the influence of the population's income on consumption of food products was estimated as well (Table 3). In the pre-war period, the very strong positive correlation was seen between the income of population and consumption of fruit, berries, nuts and grapes (0,928), and the strong positive correlation was found between this indicator and consumption of meat and meat products (0,862). At the same time, the very strong negative correlation was identified regarding bread and bread products (-0,908), while the strong negative correlation was revealed in the case of potatoes (-0,898) and sugar (-0,737).

Table 3: Pearson correlation coefficient: population's income and consumption of food products

	The pre-war period (2004-2013)		**The war period (2014-2020)**	
	PCC, value	**Interpretation**	**PCC, value**	**Interpretation**
Meat and meat products	0,862	strong positive correlation	0,972	very strong positive correlation
Milk and milk products	-0,287	negligible negative correlation	-0,478	moderate negative correlation
Eggs	0,410	weak positive correlation	0,285	negligible positive correlation

Fish and fish products	0,205	negligible positive correlation	0,785	strong positive correlation
Sugar	-0,737	strong negative correlation	-0,491	moderate negative correlation
Sunflower-seed oil and other vegetable oils	-0,492	moderate negative correlation	-0,433	weak negative correlation
Potatoes	-0,898	strong negative correlation	-0,618	moderate negative correlation
Vegetables, melons and gourds	0,545	moderate positive correlation	-0,268	negligible negative correlation
Fruit, berries, nuts and grapes	0,928	very strong positive correlation	0,821	strong positive correlation
Bread and bakery products	-0,908	very strong negative correlation	-0,321	weak negative correlation

Source: authors' calculations based on data of State Statistics Service of Ukraine

In the war period, the situation changed to a certain extent. The very strong positive correlation was found between the population's income and consumption of meat and meat products (0,972), and the strong positive correlation was determined between the mentioned indicator and consumption of fruit, berries, nuts and grapes (0,821) and fish and fish products (0,785). Similar to the case of GDP, the very strong and strong negative correlations of the population's income with consumption of foodstuffs were not revealed during the war period.

4. Conclusion

Based on received research results, the shift of the Ukrainian population towards a more balanced consumption of food products was revealed in the pre-war period. The decrease in consumption of foods in high in carbohydrates was also found in this period. These positive changes occurred because of the growth of the population's income.

The situation on food consumption was different during the war period. Mixed changes in consumption of foodstuffs were identified (for instance, the highest reduction in consumption of fish and fish products and sugar). At the same time, it was determined that the Ukrainian population made efforts to maintain a balanced consumption of food products in conditions of the limited income level.

The obtained results are essential not only for Ukraine, but also for Slovakia due to their close geographic location and economic ties. In the field of food strategy, it is related to food imports and exports between Slovakia and Ukraine, which are significantly influenced by the situation in both countries. Findings of this paper should be also taken into consideration during the implementation of the new EU food strategy in Slovakia. It should be done the way, which will help to improve the situation in both neighboring countries.

Acknowledgements

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References

[1] Abay, K., Breisinger, C., Glauber, J., Kurdi, S., Laborde, D., & Siddig, K. (2022). *The Russia-Ukraine crisis: Implications for global and regional food security and potential policy responses* (MENA Working Paper 39). IFPRI, Middle East and North Africa, doi:10.2499/p15738coll2.135913

[2] FAO. (2022). *Ukraine: Note on the impact of the war on food security in Ukraine, 20 July 2022*. Rome, doi:10.4060/cc1025en

[3] Hellegers, P. (2022). Food security vulnerability due to trade dependencies on Russia and Ukraine. *Food Security*, doi:10.1007/s12571-022-01306-8

[4] Kotykova, O., Babych, M., & Pohorelova, O. (2020). Impact of economic affordability of food on the level of food consumption by Ukrainian households. *Intellectual Economics 14*(1), 76-88.

[5] Mostenska, T.L., Mostenska, T.G., Yurii, E., Lakner, Z., & Vasa, L. (2022). Economic affordability of food as a component of the economic security of Ukraine. *PLoS ONE 17*(3): e0263358, doi:10.1371/journal.pone.0263358

[6] OECD. (2022). *The impacts and policy implications of Russia's aggression against Ukraine on agricultural markets. OECD policy responses: Ukraine tackling the policy challenges.*

[7] Seheda, S., Datsenko, A., Otkalenko, O., Musil, P. (2019). The agrarian food consumption in Ukraine and its association with socio-demographic indicators of human development. *Economic Annals-XXI 175*(1-2), 45-52, doi:10.21003/ea.V175-08

[8] Van Meijl, H., Bartelings, H., van Berkum, S., Cui, D., Smeets-Kristkova, Z., & van Zeist W.J. (2022). *Impacts of the conflict in Ukraine on global food security* (Wageningen Economic Research, Report 2022-052). Wageningen. Retrieved September 20, 2022, from https://edepot.wur.nl/570589

[9] Vasylieva, N. (2019). Problems and prospects of food security in Ukraine. *Bulgarian Journal of Agricultural* Science*, 25*(4), 668-676.

Ecological Agriculture and Impact of Selectes Aspects of Agriculture on Environment

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Abstract

The ecological crisis is an issue having impact on every inhabitant of our planet. The climate change and deterioration of the environment constitute the existential threat for Europe as well as the whole world. In 2019 the European Parliament proclaimed the climate emergency and the European Commission prepared subsequently the European Green Deal, which was approved on December 11, 2021. The principal objectives of the Deal are the decrease of fine emissions of greenhouse gases till 2030, at least by 55% in comparison with the year 1990, and also ensuring the economic growth that will not depend on the usage of sources.

The agricultural basic production ranks among the significant contaminators of the environment. It has the negative impact on the environment predominantly by application of pesticides and mineral fertilizers, and also the formation of greenhouse gases. The agricultural production creates approximately 11% of the total formation of emissions, out of it 70% comes from animal production. The ecological agricultural production presents the alternative way of utilization of agricultural soil targeted at the production of healthier foodstuffs and the elimination of harmful impact on environment.

In our paper we analyse the selected indicators of the ecological agriculture in the Slovak Republic. The long-term increase is observed in the area of ecologically cultivated soil and the number of farms of ecological farming. According to the type of areas, we have the most significantly presented the ecologically cultivated permanent grasslands. The numbers of animals kept within the ecological agricultural production vary, depending on the individual species. The application of pesticides is growing from the long-term aspect, however, in the recent evaluated year there was recorded a slight decrease.

Keywords: *agricultural soil, ecological agriculture, mineral fertilizers, pesticides, sustainable agriculture.*

JEL Classification: Q1, Q5, Q 15

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1. Introduction

Agriculture as one of the sectors of national economy has its irreplaceable role also in the world of the dynamic changes, which is more and more based on the services and information. The significance of agriculture – predominantly in its primary economic perception – is higher in less industrialized countries. However, it does not mean that in the developed countries its importance is lower. In the given cases it is very difficult even dangerous to simplify the significance of agriculture just by quantification and calculation of benefits.

This fact consists mostly in the heterogeneity of functions provided by agriculture, where the economic functions are only ones of many. Agriculture performs mainly the following functions:

- it ensures the production of healthy foodstuffs of high quality,
- it maintains and protects the natural resources and cultural landscape by the appropriate soil cultivation,
- it contributes to the preservation of viable countryside.

All the mentioned functions are related to the problems of the long-lasting sustainability.

In order the agriculture can fulfil these functions, the sector must be economically sustainable, which means it must secure the permanent restoration of its production factors. In so doing, the decisive role is played by the reimbursement of costs of the entrepreneurial entities in the sector of prices of their commodity outputs (agricultural products and services) and also other compensations, as a rule from the public sources, which cover the costs of the non-commodity outputs (e.g. environmental services) that have not been evaluated via the market so far. Therefore, the economic sustainability should be completed necessarily also by the environmental sustainability, without it the assurance of the economic sustainability is not possible.

In this regard the definition of the sustainable agriculture is often related to the ecological agriculture. The ecological agricultural production is the crop production where the special sowing procedures are being used, also green fertilization, the fertilization by organic fertilizers, permitted natural inorganic fertilizers, the mechanical, physical and biological methods for the crop protection, as well as the animal breeding, where only the feeds originated from the ecological plant production are used. A special veterinary care is provided to these farm animals.

The regulations of the ecological agricultural production in the Slovak Republic (SR) are set by the Act No. 282/2020 Col. on the ecological agricultural production which replaced the original Act No. 189/2009. The ecological agriculture is the area of the agricultural production which is developing fast in the EU coutries and also in Slovakia. This development is the consequence of the increased consumer demand for biofoodstuffs, and also the reaction to the changes in the protection of environment. From January 1, 2022 the EU has introduced the new norms in this area with the objective to make the legal regulations more efficient for this sector. The new rules for the producers will be included into these regulations that will simplify the transition to the ecological production of the small farmers and support of control system with the effort to build the consumer confidence in the system of the ecological agricultural production (EAP).

The farmers have a significant impact on the environment through their activity. The soil degradation ranks among the negative impacts of the agricultural activities, also the waste production, discharge of waste water and emissions of greenhouse gases. The agricultural soil

and its properties are affected significantly by the usage of pesticides and industrial fertilizers. The alternative forms of soil cultivation strive to eliminate the negative impacts of agricultural activities, the ecological agriculture ranks among those forms.

2. Data and Methods

The objective of the paper is to evaluate and analyse the development of the selected factors of the ecological agricultural production in the Slovak Republic in the period 2012 - 2020. The paper summarizes these indicators and provides a new view of the ecological agriculture, predominantly from the aspect of the participative indicators. The concluding part involves the analysis of the development of the utilization of pesticides and industrial fertilizers in the agriculture of the Slovak Republic.

In the paper the methods of analysis, synthesis, comparison and simple mathematic-statistical methods were applied.

We obtained the relevant data mostly from the secondary sources of the Ministry of Environment, Ministry of Agriculture and Rural develoment of the SR and Statistical Office of the SR.

3. Results

The development of the selected indicators of the ecological agriculture in the Slovak Republic in the period 2012 – 2020 is given in the Table 1. The table indicates the development of the area of ecologically cultivated soil, its proportion out of the total area of agricultural soil, the number of farms of ecological farming and the average area of these farms. The first three evaluated indicators show the rising trend, but the average area of farms is declining. The area of ecologically cultivated land (including the areas in conversion) has increased from 168, 602 ha to 222,896 ha, which constitutes the growth by 54, 294 ha. Still more significant rise was recorded with the proportion of ecologically cultivated soil out of the total area of agricultural soil. In 2012 in Slovakia 8.43 % of agricultural land was cultivated ecologically, in 2020 the percentage achieved 11.67 % out of the total area, so the growth was 38 %.

Table 1 Development of selected indicators of ecological agriculture

Year	Area of ecologically cultivated land (ha)	Proportion of total agricult. land (%)	Number of farms of ecological agriculture	Average area of farms (ha)
2012	168, 602	8.43	362	465.7
2013	162, 029	8.40	341	475.2
2014	180, 365	9.39	399	452.0
2015	186, 483	9.70	416	448.2
2016	187, 010	9.75	430	434.9
2017	189, 147	9.90	439	430.9
2018	192, 143	10.02	535	359.1

2019	196, 210	10.24	567	346.0
2020	222, 896	11.67	698	319.0
Index 20/12	1.32	1.38	1.93	0.68

Source: Author, according to the data of the Central Control and Testing Institute in Agriculture

The objective is to reach the minimal level of 13.5 % in the SR. This target can be considered to be realistic one. The most significant growth is observed in the number of the farms which are farming according to the principles of the ecological agriculture. In 2020 their number achieved 698, in 2012 there were only 362 farms, which means the rise by 336 farms. In 2012 the average area was 465.7 ha, in 2020 it constituted 319.0 ha (decline by 146.7 ha).

The Table 2 indicates the development of the totally used arable soil and the proportion of arable soil registered in the ecological system of farming in the period 2012 – 2020. We also evaluated the development of grasslands. The area of totally used arable soil decreased by 13,932 ha (1 %). The area of arable soil registered in ecological agricultural production increased from 54, 264 ha to 75,592 ha (growth by 39 %). The arable soil registered in ecological agricultural production constitutes 5.62 % out of the total arable soil. The permanent grasslands (PG) registered in ecological agricultural production achieved a higher proportion out of the total permanent grasslands in the whole evaluated period. In the last evaluated year this proprtion reached almost 28 %. The total area of these grounds is relatively stabile. In 2020 it achieved 520,334 ha, it increased by 5,392 ha (1 %) during the whole period.

Table 2 Development of arable soil and permanent grasslands

Year		**Used arable soil in total (ha)**	**Arable soil in EAP (ha)**	**Arable soil in EAP (%)**	**PG in total (ha)**	**PG in EAP (ha)**	**PG in EAP (%)**
2012		1,359,979	54, 264	3.99	514, 942	113, 075	21.96
2013		1,362,002	53, 181	3.90	513, 704	107, 622	20.95
2014		1,359,091	62, 279	4.58	510, 801	116, 528	22.81
2015		1,350,180	60, 890	4.51	520, 581	123, 855	23.79
2016		1,347,293	60, 302	4.47	521, 441	124, 807	23.94
2017		1,342,885	62, 978	4.69	517, 679	124, 230	23.80
2018		1,348,019	64, 821	4.81	523, 552	125, 366	23.95
2019		1,348,919	66, 560	4.93	518, 415	127, 619	24.62
2020		1,346 047	75, 592	5.62	520, 334	145, 209	27.90
Index 20/12		0.99	1.39	1.41	1.01	1.28	1.27

Source: Author, according to the data of Green Deal

The area of ecologically cultivated land according to the type of ground in 2020 is indicated in the Table 1. In the long term the highest proportion belongs to the permanent grasslands, which formed 65.2% out of the total ecologically cultivated agricultural land, followed by arable soil (33.9%) and orchards (0.8%). The area of the ecologically cultivated vineyards was neglectable (0.1%). These data prove that it is the simplest way to cultivate ecologically the permanent grasslands (meadows and pastures). On the other hand, it is very difficult to cultivate ecologically vineyards, and at the same time to achieve the positive result of farming. The same argument is related to the fruit growing. The permanent grasslands in our country are used mostly for sheep breeding, therefore just these animals are bred in the ecological way in the category of farming animals.

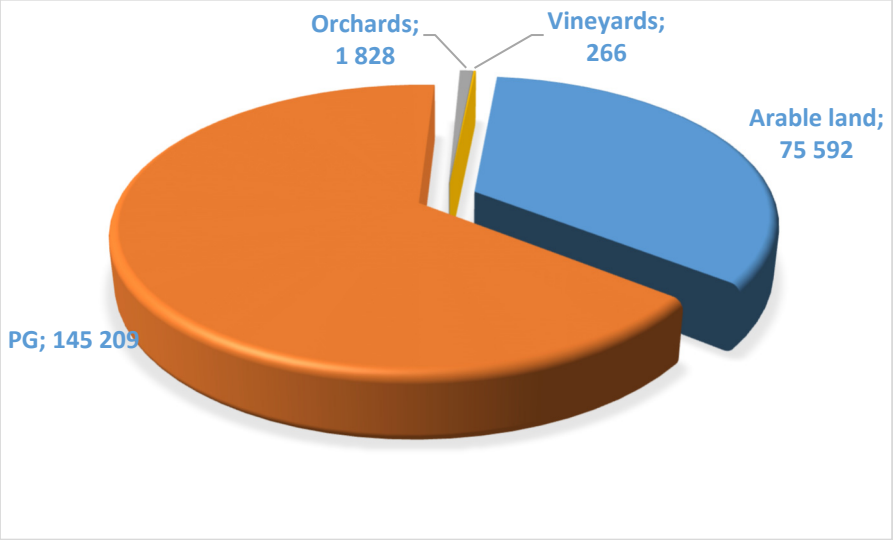

Fig. 1 Agricultural soil registered in EAP in 2020 according to the type of ground (ha)

Source: Author, according to the data of Green Deal 2021

In this part we analyse the selected indicators of the animal husbandry of ecological agricultural production. The animals bred in EAP must have the free range and their natural needs must be taken into consideration. The Table 3 illustrates the development of numbers of the selected species of farming animals registered in EAP in the period 2012 – 2020. The table indicates the numbers of sheep, cattle, poultry, pigs, horses and the total number of animals. It also includes the animals in conversion. The Table 4 shows the percentage representation of the individual categories of farming animals out of the total number of animals of the given category. In spite of the 25% drop in the period of evaluated years, the number of sheep prove the highest proportion in the long term. The numbers of cattle are growing, but the numbers of poultry, goats and horses are decreasing. We monitor the considerable rise in the number of pigs. In 2012 their number in EAP was 146 individuals and in 2020 the number achieved 1,478 individuals. The total numbers of farming animals bred in EAP decreased by 4% from 162, 278 individuals in 2012 to 155, 585 in 2020.

Table 3 Development of number of farming animals according to species bred in EAP (pieces)

Year	Sheep	Cattle	Poultry	Goats	Pigs	Horses	Total
2012	107, 327	43, 293	8, 849	2, 052	146	611	162, 278
2013	106, 713	43, 142	8, 708	1, 979	187	659	161, 388
2014	96, 976	44, 772	8, 250	1, 005	175	569	151, 747
2015	97, 239	58, 945	4, 110	1, 527	503	643	162, 967
2016	93, 596	65, 724	5, 311	1, 429	438	590	167, 088
2017	102, 000	61, 655	4, 111	1, 349	164	541	169, 820
2018	84, 912	63, 340	5, 340	1, 419	547	541	156, 099
2019	96, 955	64, 244	6, 316	1, 814	732	529	170, 590
2020	80, 978	64, 991	6, 054	1, 619	1, 478	565	155, 585
Index 20/12	0.75	1.50	0.68	0.79	10.1	0.92	0.96

Source: Author, according to the data of Green Deal and Statistical Office of SR

The proportion of the particular categories of farming animals bred in EAP out of the total number of animals is indicated in the Table 4. During the whole monitored period the highest proportion is evident with sheep. In 2020 this proportion was 31.1%. The growth was recorded also in the numbers of cattle and goats. The proportion of poultry is very low in the long term, however, there was a rise in the last year. The proportion of pigs is similar.

Table 4 Proportion of selected categories of farming animals bred in EAP out of total number of animals (%)

Year	Sheep	Cattle	Poultry	Goats	Pigs	Total
2012	26.2	9.2	0.1	5.9	0.0	8.28
2013	26.7	9.2	0.1	5.6	0.0	8.32
2014	24.8	9.6	0.1	2.9	0.0	7.48
2015	25.5	12.9	0.0	4.2	0.1	8.54
2016	25.4	14.7	0.0	3.9	0.1	8.82
2017	27.9	14.0	0.0	3.6	0.0	9.10
2018	24.2	14.4	0.0	3.8	0.1	8.50
2019	30.2	14.9	0.1	5.1	0.1	10.08
2020	31.1	15.7	0.1	8.9	0.3	12.50
Index 20/12	1.19	1.71	1.00	1.51	-	1.51

Source: Author, according to the data of Green Report and Statistical Office of SR

In this part we deal with the selected negative impacts of agiculture on the environment. We evaluate the development of pesticides and industrial fertilizers usage. Pesticides are the effective chemical substances used in agriculture for the crop protection against the harmful organisms, pests, diseases and weeds. In the world more than one thousand of the different types of pesticides are being utilized. Their incorrect usage leads to the pollution of soil, water and air. Slovakia is below the European average in the use of pesticides. The annual sale of pesticides per hectare achieves 1.3 kg. Some countries in the EU have the usage threefold even fourfold higher. As a part of the strategy "From Farm to Fork" with the objective to support the transition of the EU to the sustainable food system and decrease the use of the chemical pesticides, on August 31, 2022 the European Commossion passed the new regulations for the availability of the ecological preparations for the crop protection for the usage in the member staes of the EU. The new regulations mitigate the permitting of microorganisms usage as the effective matters in pesticides and offer other possibilities for the farmers of EU to substitute the chemical preparations for the crop protection by the more sustainable alternatives.

The development of the total pesticides usage in the agriculture of the SR in the period 2012 – 2020 is indicated in the Fig. 2. The utilization of pesticides inceased by 1,479 tonnes in the evaluated period. In the period 2018 – 2020 the pesticides usage is relatively stabile. In 2020 mostly herbicides were used (2,742 t), 1,244 t of fungicides, 378 t of insecticides and 1,057 t of other pesticides. According to the plans of the EU the pesticides usage should be decreased by a half till 2030 in the EU. In accordance with the opinion of the authors of this paper, to achieve this target will be difficult because the pesticides usage was growing in the majority of the EU countries in the period 2011 – 2020. The decrease was monitored only in seven countries, leading country is Portugal (drop by 42%), followed by Ireland (drop by 28%) and the Czech Republic (drop by 27%).

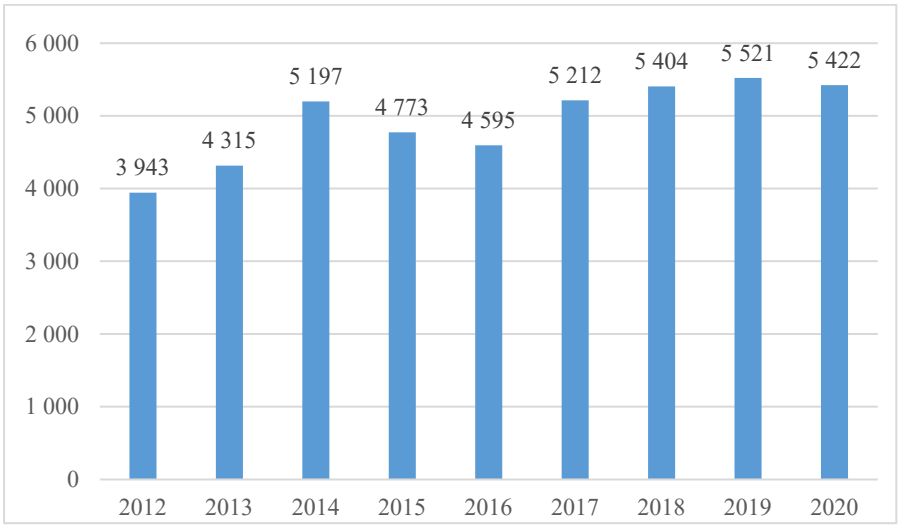

Fig. 2 Development of pesticides usage in agriculture of SR in 2012 – 2020 (t)
Source: Author, according to the data of the Central Control and Testing Institute in Agriculture

The application of industrial fertilizers (NPK) in kg of the pure nutrients per hectare of the agricultural soil in the SR in the period 2012 – 2020 is shown in the Fig.3. In 2012 the usage was 85.8 kg.ha^{-1}, in 2020 it was103,4 kg.ha^{-1}, which means the growth by 17.6 kg.ha^{-1}. The

lowest utilization was monitored in 2016 (88.2 kg.ha^{-1}). After this year there was recoreded the rise in the use above 100 kg.ha^{-1}.

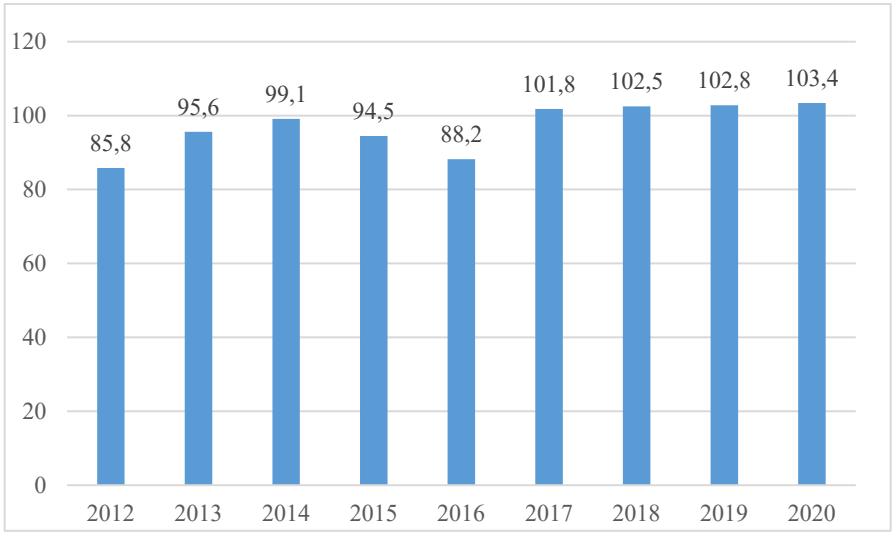

Fig. 3 Develoment of industrial fertilizers usage in agriculture of SR in 2012 – 2020 (kg.ha^{-1})
Source: Author, according to the data of the Central Control and Testing Institute in Agriculture

4. Discussion

The primary role of agriculture is to provide the sufficiency of healthy food of high quality needed for assurance of population nutrition. For longer time the other non-production functions of agriculture are being emphasized. Out of them the most significant one is the assecuration of the sustainable usage of the natural sources and maintenance of viable countryside. The ecological agriculture fulfills the idea of the sustainable development in agriculture. It represents the alternative approach of the agrarian policy and strives for the continuous production of the healthy foodstuffs in the way which has the minimal negative impacts on the environment.

The interest in this form of farming is increasing constantly. In 2020 the area of ecologically cultivated agricultural land achieved 222,896 ha. It constitutes more than 11% out of the total agricultural land. According to the type of grounds, the permanent grasslands (145,209 ha) and arable soil (75,592 ha) are ecologically managed to the highest level. The total number of the registered participants was 1,037, farmers 698. These numbers are also growing continuously.

Ones of the measures targeted at the ecologization of agriculture are so called bio-belts, which constitute the prerequisite for the acquisition of funds from the eco-schemes of the new Common Agricultural Policy. The mandatory part of the regulations for the farming companies is to divide large soil areas, which exceed the maximal acreage 50 ha, or 12 ha in the protected area. The ideas related to the formation of bio-belts differ. Many farmers are aware of the necessity and obligation of a higher ecologization of agriculture, the others do not like the introduction of this duty. The criticism also comes from the areas where the fields are divided by ties or alleys formed individually in the past, whereby the given area is exceeded only by a couple of hectares. If these producers want to comply with conditions, they will have to divide such fields again.

Emil Macho, the chairman of the Slovak Agriculture and Food Chamber said: "After the 1 January 2023 nobody will claim that the farmers are given money for doing nothing and they get the subsidies only for some wheat or rape. The fact is that we will receive less money for more work. The majority of agriculturists knew about the necessity to introduce the bio-belts, therefore they were prepared and most of them will do it."

Andrej Gajdoš, the executive chairman of the Slovak Agriculture and Food Chamber and adviser of eco-schemes stated: "The farmers have to be informed about the conditions under which they can enter into the eco-schemes as soon as possible and what exactly their duties will be. It is not that easy to form smaller areas out of large fields and also to sow the appropriate crop selection, which should bring the sufficient yield on the one hand, and to attract new animals, bees and butterflies on the other hand."

5. Conclusion

The total number of animals bred in EAP is falling. According to the individual categories we recorded the decrease of sheep, poultry, goats and horses. The significant growth in the number of pigs is observed, a moderate increase in the number of cattle.

Agriculture affects the environment in the different ways, among them there is also the usage of pesticides and industrial fertilizers. In 2020 the total utilization of pesticides in agriculture achieved 5,422 tonnes. In comparison with the year 2012 it means the rise by 1,479 tonnes (38%). The decrease of usage of chemical pesticides is not an easy way. This process takes several years. The reaction could be taking some steps – the utilization of the precise technique, growing more resistant plant species, or the support of science and research in the field of preparations for crop protection.

A moderate increase is also observed in the development of usage of industrial fertilizers. In 2012 is was at the lowest level (85.8 $kg.ha^{-1}$), in 2020 it reached the highest level (103.4 $kg.ha^{-1}$). Overall, the growth is by 17.6 $kg.ha^{-1}$ (20.5%).

The ecological agriculture ranks among the alternative forms of soil cultivation with the enormous perspective of the further development, resulting from the urgent needs of the society and the increased demand for the biofoodstuffs. In the following period the faster development of the ecological agriculture in the EU and Slovakia can be supported by the Common Agricultural Policy with the increased subsidies for this form of farming. The farmers, who would like to begin their ecological farming, are discouraged also by a high administrative burden associated with the ecological farming.

The key program EU aimed at the funding research and development Horizon Europe also emphasizes the sustainable agriculture. The declarations of the program are targeted at a better management of nutrients, the integrated protection against pests and looking for the alternatives of the chemical pesticides and synthetic fertilizers. These appeals are included in one of the supported areas entitled Fair, healthy and environmentally-friendly food systems from primary production to consumption FARM2FORK.

In the following period our farmers can expect new challenges. Apart from the preservation of the economically effective enterprising, which will become very difficult with the continuous growth of inputs, they will also have to meet the environmental objectives resulting from the new regulations of the Common Agicultural Policy 2023 – 2027.

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References

BLASS, G. – BIELEK, P. – BOZIK, M. 2010. *Pôda a poľnohospodárstvo: úvahy o budúcnosti.* Výskumný ústav pôdoznalectva a ochrany pôdy. Bratislava. 36 s. ISBN 978-80-89128-63-1.

1. CHOVANCOVÁ, J. – ADAMIŠIN, P. 2016. *Environmentálne aspekty procesov a technológií.* Prešov : Prešovská univerzita. 133 s. ISBN 978-80-555-1700-1.
2. CHOSRAVIOVÁ, R. 2022. *Európska komisia chce znížiť používanie pesticídov*. Nitra: Roľnícke noviny 27/2022. 5 s. ISSN 0231-6617.
3. GONDOVÁ, M. 2022. *Nové pravidlá pre ekologické pesticídy*. Nitra: Roľnícke noviny 36/2022. 8 s. ISSN 0231-6617.
4. HOLÉCIOVÁ. J. 2022. *Pre zelenšiu výrobu potravín*. Nitra: Roľnícke noviny 44/2022. 4 s. ISSN 0231-6617.
5. HORSKÁ, E. – NAGYOVÁ, Ľ. 2013. *Marketingové prístupy k udržateľnosti agrosektora na Slovensku.* Nitra, SPU v Nitre. 191 s. ISBN 978-80-552-1126-8.
6. HUTTMANOVÁ, E. – KISEĽÁKOVÁ, D. 2010. *Možnosti rozvoja udržateľného poľnohospodárstva v regiónoch Slovenska.* [online]. Prešov : Prešovská univerzita. [cit. 2015-5-7]. Dostupné na: http://www.pulib.sk/elpub2/FM/Kotulic13/pdf_doc/05.pdf
7. RÉCKY, R. – HORVÁTHOVÁ, J. 2021. Ecological agriculture as a form of sustainable entrepreneurship on soil. Brno: Zero Waste Management and Circular Economi. Mendel Univerzity in Brno. 71-82 s. ISBN 978-80-7509-820-7-71.
8. https://www.enviroportal.sk/spravy/detail/10361?p=9341
9. https://www.mpsr.sk/zelena-sprava-2020/122---16206/
10. https://eur-lex.europa.eu/resource.html?uri=cellar:b828d165-1c22-11ea-8c1f-01aa75ed71a1.0018.02/DOC_1&format=PDF
11. https://www.minzp.sk/klima/europska-zelena-dohoda/
12. https://eur-lex.europa.eu/resource.html?uri=cellar:b828d165-1c22-11ea-8c1f-01aa75ed71a1.0018.02/DOC_1&format=PDF
13. https://polnoinfo.sk/ako-bude-vyzerat-krajina-s-biopasmi/
14. https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal/actions-being-taken-eu/farm-fork_sk
15. https://www.uksup.sk/spotreba-pripravkov-na-ochranu-rastlin

Consumer attitudes and consumption patterns toward functional food bars in Slovakia

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Abstract

Consumers' eating habits have recently been influenced by changing lifestyles, emphasis on health and sustainability. The globally developing food market emphasizes the consumption of healthy and functional food. Currently, Slovak consumers have the ambition to eat healthier and consume foods with a high content of nutritional components. On the other hand, they look for foods that are a source of quick energy, give strength, satiate and are practical. These functional food bars include for example snack bars, energy bars, protein bars, fruit bars, cereal bars, granola bars, nut bars, sports bars. The aim of the paper was to point out the consumer perception of functional food bars and the behaviour of Slovak consumers when consuming these healthy foods. To achieve the aim of the paper, the consumer survey was conducted by snowball sampling method in 2021 in Slovakia (n=1,138 respondents). The aim of the survey was to examine consumption preferences of cereal, muesli, and protein bars and to identify the key reasons and determinants of the consumption of functional food bars. The collected data were processed and evaluated through mathematical and statistical methods. The results showed that approximately half of Slovak consumers are consumers of functional food bars, while cereal and muesli bars are the most consumed. The survey showed that the key reasons for consumption are taste, health aspect and energy replenishment. The content of proteins, fibre, vitamins, and minerals are the most important determinants of choosing and consuming functional food bars. Based on the results of the survey, it is possible to state that 66% of Slovak consumers will not change consumed amount of functional food bars, and 28% of Slovak consumers plan to increase their consumption of healthy functional foods in the future. It follows that it is desirable to consume functional food bars due to their health aspect, nutritional composition, and convenience. The consumer study provides an insight into the behaviour of Slovak consumers when consuming functional food bars, with an emphasis on cereal, muesli, and protein bars, and becomes a suitable basis for the scientific and research sphere, as the issue of consuming functional food bars has not yet been solved in Slovakia. The study also provides information for business enterprises, which should expand the range of functional food bars and develop new innovative functional food bars containing various flours rich in proteins, vitamins, and minerals in view of the growing consumer demand. The study can also be beneficial in the creation of food policy, or in raising consumer awareness of the health benefits of consuming functional food bars.

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Keywords: *consumer, consumer behaviour, consumer perception, functional food bars, Slovakia*

JEL Classification: *Q13, M31, M39*

1. Introduction

Nowadays, the trend in the food market is the preference of consumers towards healthy foods, which are easy to consume, store and handle (Constantin & Istrati, 2019; Singh, Kumari & Chauhan, 2022). Functional food bars meet changing consumer requirements related to health-promoting and convenient products (Kosicka-Gębska, Jeżewska-Zychowicz, Gębski, Sajdakowska, Niewiadomska & Nicewicz, 2022). These bars are often produced foods with content of cereals, fruits and nuts, which are a significant source of healthy nutrients, bioactive compounds and fiber (Constantin & Istrati, 2019). Food bars are most often made based on cereals, such as oats, rice, corn or on the basis of proteins (dairy milk proteins, soy or whey). These foods are enriched with vitamins, minerals and other ingredients rich in nutrients or energy, and are becoming a popular functional food.

Many studies differ in the definitions and formulations of food bars. The most famous types are fruit bars (Sun-Waterhouse, Teoh, Massarotto, Wibisono & Wadhwa, 2010; Orrego, Salgado & Botero, 2013), wheat or soy based bars (Aramouni & Abu-Ghoush, 2010; Qin, Wang, & Luo, 2022; Lu & Zhou, 2019), cereal bars (Aleksejeva, Siksna & Rinkule, 2017), fruit and vegetable bars (Da Silva, Siqueira, Do Lago, Rosell & Vilas Boas, 2013), vegetable bars (Ferreira, Santos, Moro, Basto, Andrade & Gonçalves, 2013) or high-protein bars and protein energy bars (Hogan, Chaurin, O'Kennedy & Kelly, 2012; Szydłowska, Zielińska, Łepecka, Trząskowska, Neffe-Skocińska & Kołożyn-Krajewska, 2020; Jabeen, Huma, Sameen & Zia, 2021).

However, in general, it can be stated that the bars are consumed by consumers from all over the world (Srebernich, Gonçalves, Ormenese & Ruffi, 2016) because they provide instant energy (Zulaikha, Yao & Chang, 2021). In addition, Kowalska, Kowalska, Ignaczak, Masiarz, Domian, Galus, Ciurzyńska, Salamon, Zajac, and Marzec (2021) add that consumers are oriented towards light meals, have a lack of time to prepare and consume traditional meals, but are interested in eating healthy. According to Ferreira, Pontes and Rodrigues (2007), bars are suitable for consumption, and the key motive for consumption is a practical and convenient way of nutrient intake. Bars are therefore preferred by consumers due to their high content of fiber, vitamins, and minerals, the consumption of which can prevent various diseases such as obesity, cancer, and diabetes. The consumption of functional bars is mainly preferred by consumers who are on a diet, have health problems, or are looking for a quick snack (Farinazzi-Machado, Barbalho, Oshiiwa, Goulart & Pessan Junior, 2012; Zaveri & Drummond, 2009). Constantin & Istrati (2019) state that functional bars can be consumed as part of a meal, as a dessert, or as a meal replacement. The consumption of functional bars is also often associated with consumers who engage in sports activities (Hogan et al., 2012; Jovanov, Sakač, Jurdana, Pražnikar, Kenig, Hadnađev, Jakus, Petelin, Škrobot & Marić, 2021), or consumers who perceive functional bars as a substitute for sweets and candies (Da Silva et al., 2013). This is also confirmed by Aleksejeva et al. (2017), who state that consumers primarily prefer cereal bars, which they choose as an alternative to the less-healthy snacks, a quick source of energy before a workout, or a substitute for a meal. Constantin and Istrati (2019) summarized that the food bars consumption is influenced by satisfying the need for sweets; saving time; using as an energy source; using for weight loss; and using for the protein, fiber, vitamin contents, etc.

In the context of the mentioned the aim of the paper is to point out the consumer perception of functional food bars and the behaviour of Slovak consumers when consuming these healthy foods. Based on the aim of this paper, the following research questions were formulated

1. Which functional food bars are most preferred among Slovak consumers?
2. What are the reasons for functional food bars consumption?
3. What are the key determinants of functional food bars consumption?

2. Data and Methods

Consumer study is based on questionnaire survey aimed to consumption functional food bars, consumption frequencies of individual functional food bars, consumer preferences of functional food bars, as well as to identifying key reasons and composition factors affecting functional food bars and future perspectives related to consumption patterns toward functional food bars. The consumer survey was conducted in the Slovak Republic in 2021 by snow-ball method. The sample of respondents consisted of 1138 consumers, of which 594 were consumers of functional bars. Respondents were divided according to the following socio-demographic characteristics, namely gender, age, education, place of residence, economic activity, personal net income per month (Table 1).

Table 1: Socio-demographic profile of the sample

Variables		*Total sample*		*Sample of functional bars consumers*	
		(n)	**(%)**	**(n)**	**(%)**
Gender	Male	482	42.4	223	37,5%
	Female	656	57.6	371	62,5%
Age	18 – 24 years	469	41.2	297	50,0%
	25 – 40 years	199	17.5	104	17,5%
	41 – 56 years	327	28.7	149	25,1%
	More than 56 years	143	12.6	44	7,4%
Education	Elementary	38	3.3	22	3,7%
	Secondary	905	79.5	481	81,0%
	Higher education	195	17.1	91	15,3%
Place of residence	Rural	643	56.5	335	56,4%
	Urban	495	43.5	259	43,6%
Economic activity	Employed	484	42.5	228	38,4%
	Student	412	36.2	267	44,9%
	Self-employed	79	6.9	41	6,9%
	Unemployed	27	2.4	15	2,5%
	Retired	112	9.8	32	5,4%
	Maternity leave	9	0.8	2	0,3%
	Other	15	1.3	9	1,5%
Personal net income per month	Up to 400 €	411	36.1	255	42,9%
	401-600 €	145	12.7	56	9,4%
	601-800 €	158	13.9	81	13,6%
	801-1, 000 €	188	16.5	93	15,7%
	More than 1, 000 €	236	20.8	109	18,4%

Source: questionnaire survey

Consumers involved to the questionnaire survey determined consumer preferences of individual functional food bars and their consumption frequencies. Differences between consumption patterns between individual consumer groups of consumers in terms of socio-demographic characteristics were identified using Chi square test of independence.

Respondents who consume functional food bars evaluated reasons of consumption on a 5-point Likart scale, with 1 representing the least important reason and 5 representing the most important reasons. Consumers determine significance of eight different reasons, namely replacement of one meal a day, slimness and beauty, practical reasons, substitute for wafer biscuit/cookies, source of protein, energy source, health aspect and taste. Differences among the examined reasons of consumption were analysed using Friedman test and consequent post hoc pairwise multiple comparison test according to Nemenyi.

The aim of survey was to identify key composition factors affecting purchase and consumption of functional food bars. Consumers evaluated thirteen factors related to composition on a 5-point Likart scale, with 1 representing the least important factor and 5 representing the most important factor. A deeper analysis aimed at identifying the differences between these factors was also carried out using the Friedman test and the Nemenyi method.

Using statistical methods in the XLStat and IBMSPSS programs, we evaluated consumer attitudes and consumption patterns towards functional food bars in Slovakia.

3. Results and Discussion

The results of the consumer survey show that more than 50% of Slovak respondents are consumers of functional food bars. We also identified that 16.6% of Slovak consumers of functional food bars consume them several times a week and 18% of these consumers consume bars once a week. Survey also showed that two thirds of consumers consume functional food bars occasionally or once a week.

Research was oriented on the consumer preferences of the functional food bars. Based on the results it could be stated that cereal bars and muesli bars are the most consumed. Muesli bars are consumed by approximately 40% of Slovak consumers at least once a week. Cereal bars are less consumed and about third of consumer consume them once a week or more often. The least consumed are protein bars and results show that more than 70% of Slovak consumer consume them occasionally or they do not consume at all. Consumption frequencies of functional individual food bars are stated in the table 2. In the context of functional bars consumption in the Slovak Republic we identified differences in consumption between individual consumer groups of consumers in terms of socio-demographic characteristics. Based on the results of Chi square test of independence (p-value = <0.05) we found that younger consumers and consumers with higher income tend to consume mainly cereal bars. Further finding was that protein bars are preferred mainly by men, younger generation, university educated and consumers with higher income.

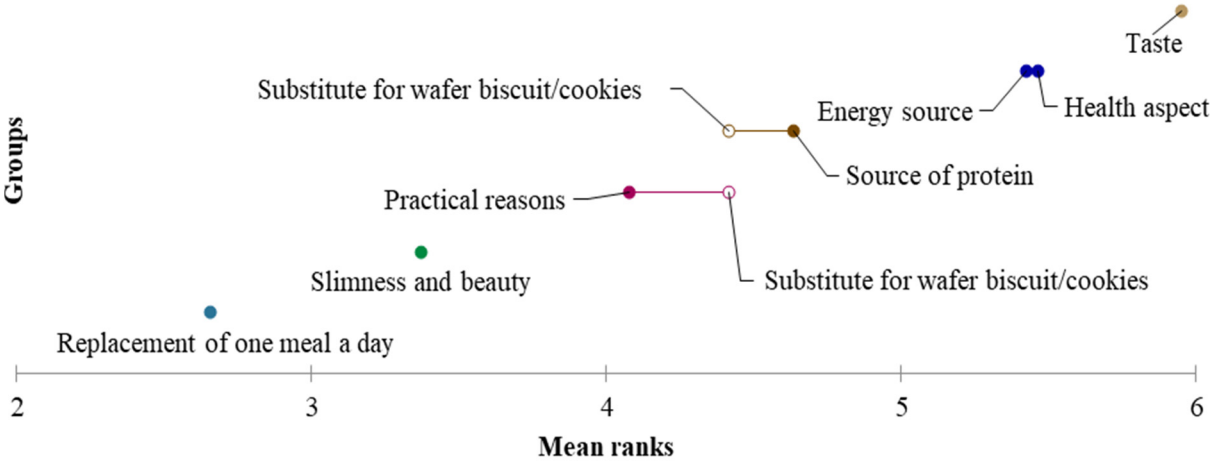
Table 2: Consumption frequency of functional food bars

Consumption Frequency	*Muesli*	*Cereal bars*	*Protein bars*
Several times a week	19.0 %	11.8 %	10.6 %
Once a week	19.5 %	21.7 %	15.5 %
Once a month	48.2 %	52.7 %	37.4 %
No consumption	13.3%	13.8%	36.5 %

Source: questionnaire survey

The next aim of survey was to identify reasons of functional food bars consumption. Consumers evaluated 8 reasons for consumption on a scale from 1 to 5, with 1 being the least important reason and 5 being the most important reason. The results showed that consumers consider taste and health reasons as key ones for functional food bars consumption. We also identified differences in the evaluation of the reasons which were confirmed by applying the Friedman test (p-value = <0.001). Consequent post hoc pairwise multiple comparison test according to Nemenyi groups the examined reasons according to differences between mean of ranks. Differences among reasons for consumption of functional food bars are shown by Demsar plot (Figure 1).

Figure 1: Reasons for consumption of functional food bars



Source: questionnaire survey

Questionnaire survey was aimed at identifying composition factors affecting consumption of functional food bars. Slovak consumers evaluated 13 different ingredients of functional bars on a 5-point scale, with 1 being the least important composition factor and 5 being the most important composition factor. Based on the results of the survey it could be concluded that the most significant factors related to composition are energy value, content of proteins, fibre, vitamins, as well as the lowest content of sugar. Differences between examined composition factors were also analysed using the Friedman test and we identified differences (p-value = <0.001). Table 3 shows the results of using Nemenyi method and points out the means for individual composition factors and based of which these factors are grouped. In addition, the results of Nemenyi's method are presented graphically using the Demsar plot (Figure 3).

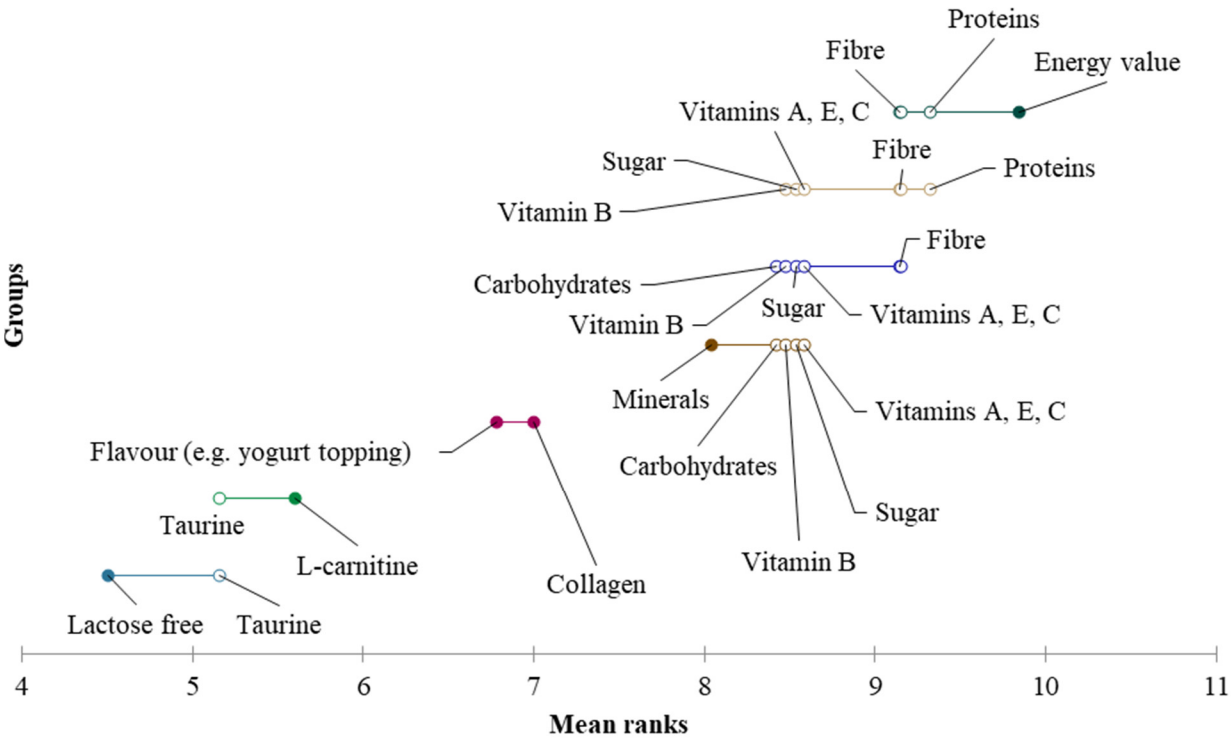
Table 3: Results of Nemenyi's method: Differences among examined composition factors

Sample	*Frequency*	*Sum of ranks*	*Mean of ranks*	*Groups*
Lactose free	594	2676,000	4,505	A
Taurine	594	3062,500	5,156	A B
L-carnitine	594	3325,000	5,598	B
Flavour (e.g. yogurt topping)	594	4028,500	6,782	C
Collagen	594	4160,000	7,003	C
Minerals	594	4778,500	8,045	D
Carbohydrates	594	5004,000	8,424	D E
Vitamin B	594	5034,000	8,475	D E F
Sugar	594	5070,000	8,535	D E F

Vitamins A, E, C	594	5100,000	8,586	D E F
Fibre	594	5433,500	9,147	E F G
Proteins	594	5539,500	9,326	F G
Energy value	594	5850,000	9,848	G

Source: questionnaire survey

Figure 2: Composition factors affecting consumption of functional food bars



Source: questionnaire survey

The last part of consumer survey was oriented on the future consumption. Results show that 70 % of Slovak consumer will not plan to change consumption of functional bars. Positive finding was, that more than 25 % of Slovak consumer will plan to increase consumption and only 2 % of consumers will plan to consume fewer functional food bars compared to current consumption.

The results of a consumer study in Slovakia showed that approximately half of consumers consume functional bars, and cereal and muesli bars are the most preferred. Furthermore, we identified the need to obtain quick energy, the health aspect and the taste of bars as key reasons for consuming these foods. In addition, energy value, fiber and protein content are decisive for consumers when choosing functional bars. Consumer studies focused on snack bars, cereal bars, fruit bars or protein bars were also carried out in other countries. According to Brazilian consumer study, the most consumed food bars were fruit and cereal bars. Protein and nut bars may be more attractive only if they would be offered for affordable prices (Pinto, Oliveira Freitas, Melo, Freitas, Souza Araújo, Minim, de Souza & Bressan, 2018). Another study indicated that cereal and fruit bars are consumed by majority of respondents 1 or 2 times per week. The primary reason for consumption were possible positive effects, nutritional value or simple desire for sweet taste (Kosicka-Gębska et al., 2022). Based on the research elaborated by Perkovic, Otterbring, Schärli, and Pachur, (2022), it can be stated that

higher fiber content and healthy perception of fruit inside of bars were the main reason for consumer acceptance. In this context, Forbes, Kahiya and Balderstone (2015) emphasize that sugar and total fat are the most important nutritional factors for consumer decision-making purchases of food bars. In addition, level of knowledge telated to nutrition and demographic variables such as gender and age have certain impact on overall consumption of snack bars. (Constantin & Istrati, 2019).

4. Conclusion

To conclude the functional bars market will grow significantly in the coming years. A growing health-conscious population across the globe has shown increasing preference towards the consumption of different types of functional bars available in the market. The growth is mainly driven by the trend of population obesity and also an increasing inclination of people towards weight loss. The most preferred functional bars are energy bars, protein-rich bars, meal replacement bars and low carbohydrate bars. As these functional food bars are very healthy we conducted questionnaire survey and its results showed that in Slovakia more than 50% consumers consume functional bars and the most consumed functional bars are muesli and cereal bars. Interesting finding was that protein bars are preferred by younger generation, men, employed consumers with higher income. We identified key reasons for consumption which are taste, health and energy source. Slovaks prefer bars with high energy value, high protein, fiber, vitamin content and reduced sugar content. In the future 70 % Slovaks will not plan to change functional bars consumption, and moreover more than 25% will plan to increase their consumption. Based on the results of the consumer study and the situation on the functional food bars market, it is desirable for Slovak consumers to be motivated for consumption of functional bars. Furthermore, we suggest to consumer awareness of functional bars and inform and educate consumers about healthy and functional food. We also suggest to appeal to food enterprises and initiate them to develop and produce new functional bars containing various flours rich in proteins, vitamins, and minerals in view of the growing consumer demand. In the future research it is necessary to monitor trends in the functional bars market and to examine motives and barriers of consumption in other countries.

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References

[28] Aleksejeva, S., Siksna, I., & Rinkule, S. (2017). Composition of cereal bars. *Journal of Health Science*, *5*(3), 139-145. doi:10.17265/2328-7136/2017.03.004

[29] Aramouni, F. M., & Abu-Ghoush, M. H. (2010). Physicochemical and sensory characteristics of no-bake wheat-soy snack bars. *Journal of the Science of Food and Agriculture, 91*(1), 44-51. doi:10.1002/jsfa.4134

[30] Constantin, O.E., & Istrati, D. I. (2019). Functional properties of snack bars. *Functional Foods*. doi:10.5772/intechopen.81020

[31] Da Silva, E. P., Siqueira, H. H., Do Lago, R. C., Rosell, C. M., & Vilas Boas, E. V. (2013). Developing fruit-based nutritious snack bars. *Journal of the Science of Food and Agriculture, 94*(1), 52-56. doi:10.1002/jsfa.6282

[32] Farinazzi-Machado, F. M., Barbalho, S. M., Oshiiwa, M., Goulart, R., & Pessan Junior, O. (2012). Use of cereal bars with quinoa (chenopodium quinoa W.) to reduce risk factors related to cardiovascular diseases. *Food Science and Technology, 32*(2), 239-244. doi:10.1590/s0101-20612012005000040

[33] Ferreira, L. G., Pontes, D. F., & Rodrigues, M. C. P. (2007). Avaliação sensorial de barras de cereais com propriedades funcionais, direcionadas a mulheres no período do climatério, São Paulo. Higiene Alimentar, 21(155), 33-37.

[34] Ferreira, M. S., Santos, M. C., Moro, T. M., Basto, G. J., Andrade, R. M., & Gonçalves, É C. (2013). Formulation and characterization of functional foods based on fruit and vegetable residue flour. *Journal of Food Science and Technology, 52*(2), 822-830. doi:10.1007/s13197-013-1061-4

[35] Forbes, S. L., Kahiya, E., & Balderstone, C. (2015). Analysis of snack food purchasing and consumption behavior. *Journal of Food Products Marketing, 22*(1), 65-88. doi:10.1080/10454446.2014.949992

[36] Hogan, S. A., Chaurin, V., O'Kennedy, B. T., & Kelly, P. M. (2012). Influence of dairy proteins on textural changes in high-protein bars. *International Dairy Journal, 26*(1), 58-65. doi:10.1016/j.idairyj.2012.02.006

[37] Jabeen, S., Huma, N., Sameen, A., & Zia, M. A. (2021). Formulation and characterization of protein-energy bars prepared by using dates, apricots, cheese and whey protein isolate. *Food Science and Technology, 41*(Suppl 1), 197-207. doi:10.1590/fst.12220

[38] Jovanov, P., Sakač, M., Jurdana, M., Pražnikar, Z. J., Kenig, S., Hadnađev, M., Jakus, T., Petelin, A., Škrobot, D., & Marić, A. (2021). High-Protein Bar as a meal replacement in Elite Sports Nutrition: A pilot study. *Foods, 10*(11), 2628. doi:10.3390/foods10112628

[39] Kosicka-Gębska, M., Jeżewska-Zychowicz, M., Gębski, J., Sajdakowska, M., Niewiadomska, K., & Nicewicz, R. (2022). Consumer motives for choosing fruit and cereal bars—differences due to consumer lifestyles, attitudes toward the product, and expectations. *Nutrients, 14*(13), 2710. doi:10.3390/nu14132710

[40] Kowalska, H., Kowalska, J., Ignaczak, A., Masiarz, E., Domian, E., Galus, S., Ciurzyńska, A., Salamon, A., Zajac, A., & Marzec, A. (2021). Development of a high-fibre multigrain bar technology with the addition of Curly Kale. *Molecules, 26*(13), 3939. doi:10.3390/molecules26133939

[41] Lu, N., & Zhou, P. (2019). Whey protein-based Nutrition Bars. *Whey Proteins,* 495-517. doi:10.1016/b978-0-12-812124-5.00014-x

[42] Orrego, C. E., Salgado, N., & Botero, C. A. (2013). Developments and trends in fruit bar production and characterization. *Critical Reviews in Food Science and Nutrition, 54*(1), 84-97. doi:10.1080/10408398.2011.571798

[43] Perkovic, S., Otterbring, T., Schärli, C., & Pachur, T. (2021). The perception of food products in adolescents, lay adults, and experts: A psychometric approach. doi:10.31234/osf.io/uya7m

[44] Pinto, V. R., Oliveira Freitas, T. B., Melo, L. F., Freitas, L. S., Souza Araújo, L. G., Minim, V. P., de Souza, T. D., & Bressan, J. (2018). What grabs our attention most to consume a snack bar in Brazil? following trends in choice of snack bars to boost market for healthier options. *The Open Food Science Journal, 10*(1), 62-78. doi:10.2174/1874256401810010062

[45] Qin, P., Wang, T., & Luo, Y. (2022). A review on plant-based proteins from soybean: Health benefits and soy product development. *Journal of Agriculture and Food Research, 7*, 100265. doi:10.1016/j.jafr.2021.100265

[46] Singh, A., Kumari, A., & Chauhan, A. K. (2022). Formulation and evaluation of novel functional snack bar with Amaranth, rolled oat, and unripened banana peel powder. *Journal of Food Science and Technology, 59*(9), 3511-3521. doi:10.1007/s13197-021-05344-6

[47] Srebernich, S. M., Gonçalves, G. M., Ormenese, R. D., & Ruffi, C. R. (2016). Physico-chemical, sensory and nutritional characteristics of cereal bars with addition of acacia gum, inulin and Sorbitol. *Food Science and Technology, 36*(3), 555-562. doi:10.1590/1678-457x.05416

[48] Sun-Waterhouse, D., Teoh, A., Massarotto, C., Wibisono, R., & Wadhwa, S. (2010). Comparative analysis of fruit-based functional snack bars. *Food Chemistry, 119*(4), 1369-1379. doi:10.1016/j.foodchem.2009.09.016

[49] Szydłowska, A., Zielińska, D., Łepecka, A., Trząskowska, M., Neffe-Skocińska, K., & Kołożyn-Krajewska, D. (2020). Development of functional high-protein organic bars with the addition of whey protein concentrate and bioactive ingredients. *Agriculture, 10*(9), 390. doi:10.3390/agriculture10090390

[50] Zaveri, S., & Drummond, S. (2009). The effect of including a conventional snack (cereal bar) and a nonconventional snack (almonds) on hunger, eating frequency, dietary intake and body weight. *Journal of Human Nutrition and Dietetics, 22*(5), 461-468. doi:10.1111/j.1365-277x.2009.00983.x

[51] Zulaikha, Y., Yao, S., & Chang, Y. (2021). Physicochemical and functional properties of snack bars enriched with tilapia (Oreochromis niloticus) by-product powders. *Foods, 10*(8), 1908. doi:10.3390/foods10081908

Opportunities and Obstacles of Regenerative Agriculture

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Abstract

The importance of agriculture as a food producer is unquestionable in every society. In the global context of population growth and climate change, this role takes on even greater importance. It manifests itself in the increase of the social order for affordable and high-quality food. Currently, not only the conventional agriculture but also their alternatives, regenerative agriculture, contribute to ensuring the required amount and assortment of food in society. What are the possibilities and benefits of regenerative agriculture and what difficulties must be faced by those who choose this path in the conditions of Slovakia – this forms the essence of the concept of the article in question? The aim of the paper is to highlight regenerative agriculture as a challenge for farmers to improve soil health in the current state, where the main problems are lack of rainfall and high input prices. The paper analyzes, synthesizes, compares studies on the given issue.

Regenerative agriculture is a term denoting an approach to farming that reduces the use of tillage and improves soil and water quality. Both thanks to the cultivation of diverse types of plants and crops and thanks to the retention of organic matter in the land.

While studies have shown that there is a difference in crop yields between industrial farming and more traditional methods, as well as many other emerging technologies, production efficiency as the industry grows often leads to both lower costs and higher yields. The study by the US National Center for Biotechnology Information (from 2018) found that regenerative farms are 78% more profitable than conventional ones, in part due to lower input costs.

Keywords: *regenerative agriculture, studies, benefits, conventional agriculture*

JEL Classification: *Q10, Q15*

1. Introduction

Regenerative agriculture is an alternative means of producing food that, its advocates claim, may have lower—or even net positive—environmental and/or social impacts. Regenerative agriculture has recently received significant attention from producers, retailers, researchers, and consumers, as well as politicians and the mainstream media. Despite widespread interest in regenerative agriculture, no legal or regulatory definition of the term “regenerative agriculture” exists nor has a widely accepted definition emerged in common usage (Newton P, Civita N, Frankel-Goldwater L, Bartel K and Johns C, 2020).

The adjective ‘regenerative’ has been associated with the nouns ‘agriculture’ and ‘farming’ since the late 1970s but the terms Regenerative Agriculture and Regenerative Farming came into wider

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circulation in the early 1980s when they were picked up by the US-based Rodale Institute. Through its research and publications (including the magazine Organic Gardening and Farming), the Rodale Institute has, over decades, been at the forefront of the organic farming movement. (Giller, K. E., Hijbeek, R., Andersson, J. A., & Sumberg, J.,2021)

Robert Rodale (1983) defined Regenerative Agriculture as 'one that, at increasing levels of productivity, increases our land and soil biological production base. It has a high level of built-in economic and biological stability. It has minimal to no impact on the environment beyond the farm or field boundaries. It produces foodstuffs free from biocides. It provides for the productive contribution of increasingly large numbers of people during a transition to minimal reliance on non-renewable resources'.

2. Data and Methods

For research we reviewed publications as journal articles, articles in magazines, web portal, web blogs , where regenerative agriculture was solved Our searches were designed to generate representative insights into the diversity of use of the term "regenerative agriculture." But the searches were not designed to be completely systematic nor completely exhaustive, nor did they need to be for the purposes of responding to our research question.

The paper analyzes, synthesizes, compares studies on the given issue of regenerative agriculture.

3. Results and Discussion

Climatic changes

Climate change is becoming one of the biggest environmental policy challenges of the 21st century. The World Economic Forum's report on global risks (WEFGR, 2017) included among the 5 biggest global risks, in addition to weapons of mass destruction, four risks somehow connected to climate change, namely (I) extreme weather, (II) water crisis, (III) natural disasters and (IV) failure of mitigation (elimination) and adaptation (adjustment) measures against climate change.

Agriculture also contributes to and is significantly affected by climate change.

In Europe and around the world, the consequences of climate change are becoming more and more noticeable. The average global temperature continues to rise. Some natural processes and precipitation patterns are changing, glaciers are melting, sea levels are rising and the water temperature in the oceans is increasing.

Although the manifestations of climate change are different around the world and in regions, its adverse consequences on socio-economic and natural systems are increasingly significant and require an active solution. Global warming is clearly happening, faster than some scenarios in the past have predicted. The updated linear trend (1906–2005) shows a temperature increase of 0.74 °C (in the last 50 years it shows an average warming trend of 0.13 °C per 10 years). By 2100, the Earth may warm on average by 1.5 to 4.5 °C compared to pre-industrial levels. The continued increase in air temperature will result in a reduction in the ability of the earth's surface (including seas and oceans) to absorb CO2. It is very likely that periods of extremely high temperatures and torrential rainfall will become more frequent. A temperature increase of 1.5 to 2.5°C will cause 20 to 30% of plant and animal species to be affected and hundreds of millions of people on the planet will suffer from water shortages. According to the most pessimistic scenarios, the air temperature on Earth will increase by about 7 °C and the ocean level will rise by approximately 0.6 m by the end of this century. Atmospheric

concentrations of carbon dioxide, methane and nitrous oxide have risen to levels that exceed those of the past 800,000 years, mainly as a result of human activity, such as the production of emissions from burning fossil fuels or from land-use change and deforestation.

The share of the production of the crucial greenhouse gas – CO2, according to sources, in 2014 was as follows: 37% – electricity production, 31% – transport, 15% – industry, 10% – housing and services, 7% – others. We consider agriculture to be generally indifferent – within the balance of production and sequestration of CO2, this balance is balanced – how much carbon dioxide is released into the atmosphere during the year, during agricultural activity, how much is also bound from the atmosphere into the new organic matter of agricultural crops through photosynthesis and cultures.

CO2 production by country in billion t and the resulting percentage of global production (35,890 t) is as follows: 1. China – 9,680 t (27.0%), 2. USA – 5,561 t (15.5%), 3. EU – 3,420 t (9, 5%), 4. India – 2,597 t (7.2%), 5. Russia – 1,595 t (4.4%), 6. Japan – 1,232 t (3.4%), 7. Indonesia – 0.641 t (1.8%), 8. Iran - 0.616 t (1.7%), 9. Saudi Arabia - 0.602 t (1.7%) and 10. South Korea - 0.599 t (1.6%).

Together, these ten biggest polluters of the atmosphere with CO2 produce 73.8% of it, which is basically three quarters of its global annual production.

In Central Europe, since the end of the 19th century, the average air temperature has increased by approximately 2 °C in both the warm and cold half of the year. The increase in temperature in the other 37 years (since 1980) was significantly the highest in the entire era of meteorological measurements in Central Europe (since 1775) and is probably the highest in the other 2,000 years for the same period of time. Precipitation totals have not had a significant trend in Central Europe since the end of the 19th century, but their variability has increased. (Smatana, J., Macák, M.,2022)

The goal of regenerative farming systems (Rodale, 1983) is to increase soil quality and biodiversity in farmland while producing nourishing farm products profitably. Unifying principles consistent across regenerative farming systems include (1) abandoning tillage (or actively rebuilding soil communities following a tillage event), (2) eliminating spatio-temporal events of bare soil, (3) fostering plant diversity on the farm, and (4) integrating livestock and cropping operations on the land. Further characterization of a regenerative system is problematic because of the myriad combinations of farming practices that comprise a system targeting the regenerative goal. Other comparisons of conventional agriculture with alternative agriculture schemes do not compare in situ best management practices developed by farmers, and frequently ignore a key driver to decision making on farming operations: the examined systems' relative net profit to the farmer. (LaCanne CE, Lundgren JG., 2018)

From the research activities of many authors we can see that the main principles of regenerative agriculture are:

- Minimising soil disturbance
- Minimising the use of chemical inputs
- Maximising biodiversity, both animals and plants
- Keeping the soil covered with crops as long as possible
- Adapting to the local environment

These are put into practice under a general, guiding principle of integrating all the farm's operations as far as possible. In today's conventional farming approach, crops and livestock production are

typically kept separate. Regenerative agriculture combines them in circular ecosystems; essentially, the animals feed the plants, and the plants feed the animals. The regulated grazing of sheep or cows, for example, encourages plant growth, and distributes natural nutrients back over the land in the form of dung. Poultry also fertilises land, as well as eating unwelcome bugs and weeds.

Growing crops can also remove and add nutrients, and regenerative farmers use growing practices that improve the health of their land. The more common regenerative farming methods include:

- No-till systems, which heavily reduce the digging and ploughing that can lead to loosened topsoil being blown away by wind or carried away by water
- Cover crops, which are grown in the soil when the main commercial crop has been harvested, and can be grazed by livestock or harvested themselves
- Increasing biodiversity, which increases the variety of nutrients going into the soil through roots and natural decomposition and, if well-managed, attracts insects which are the natural predators of pests
- Rotating crops, so that what is being taken out and put into soil naturally by plants is balanced
- Integrating livestock, so as to combine animals and plants in a single ecosystem
- Minimising chemical inputs, to minimise negative impact on biodiversity and pollution of waterways due to runoff. (EIT Food, 2022)

The conventional agriculture vs the regenerative agriculture

The basis of conventional agriculture is tilling the soil, usually in the following sequence: tillage – plowing – pre-sowing soil preparation – sowing – rolling. Plowing with plowshares and disc plows has adverse consequences for soil biota. During plowing, the upper soil horizon is turned by approx. 25 cm. Organisms living in the surface layer of the soil get into unsuitable conditions in depth, and vice versa – organisms from the "inside" of the soil get to the surface. Some of these organisms are able to relocate, but a large part dies due to unsuitable conditions. This is mainly due to the illumination of the soil and the rapid drying of the layer that was 25 cm deep before plowing. Soil aggregates are broken during pre-sowing preparation and become pseudo-aggregates that are not resistant to water erosion because they are not stabilized. All corridors, channels for edaphon and dead roots, important for the natural water regime of the soil, will be disturbed. The consequence is that the soil is loose after cultivation, but prone to re-consolidation during rainfall. After a heavy rainfall, air cannot enter the soil until the network of channels is formed anew. Infiltration of larger amounts of precipitation is very limited.

Conventionally cultivated soils have low biological activity, sometimes only at the level of 10% biological activity of regeneratively cultivated soils. As a result of conventional farming, the soil has poor resistance - resistance to external influences, and fertility must be maintained by supplying fertilizers in conventional agriculture. A dysfunctional soil ecosystem results in an increased incidence of pests and diseases, which are fought with chemical protective substances. These agrochemicals further reduce the functionality of the ecosystem, thus closing the circle. Simple crop rotation and the cultivation of monocultures on large areas also contribute to this. After harvesting the main market crop, the fields are left bare and not covered by any vegetation, where intensive mineralization of organic matter takes place in autumn. Carbon is oxidized into the atmosphere and contributes to climate change, nitrogen is leached into surface and groundwater. Bare soil is also extremely susceptible to wind and especially water erosion.

Regenerative agriculture can produce the same yields per hectare as conventional agriculture. It protects the soil and our homes from water erosion and flooding. It captures nutrients where they

should be, i.e. in the soil and not in the water. It also contributes to mitigating climate change – by growing plants, atmospheric carbon dioxide is captured and transferred to the soil, where it is effectively bound. This effective technology thus helps capture greenhouse gases that are already in the atmosphere. (Čaja, R. 2021)

Although the concept of regenerative agriculture was developed in the 1970s, there is still no consensus definition and although regenerative agriculture is gaining increasing international interest, a critical scientific evaluation of objectives and assumptions has yet to be made Furthermore, there is a multitude of other concepts that also relate to sustainable agriculture: for example agroecology, conservation farming, organic farming, ecological intensification and carbon farming, among others. Regenerative agriculture, as defined in Oberc˘ and Arroyo Schnell (2020), addresses similar objectives as many of the other above-mentioned concepts and approaches: maintaining agricultural productivity, increasing biodiversity and enhancing ecosystem services including carbon capture and storage. (Oberč, B.P., & Schnell, A.A., 2020). In contrast to other related concepts, regenerative agriculture is not viewed as defined a priori by a given set of rules and practices; instead, the goals that should be achieved are set and then practices and new technologies are adopted over time which contribute to achieve these goals. Regenerative agriculture explicitly stresses the opportunities of restoration, especially for soils in the agricultural landscape and the interplay in the production chain of various crops and ruminant and non-ruminant farm animals. These are principles also found in agroecology and organic agriculture. The concept is nonetheless viewed as broader and less prescriptive than other related concepts. Therefore, in contrast to some of the other approaches, regenerative agriculture does not exclude the use of, for example, modern plant and animal breeding technology, tilling, use of inorganic fertilisers or pesticides, but instead aims for a limited and more targeted use. A characteristic feature that regenerative agriculture shares with other concepts is that it aims to go beyond just reducing negative environmental effects of agriculture to actually producing positive environmental externalities.(EASAC, 2022)

Main advantages of regenerative agriculture

The main advantages of regenerative agriculture:

Ecologically regenerative: it is a type of agriculture that is able to restore the potential of ecosystem services. These are services offered by nature and which are intangible. This means that these services are, for example, the absorption of carbon dioxide from the atmosphere during the process of photosynthesis. It is not a service that we can quantify or value economically, but we are offered an important service.

Economically beneficial: By improving soil conditions, variable production costs can be drastically reduced. It also helps increase the yields they achieve by producing more crops.

Socially cohesive: Because it is a way to increase performance and productivity, it can create employment and wealth at the local level. It is a good way to unite people around a new vision. (JardineriaOn, 2022)

Regenerative agriculture in the World

The Rodale Institute has been running side-by-side field studies for the last 30 years, comparing organic and conventional agriculture. Results show that after a 1 to 2 year transition period, when yields tend to decline, there is no difference between conventional and regenerative farming in terms of yields. In stressful conditions, particularly during droughts, the regenerative fields perform better because they

are more resilient – the soil can absorb more water because it contains more biomass. And certainly farmers we work with say the yields are the same, while their input costs go down.

Crucially, even where yields are lower, the price premium on regenerative and organic food can make the crops more profitable than their conventionally-grown counterparts. In 2018, US researchers showed that on farms in the Northern Plains of the USA, regenerative fields had 29% lower grain production but 78% higher profits over conventional corn production systems. The picture can be complex, and there are differences when it comes to input costs: regenerative and organic farming tend to have higher labour inputs, while conventional use more pesticide and fertiliser.

The global regenerative agriculture market was valued at USD 7.74 billion in 2021 and is expected to grow at a CAGR of 14.4% during the forecast period. Rising awareness and adoption of regenerative agriculture, along with development due to increased concern and understanding about agriculture's depletion of water, land, and air condition, is expected to propel regenerative agriculture market growth during the forecast period.

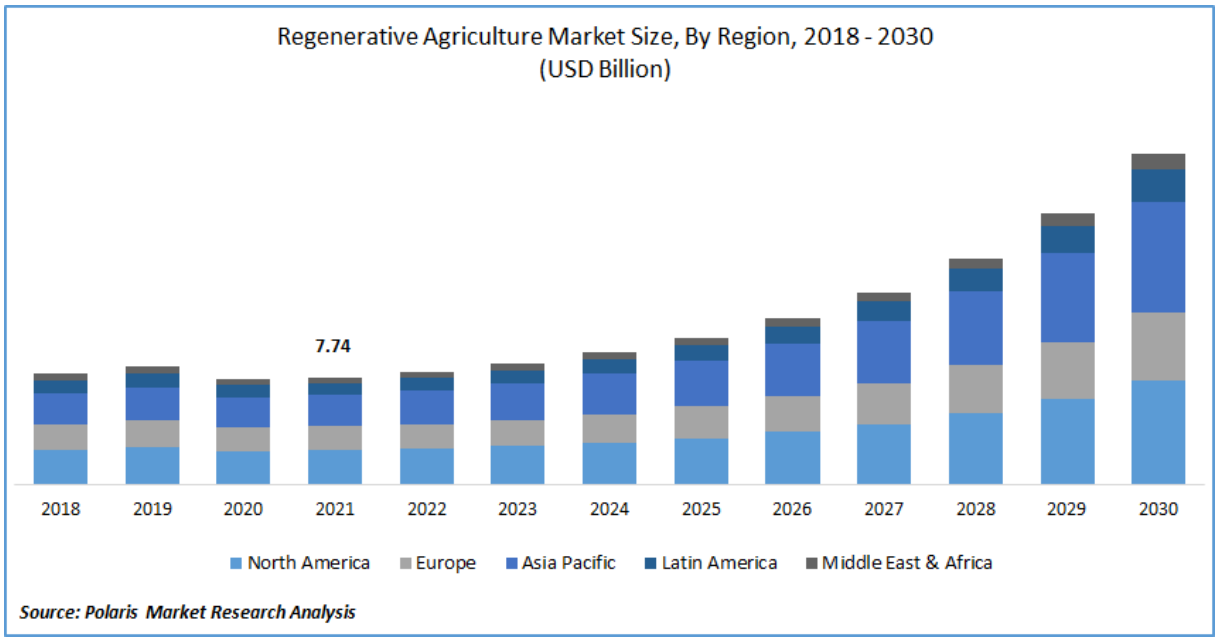

Figure: Regenerative Agriculture Market Size, By Region, 2018-2030)

Source Polaris Market Research Analysis

Regenerative agriculture in Slovakia

According to the principles of regenerative agriculture, an estimated 6,000 ha of land is farmed in Slovakia, which is less than 0.4% of Slovakia's arable land (1,408,428 ha). Regenerative agriculture practices are managed by two larger agricultural entities and several smaller self-employed farmers. For comparison – the area of land registered in organic production as of September 2021 is 10.46%. Compared to 2019, this is a slight increase, when a total of 859 entities were registered in the system of organic agricultural production in the Slovak Republic, managing approximately 196,209.9 ha of agricultural land, which represented 10.19% of the total area of agricultural land. In addition, we have 851,718 ha of permanent grassland and 118,955 ha of orchards, vineyards and gardens, where agroforestry systems can be considered on a small part.

There are many agronomists who are interested in the topic, but they are hindered by the economic separation of companies. Business economists are not familiar with the topic and object to the higher prices of sowing with a no-till seed drill. Savings in other activities and thus lower costs are often not taken into account. The average consumption of diesel in conventional agriculture is around 110-120 l/ha/year. Diesel consumption in regenerative agriculture is around 45 l/ha/year. Restraint in the agricultural sector is largely related to the conservative approach of the population of Slovakia to adopting new procedures in general. Willingness to introduce changes and new technologies is low. The fear of possible economic instability during the transition to regenerative agriculture also plays a role. The transition to no-till farming is generally associated with a temporary reduction in yields by 10-20%, which is, however, compensated by a more significant reduction in costs (30-40%). So the farmer does not make a loss in the first year of the transition. After an average of five years (3 to 8 years), the fertility returns to the level of conventional farming. At lower costs, this means higher profitability for the farmer. This time depends on the type of soil (sandy, loamy, clayey) and the degree of its degradation before the start of the transition.

4. Conclusion

In the 21st century conventional agriculture incurs other indirect costs that cannot be ignored. The long-term threat of climate change to the natural environment is well established, and agriculture bears much of the responsibility for this. In its latest report on climate change, the IPCC states that 23% of the total global greenhouse gas (GHG) emissions are directly related to “agriculture, forestry and other types of land use”. Conversely, regenerative agriculture seeks to increase the organic matter in soil, which makes it better able to sequester carbon from the atmosphere, meaning it has the potential to reduce climate change instead of contributing to it.

Some regenerative farmers argue that their grazing techniques can play a significant role in reducing the carbon intensity of agriculture, and while some of these claims have been credibly disputed, some scientists endorse the findings.

Regenerative farming has other demonstrable benefits besides improving soil health and helping to fight climate change. Improving the soil not only increases fertility in a sustainable way, but also tends to improve water infiltration. Better infiltration means less runoff, and also less erosion and pollution from soil being carried away in the runoff water. In some areas, water springs that dried up several years ago have begun to flow again due to new regenerative farming approaches.

In integrating different elements on the farm, the regenerative farmer seeks to revive the classic mixed-farm model, which is an important consideration in food industry. By producing a greater diversity of foodstuffs on one site, a farm can reduce external inputs and outputs, and thus reduce the risk of contamination.

However, to practice regenerative agriculture effectively, many farmers will need to acquire new knowledge and skills, particularly in respect of soil management. And managing farmers’ expectations of results might be difficult, as critics have accused exponents of over-claiming on yield and benefits. By not tilling the soil, farmers can save between 30 and 40 percent of time, and can decrease the amount of soil erosion in certain terrains, but the disadvantages of regenerative agriculture are, in many cases, that more unwelcome plants grow on the land, and some farmers compensate for this by increasing their use of herbicide.

Therefore, the main disadvantages of regenerative agriculture are:

- Farmers will need to acquire new knowledge and skills
- Less tilling may lead to more unwelcome plants
- Some farmers compensate by increasing their use of herbicides
- Potentially lower yields, dependent on crop and local conditions
- The transition away from conventional methods will take time

Regenerative farming clearly has some way to go yet before it can offer an alternative to current conventional, large-scale agriculture. However, it's equally clear that it is a source of important ideas and influence. For farmers, a regenerative approach can offer new profitable and nature-friendly economic models. For policymakers, it offers alternative ways of thinking about sustainability. And for changemakers looking to reduce the negative impacts of farming, it represents small actions and changes that are closely linked to a large-scale vision. (EIT Food, 2022)

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References

[1] Čaja, R. 2021. Regeneratívne poľnohospodárstvo a agrolesníctvo, Analýza súčasnej situácie na Slovensku, 2021, Nadácia Ekopolis, 24 s. https://prepodu.sk/engine/wp-content/uploads/2022/06/Analyza-2.korekt.pdf

[2] EASAC (2022, November 25) Regenerative agriculture in Europe A critical analysis of contributions to European Union Farm to Fork and Biodiversity Strategies EASAC policy report 44 , April 2022, ISBN: 978-3-8047-4372-4 https: //easac.eu/fileadmin/PDF_s/reports_statements/Regenerative_Agriculture/EASAC_RegAgri_Web_290422.pdf

[3] EIT Food (2022, November 21) The Regenerative Agriculture Revolution. 2022. Message posted to https://www.eitfood.eu/projects/regenag-revolution

[4] Giller, K. E., Hijbeek, R., Andersson, J. A., & Sumberg, J. (2021). Regenerative Agriculture: An agronomic perspective. Outlook on Agriculture, 50(1), 13–25. https://doi.org/10.1177/0030727021998063

[5] JardineriaOn (2022, November 25) Regeneratívne poľnohospodárstvo Message posted to https://www.jardineriaon.com/sk/agricultura-regenerativa.html

[6] LaCanne CE, Lundgren JG. (2018) Regenerative agriculture: merging farming and natural resource conservation profitably. PeerJ. 2018 Feb 26;6:e4428. doi: 10.7717/peerj.4428. PMID: 29503771; PMCID: PMC5831153. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5831153/

[7] Newton P, Civita N, Frankel-Goldwater L, Bartel K and Johns C (2020) What Is Regenerative Agriculture? A Review of Scholar and Practitioner Definitions Based on Processes and Outcomes. Front. Sustain. Food Syst. 4:577723. doi: 10.3389/fsufs.2020.577723

[8] Oberč, B.P., & Schnell, A.A. (2020). Approaches to sustainable agriculture: exploring the pathways towards the future of farming. DOI:10.2305/iucn.ch.2020.07.en

[9] Rodale, R. (1983). Breaking New Ground: The Search for a Sustainable Agriculture. In Futurist, 1983, vol. 17, p. 15-20.

[10] Smatana, J., Macák, M. (2022, November 21) Naše pole, 2022. Message posted to https://nasepole.sk/polnohospodarstvo-a-klimaticke-zmeny/

The Impact of Selected Nutrition Labels (FoPL) on Consumer Preferences for Functional Foods

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Abstract

Healthy eating is one of the key changes in people's lifestyles. As a result of these changes, food purchasing mindsets have changed significantly in recent years. Until recently, price was the most important criterion for most customers in grocery stores, but nowadays the quality and composition of food is the most important criterion, especially according to consumer surveys. Recent surveys suggest that price still plays an important role, and in many cases even more than the quality declared in questionnaires. This is the typical question that respondents in surveys tend to answer as they are expected to, rather than as they actually make their purchasing decisions in the shop. For the segment of customers that tends towards a healthy lifestyle, getting enough exercise and eating a healthy diet is important. In order to facilitate the choice of foods for a healthy and balanced diet, nutritional values are displayed on products in some countries, with the three most widely used versions of labelling being NS (Nutri-Score), GDA (Guideline Daily Amounts), MTL (Multiple Traffic Light). The paper highlights the influence of selected nutritional indicators in consumer choice of functional foods. The paper concludes by highlighting the merits of different types of FoPL food labels.

Keywords:*, consumer behavior, functional foods, lifestyle, nutritional indicators*

1. Introduction

Food consumption is one of the basic physiological needs of human beings. The food that our body needs to function daily should contain a balanced ratio of essential macronutrients such as protein, carbohydrates and fat. However, these values are often not considered or not understood by the average consumer when selecting individual food products in the store. These are the most common reasons why food manufacturers have facilitated purchasing decisions by labelling their products with nutritional indicators on the front of the packaging to motivate consumers to make healthier food choices.

1.1 Consumer Behaviour and Lifestyle

Consumer behaviour since 2020 has been strongly influenced by the global problem associated with the Covid-19 pandemic, which has also had an impact on the economic side of individual countries.

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Consumer behaviour and consumption are highly dependent on the market context. Due to the prolonged adverse situation, consumers have also had to adapt their purchasing habits and thus modify their consumption motivations. Moreover, we still do not know what the future effects of the closed and isolated nature of the pandemic in more than one country will have on consumers' purchasing behaviour (Blazquez-Resino, Gutierrez-Broncano & Golab-Andrzejak, 2022).

Lifestyle more closely describes how individuals function and behave on a day-to-day basis when carrying out various activities at work, in leisure or in the way they eat. It is the way in which a personality is shaped by geographical, economic, political, cultural and religious influences throughout its existence. As Farhud (2015) states in his article, according to WHO, up to 60% of the factors influencing a person's health and quality of life stem from his/her lifestyle.

1.2 Healthy Foods and The Current Trend

Food is essential fuel for human functioning. Their purchase and processing pattern is related to the characteristics of the consumer - their social status, economic opportunities, lifestyle, the environment they are in, consumption preferences and various other factors determine this relationship between consumer and food consumption (Martinho et. al., 2022).

In recent years, the prices of products and services have been rising steadily, which unfortunately has not spared the agri-food industry. Food is a product that is inherently related to the basic physiological need of human beings – eating, hence its primary position in the market. The purchase and consumption of food is therefore the primary motive for all consumers, for which they are willing to pay, but often price is the decisive factor in their choice. As mentioned by Carlson et al. (2012), when comparing costs between healthy and less healthy foods, it is also essential to pay attention to the price metric used, and portion sizes (e.g., per 100 grams) should be the same between the pairs being compared. In addition, it is also important to look at how consumers perceive the term 'healthy' in relation to such labelling on food packaging (Waterlander et. al., 2013), as we are unfortunately in an era where the terms 'fit, zero, light, protein, organic, eco, raw and vegan' are becoming synonymous with 'healthy', when their nutritional values on the back of food product packaging may show us otherwise. However, in this context, we are faced with a contradiction between the price and quality of healthy food. On the one hand, we have consumers who will prefer to buy an unhealthy option over a healthier one because of the lower price, and on the other hand, we have consumers who are looking for 'fitness or high in protein, low in calories, etc.' on food products when they buy them, and price doesn't play such a significant role in their choice (Jo, 2016). A factor that can also greatly influence this consumer decision making is a nutritional indicator such as a certain food labelling system (FoPL).

1.3 Nutritional Indicators and Their Role in Consumer Behaviour

The policy of labelling food products with nutritional indicators has been met with conflicting considerations (Lusk, 2019). Labels and nutrition labels on food packaging make consumers more informed choices directly during the purchasing process (Lusk, 2012). However, the flip side of food indicator labels is precisely their costliness and their potential to mislead rather than inform consumers (Schuldt & Schwarz, 2010), (Syrengelas et al., 2017). Such food indicator labelling on product packaging can be objective – scientific in nature, but many companies use the labelling system only as a kind of marketing purpose, such as the use of the word "natural" on non-meat foods (Lusk, 2019). Some of the most well-known food labelling methods include calorie labelling on restaurant menus (Ellison, Lusk & Davis, 2013), nutrition panels (Garretson & Burton, 2000), nutrition labels on the front of product packaging (Julia et.al., 2016), semaphore, numeric and symbolic nutrition labels (Hersey et.al., 2013), and others.

2. Data and Methods

The subject of interest was testing the understanding and perception of the nutritional indicator Nutri-Score and Nutrinform in the selection of functional foods. The experiment consisted of 2 separate surveys. A quantitative survey with a sample of 1000 respondents was administered to 52% of women and 48% of men aged 18 to 75 years (18-29 years, 18%; 30-39 years, 20%; 40-49 years, 19%; 50-59 years, 16%; 65 years and over, 27%). The survey was carried out from 19 April 2021 to 23 April 2021 by an external panel of the MNForce agency. The questionnaire included questions focusing on food purchasing attitudes and healthy lifestyles. For the purposes of the survey, a fictitious brand Fine was created to eliminate the influence of the brand, on which the influence of the Nutri-Score and Nutrinform indicator was subsequently tested. The methodology was modeled after the Swiss model by Egnel et al. (2020).

15 respondents participated in the qualitative survey under laboratory conditions. The testing process can be seen in Figure 1.

Figure 1: The testing process in Laboratory conditions

Source: Own database based qualitative research 2022

Testing was conducted through in-depth interviews using Eye tracking in order to reveal explicit and implicit preferences influenced by the Nutri-Score nutritional indicator.

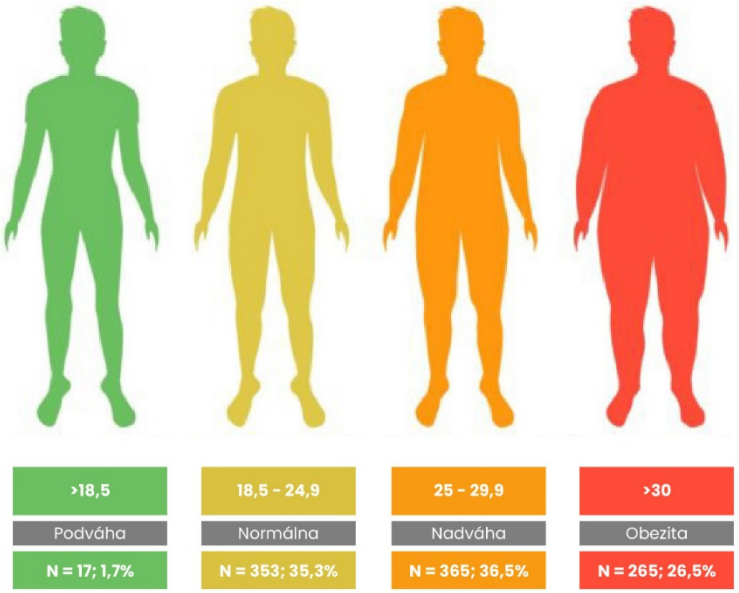
Visual attention of the respondents was monitored by a Tobii Glassess 2 (100Hz) mobile eye camera (eye tracking) and processed using Tobii Pro Lab studio software. Primary data were statistically processed using descriptive and inductive statistics in RStudio software environment.

The survey was conducted on February 2022 in the Laboratory of Consumer Studies at FEM SUA in Nitra.

3. Results and Discussion

The results of the quantitative research on a sample of 1,000 respondents show that 55% of respondents pay a great deal of attention and 13% even a very great deal of attention to buying healthy foods, but this is not reflected in the data based on the calculated BMI of overweight (36.5%) and obese (26.5%) of the sample. In Figure 2, it can be seen that more than half (63%) of the respondents are overweight (36.5%) and (26.5%) are obese according to the BMI index.

Figure 2: BMI index of the survey participants



Source: Own processing based quantitative research 2021

In terms of gender, based on the BMI calculation, more men (44.33%) than women (29.13%) are overweight. By income group, the most obese people are 37.84% in the income category 401 – 700 € and the most overweight people are in the income categories 701 – 1000 € and 1001 – 2000 €. These findings suggest the assumption that although most respondents are interested in healthy eating ultimately at the point-of-sale price determines people reaching for less healthy alternatives. Next, we investigated the impact of two selected nutritional indicators, Nutri-Score and Nutrinform, on the ability to influence consumer choice in the functional food category.

Figure 3: Fictitious brand of functional foods with different nutritional balance

Source: Own processing based quantitative research 2021

When selecting the products in terms of nutritional balance as indicated by the chosen indicators, Nutrinform did not show any significant effect of the variables studied (BMI, healthy eating) (Table I). For the Nutri-Score, a very weak positive correlation can be observed for the variables income and education, i.e. there is a weak tendency for people with higher income/education to improve their product choice more than those with lower income/education (Table II).

Table 1: Selection of products depending on selected factors I.

Variable		
BMI	-0,027	-0,025
Healthy eating	-0,037	0,036
Score	1	1

Source: Own processing based quantitative research 2021

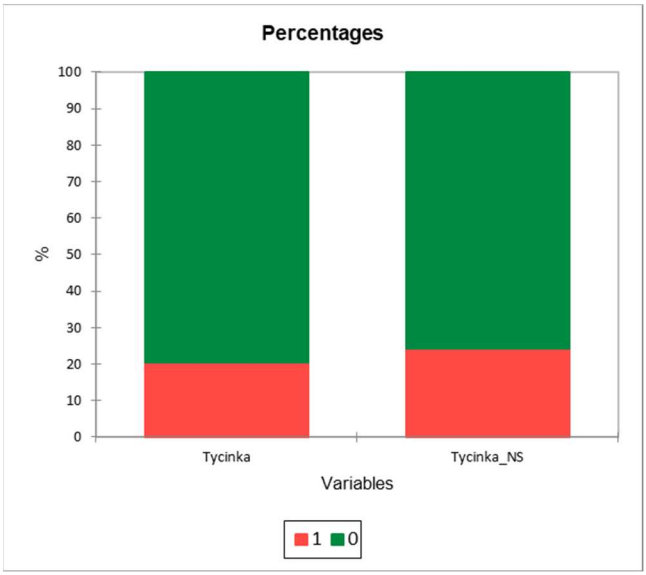
Table 2: Selection of products depending on selected factors II.

Variable		
City size	-0,055	-0,037
Education	**0,108**	0,001
Income	**0,146**	0,020
Score	1	1

Source: Own processing based quantitative research 2021

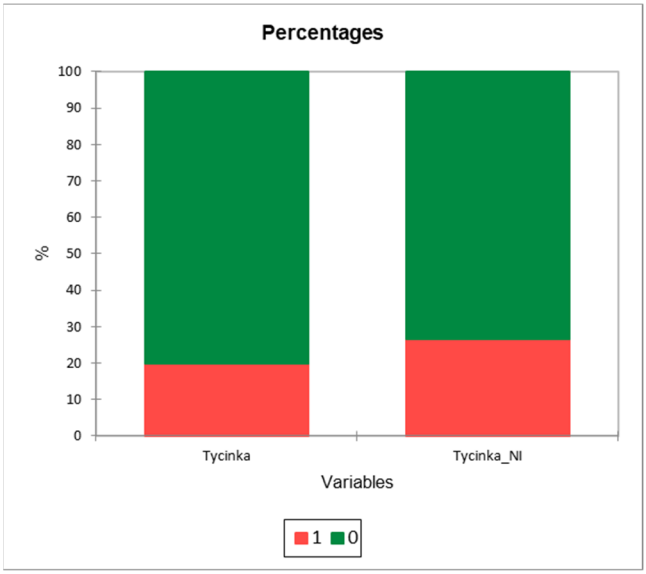
In the case of functional foods (protein, muesli bars), a statistically significant difference in the understanding of nutritional quality through Nutri-Score (p=0.061) was confirmed at α=0.1, indicating that the inclusion of Nutri-Score on the product thus improved the understanding of nutritional quality for this product, but very slightly (if we work with the standard significance level α=0.05, we do not observe a significant improvement), see Figure 4.

Figure 4: Correctness of the determination – Nutri-Score



Source: Own processing based quantitative research 2021

Figure 5: Correctness of the determination – Nutrinform



Source: Own processing based quantitative research 2021

A statistically significant difference in the understanding of nutritional quality at α=0.05 was also found for the Nutrinform labelling of the bar (p=0.001) see Figure 5, indicating that the inclusion of both models (NS and NI) on this product improved consumer understanding of nutritional quality.

Under laboratory conditions, three functional bars (with real labels) were tested and differed in terms of nutritional balance see Figure 6.

Figure 6: Testing of 3 functional (protein) bars under laboratory conditions

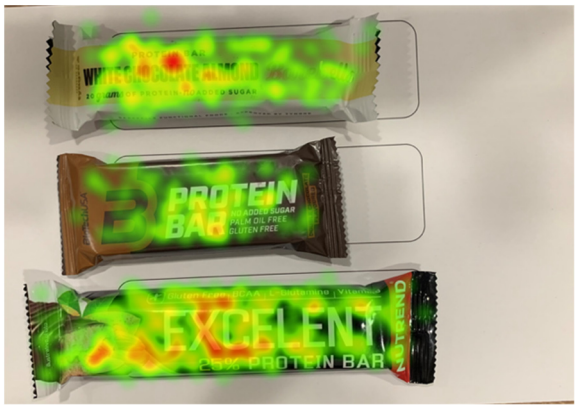
Source: Own database based qualitative research 2022

In the experiment, we focused on the external aspect of each sample, in which we investigated the influence of the factor - packaging design on the respondent. The respondent's task was to answer a question about which of the selected protein bar samples they would choose based on its packaging.

Up to 77% of respondents would choose the Barebells brand, and cited “the white color of the packaging” and “the style of the font” as the most common reasons. Only 14% would choose BioTechUSA, which caught their eye with its chocolate-colored packaging, and seven percent of respondents were represented by the Nutrend brand, which had attractive packaging.

Figure 7 shows us again a heat map, which allows us to see which packaging was the most appealing to respondents. The Excelent bar from the Nutrend brand had the hottest spots, i.e. the spots with the most eye-catching packaging. Respondents paid attention to the picture showing the bar with pistachios on the left side of the packaging and were also attracted by the name of the bar, especially in the areas of the letters 'EXC'. They paid less attention to the right-hand side of the bar packaging where they read the manufacturer's brand name. The second most viewed sample was Barebells, which caught respondents' attention with the flavor name, particularly in the area of the words 'CHOCOLATE – PROTEIN BAR'.

Figure 7: Visual perception of functional bars under laboratory conditions without nutritional labelling



Source: Own processing based qualitative research 2022

The heat map (Figure 8) shows that the hottest spots - the spots with the hottest content – are on the Nutri-Score food indicator for Nutrend's Excelent bar, which has the worst rating on this indicator, but the hotter spots are also on the remaining Nutri-Score ratings. Among the packaging, the most eye-catching this time was the design of the Barebells protein bar, which again caught the eye with its graphic lettering. The indicator also increased preferences, with up to 93% of respondents opting for the Barebells protein bar after seeing the indicator, which is confirmed by the results from the biometric measurement with the eyetracker, with an increase of up to 14% in this round due to the influence of the Nutri-Score.

Figure 8: Visual perception of functional bars under laboratory conditions with nutritional labelling

Source: Own processing based qualitative research 2022

The results suggest that Nutri-Score is an easy-to-read type of nutritional food label that can quickly and efficiently facilitate consumers' purchasing decisions at the point of sale.

4. Conclusion

The results of the study show that despite higher BMI values (36.5% overweight, 26.5% obese), reflecting the state of the population, 86% of respondents said that healthy eating was important to them, with 24% saying it was even very important. We decided to test the impact of two nutritional indicators, Nutri-Score and Nutrinform, in functional food choices. In this context, we tested whether size of residence, BMI and equally healthy eating have an impact on improving the choice in terms of nutritional quality, but this could not be statistically confirmed. For the Nutri-Score, we found a very weak positive correlation for the variables income and education, i.e. there is a weak tendency for people with higher income/education to improve their choice of product more than those with lower income/education. These findings suggest two facts. The first is that people would probably like to get better at losing but their income does not allow them to do so. The second is that people focus on price when making food choices. The fact is that putting both models (NS and NI) on a protein bar product improved consumer understanding of nutritional quality, which was confirmed statistically.

The results of qualitative testing also confirmed that the use of the 'Front of pack labelling' model in the form of the Nutri-Score label has an impact on consumer decision making when choosing a functional food. However, a limitation of the realised survey was to some extent the structure of the tested sample of respondents, where more than half of the individuals confirmed an interest in healthy eating and fitness, which may have influenced the results of the survey.
In order to validate and improve the results, we plan to conduct a similar quantitative study in a real store setting in order to reveal the true impact of the Nutri-Score indicator on consumer purchasing behaviour using eye tracking and electroencephalography (EEG).

Acknowledgements

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References

Blazquez-Resino, J. J., Gutierrez-Broncano, S., & Gołąb-Andrzejak, E. (2022). Neuroeconomy and neuromarketing: the study of the consumer behaviour in the Covid-19 context. *Frontiers in Psychology*, *13*, 822856.

Carlson, A., & Frazão, E. (May 1, 2012). Are healthy foods really more expensive? It depends on how you measure the price. It Depends on How You Measure the Price (2012). USDA-ERS Economic Information Bulletin, (96).

Egnell, M., Galan, P., Farpour-Lambert, N. J., Talati, Z., Pettigrew, S., Hercberg, S., & Julia, C. (2020). Compared to other front-of-pack nutrition labels, the Nutri-Score emerged as the most efficient to inform Swiss consumers on the nutritional quality of food products. *PloS one*, *15*(2), e0228179.

Ellison B., Lusk J.L. and Davis D., (2013). Looking at the label and beyond: the effects of calorie labels, health consciousness, and demographics on caloric intake in restaurants. *International Journal of Behavioral Nutrition and Physical Activity*, 10(1), p.21.

Farhud, D. D. (2015). Impact of lifestyle on health. *Iranian journal of public health*, *44*(11), 1442.

Garretson J.A. and Burton S., (2000). Effects of nutrition facts panel values, nutrition claims, and health claims on consumer attitudes, perceptions of disease-related risks, and trust. *Journal of Public Policy & Marketing*, 19(2), pp.213–227.

Hersey J.C., Wohlgenant K.C., Arsenault J.E., Kosa K.M. and Muth M.K., 2013. Effects of front-of-package and shelf nutrition labeling systems on consumers. Nutrition reviews, 71(1), pp.1–14. pmid:23282247

Jo J., Lusk J.L., Muller L. and Ruffieux B., 2016. Value of parsimonious nutritional information in a framed field experiment. Food Policy, 63, pp.124–133.

Julia C., Blanchet O., Méjean C., Péneau S., Ducrot P., Allès B., et al., 2016. Impact of the front-of-pack 5-colour nutrition label (5-CNL) on the nutritional quality of purchases: an experimental study. International Journal of Behavioral Nutrition and Physical Activity, 13(1), p.101. pmid:27645372

Lusk J.L. (2012). "Consumer Information and Labeling." in US Programs Affecting Food and Agricultural Marketing. Armbruster W.J.and Knutson R.D.(eds). New York: Springer Science + Business Media, 2012.

Lusk, J. L. (2019). Consumer beliefs about healthy foods and diets. *PLoS One*, *14*(10), e0223098.

Martinho, V. J., Bartkiene, E., Djekic, I., Tarcea, M., Barić, I. C., Černelič-Bizjak, M., ... & Guiné, R. P. (2022). Determinants of economic motivations for food choice: Insights for the understanding of consumer behaviour. International Journal of Food Sciences and Nutrition, 73(1), 127-139.

Schuldt J.P. and Schwarz N., (2010). "The "organic" path to obesity? Organic claims influence calorie judgments and exercise recommendations." *Judgment and Decision Making*, 5(3), 144–150.
Syrengelas K.G., DeLong K.L., Grebitus C. and Nayga R.M. Jr, (2017). Is the natural label misleading? Examining consumer preferences for natural beef. *Applied Economic Perspectives and Policy*, 40(3), pp.445–460.

Waterlander W.E., Steenhuis I.H., de Boer M.R., Schuit A.J. and Seidell J.C., (2013). Effects of different discount levels on healthy products coupled with a healthy choice label, special offer label or both: results from a web-based supermarket experiment. *International Journal of Behavioral Nutrition and Physical Activity*, 10(1), p.59.

Quality of Life as a Predictor of Sustainable Consumer Behaviour

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Abstract

Food waste is a serious environmental problem throughout the entire food chain. About 1/3 of the total amount of food produced worldwide ends up as waste, requiring about half as much agricultural land and using about half as much energy and fertilizer as would be needed to feed all the people on Earth. Consumer behaviour on the market of products and services forms the core of interest in economics, marketing, and social and psychological (behavioural) research. How consumers behave and make their decisions on the food market, and how they deal with them after the purchase, affects not just the producers and sellers but also the entire society and environment. Despite a large number of studies dealing with consumer behaviour in the context of food waste, we are still only at the beginning of the research into what influences responsible consumer behaviour, as there is still no comprehensive framework that explains the determinants of the behaviour under study. The present paper aims to present a comprehensive picture of food waste and to point out the importance of life satisfaction in responsible consumer behaviour. The research group comprises 683 respondents aged between 18 and 83 with Slovak citizenship and permanent residence in the Slovak Republic. To meet the research objective and collect the data, a complex questionnaire, which combines several survey techniques, including psychometric methods, was created – while the first part of the questionnaire ascertains the socioeconomic characteristics of the consumers involved in the research, the second part of the questionnaire contains 48 items from the NEO five-factor personality inventory (from the original NEO – FFI; NEO Five-Factor Inventory). Consumers' quality of life was evaluated based on the life satisfaction questionnaire and the LISAT-11. We determined the level of food waste among consumers through a 34-item attitude test. The results of our research show that overall satisfaction with life largely depends on what a person is like, how he/she can live in society and communicate, what his/her cognitive processes and affective states are and how he/she experiences them. Whether a person is satisfied depends on many factors and areas of life. We work only with some of them in research. We also found that the quality of life in selected areas significantly affects responsible consumer behaviour and the rate of food waste.

Keywords: *food waste, quality of life, consumer behaviour, consumer*

JEL Classification: *M39, L66, Q18*

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1. Introduction

The concepts of sustainability and sustainable development are inherently linked to the environment and environmental problems. Today, sustainability is a concept we encounter in various areas of our lives daily, and sustainability and environmental issues are now becoming an integral part of our daily lives.

The efforts to protect the environment and raise awareness of sustainability issues have undergone a turbulent development. The critical year was 1983 when the United Nations (UN) established the World Commission on Environment and Development, which focused on environmental problems. This commission, also known as the Brundtland Commission, issued a report entitled Our Common Future in 1987 (minzp.sk, 2020). This report deals with the problem of economic development that can be sustainable without destroying non-renewable natural resources and the environment. In this report, which politicians and environmental experts drew up, there can be found the first and most frequently cited definition of sustainable development, according to which sustainable development is the development that meets the needs of the present generations without compromising the ability of future generations to meet their own needs (World Commission on Environment and Development, 1987).

In the conditions of the Slovak Republic, sustainability is defined by Act No. 17/1992 Coll. about the environment as such development, which preserves the possibility for current and future generations to satisfy their basic life needs, while the diversity of nature and preserving the natural functions of ecosystems are not reduced.

Since the 1980s, the UN has been making efforts to raise the profile of sustainability issues and to design, implement and monitor activities to mitigate the impact of human economic activities on the environment. On September 8, 2000, the largest meeting of world leaders took place in New York, during which the heads of state and government adopted the so-called UN Millennium Declaration. In it, the countries committed to a new global partnership to help alleviate poverty and set several goals with a deadline for their fulfilment by 2015. We refer to these goals as MDGs – Millennium Development Goals (unis.unvienna.org, 2015; un.org, 2015), which are globally time-bound and measurable targets focused on addressing extreme poverty in all its dimensions – income poverty, hunger, disease, lack of adequate housing and exclusion while simultaneously promoting gender equality, education and sustainability in the area of environment. They also contain fundamental human rights – the right of every person on Earth to health, education, housing, and security.

Figure 1: Millennium Development Goals

Source: *Miléniové rozvojové ciele (Millennium Development Goals).* (2015). https://unis.unvienna.org/unis/sk/topics/2013/mdg.html

On September 25, 2015, the 2030 Agenda for Sustainable Development was approved at an extraordinary UN summit in New York, determining the general framework for the world's countries to eliminate poverty and achieve sustainable development by 2030. It is based on the Millennium Development Goals from 2000 and builds on them.

The UN's 2030 Agenda for Sustainable Development is the most comprehensive set of global goals for achieving sustainable development. The fundamental principles of the 2030 Agenda outlined in the document approved by the UN General Assembly, "Transforming our world: 2030 Agenda for sustainable development," are transformation, integration, and universality (vicepremier.gov.sk, 2015).

The transformative power of the 2030 Agenda is represented by the 17 Sustainable Development Goals (SDGs) developed into 169 related sub-goals, which are intended to guide the structural political, economic and social transformation of individual countries in the world response to the threats that humanity currently faces. The 2030 Agenda is not legally binding. It expresses the intention of countries to lead their development toward sustainability and set their national policies, strategies, and planning to contribute to the achievement of global goals (sustainabledevelopment.un.org, 2018).

Figure 2: Goals of sustainable development

Source: United Nations. (2015). *The 17 Goals*. https://sdgs.un.org/goals

There are nine years left to fulfil the 17 Sustainable Development Goals. The Social Progress Index report (Green et al., 2020) indicates that if the current trend does not change, the goals will not be met before 2082. The pandemic of the disease COVID-19 postpones the fulfilment of the goals by another decade, until 2092, so the delay is more than 60 years.

Several experts are worried about whether we can fulfil the goals of the 2030 Agenda, and they propose radical changes in primary, secondary, and tertiary education. According to them, our inability to solve worsening environmental problems stems from the fact that entire generations have been led to unsustainability, even within the education framework. As an example, they cite the excessive use of plastic bags (until recently, they were available for purchase in supermarkets and shops for free) and plastic packaging, excessive use of private means of transport, consumerist lifestyles, excessive consumption of fast food and others (The Baltic University Programme, 2021).

Food and water are essential resources that humans need for their survival. In developed European countries, we do not yet experience food shortages to a large extent. We have relatively little (or no) problems with drinking water supplies, so it might seem that the problem of food waste does not affect us in any way. Consumers often struggle to realize their lifestyle and the associated food waste. They

often do not see anything wrong with their way of life, so they are not willing or able to change anything (Rybanská et al., 2021).

Food waste is a global and societal problem, falling under the issue of sustainable development. Preventing food waste is one of the current priorities of the European Commission and its activities. According to the Food and Agriculture Organization (FAO, 2011; FAO, 2013), excessive waste leads to higher emissions of greenhouse gases and more significant changes in biodiversity.

The task of the EU member states is to reduce global food waste at the retail and consumer level by 50% by 2030 and to reduce food losses in the entire production and supply process (vicepremier.gov.sk, 2015). Reducing food waste and loss can lower production costs, improve food security and contribute to sustainability (FAO, 2019).

Consumers are the biggest producers of food waste, so the final buyers and consumers – people in households – waste the most from the entire food supply chain (Visschers et al., 2016; free-food.sk, 2021).

For consumers, this finding is often surprising (Rybanská, 2020). They believe supermarkets and catering service providers are the most significant food waste producers. Therefore, several studies and research, e.g., Evans (2011), Quested et al. (2013), Stefan et al. (2013), Abeliotis et al. (2014), Graham-Rovew et al. (2014), Stancu et al. (2016), Diaz-Ruiz et al. (2018), Revilla and Salet (2018), Schanes et al. (2018), Hebrok & Heidenstrøm (2019), Světlík and Bulanda (2019), Lincényi et al. (2022), and Aka & Buyukdag (2021) deal with factors that influence consumer behaviour that leads to food waste. Although the issue of food waste has attracted the attention of many experienced experts in the last decade, it has not yet been possible to create a comprehensive model that would reliably explain consumer behaviour in this regard. Further research is therefore essential, as a thorough understanding of consumer behaviour concerning food waste can significantly change the current situation (Diaz-Ruiz et al., 2018).

The subject of our research is the quality of life as a potential predictor of consumer behaviour in food waste.

2. Data and Methods

The present paper aims to present a comprehensive picture of food waste and to point out the importance of life satisfaction in responsible consumer behaviour.

The research was carried out from January to December 2021, during the duration of the Covid-19 pandemic, which affected almost all aspects of our lives. Since the research subject is also consumers' quality of life, we believe that the found evaluations are influenced mainly by the given situation.

In order to meet the research objective and collect the data, a complex questionnaire, which combines several survey techniques, including psychometric methods, was created – while the first part of the questionnaire ascertains the socioeconomic characteristics of the consumers involved in the research, the second part of the questionnaire contains 48 items from the NEO five-factor personality inventory (from the original NEO – FFI; NEO Five-Factor Inventory). Consumers' quality of life was evaluated based on the life satisfaction questionnaire and the LISAT-11. We determined the level of food waste among consumers through a 34-item attitude test.

The research group comprises 683 respondents aged between 18 and 83 with Slovak citizenship and permanent residence in the Slovak Republic.

3. Results

To verify the statistical dependencies and relations, the Tobit model represents a linear regression model, which works with the so-called censored data. Censored data are those for which the value of y in a given interval is reported as a given constant. We distinguish two basic types of censored data (Greenberg, 2007):

1. Data bounded from above – values of y_i are reported only for $y_i \leq Y$, for values of $y_i > Y$, the value of Y is reported. Thus, the observations are a combination of continuous data for $y_i \leq Y$ and the number of observations of the value of Y. This model assumes that the vector of explanatory variables x_i is observed for all *i*.
2. Results of extreme solutions – the values of y_i are forcibly bounded.

Using a comprehensive questionnaire, we tried to find out as many socioeconomic characteristics of consumers as possible (age, gender, place of residence, region of Slovakia where they live, marital status, the highest level of education, employment, number of members in the household, number of children in the household, net income in the household, etc.).

We did not find a statistically significant relationship between the mentioned socioeconomic characteristics and the overall rate of food waste. We also did not find a statistically significant dependence between the socioeconomic characteristics of consumers and individual indicators of the rate of food waste. Consumer behaviour in food waste does not even depend on consumers' characteristics.

Using the LISAT-11 life satisfaction questionnaire, we have evaluated the respondents' overall satisfaction with their life while evaluating ten areas (leisure time, working life, financial situation, contact with friends and acquaintances, sexual life, self-care, family, partner relationship, physical health, and mental health), with which the respondents expressed their level of satisfaction. We found out that the personality characteristics neuroticism, extroversion, and conscientiousness predict overall satisfaction with life (Table 1).

Table 1: Tobit model for personality dimensions (NEOS) as predictors of life satisfaction

Satisfaction with life	*b*	*Std. Err.*	*t*	*p > t*
Neuroticism	- 0.2169316	0.0431661	-5.03	0.000**
Extroversion	0.2703734	0.0524166	5.16	0.000**
Openness	0.0805049	0.0586009	1.37	0.170
Conscientiousness	0.166631	0.0532862	3.13	0.002**
const.	27.12573	0.6790526	39.95	0.000

Note: ** means p < .01. Neuroticism, Extroversion, Openness, and Conscientiousness take on values from 1 to 12, with a lower value indicating a lower level of the given characteristic. Satisfaction with life represents the achieved raw score in the LISAT-11 questionnaire and takes on values from 10 to 40. Higher values indicate a higher level of satisfaction with life.

Source: Results of the own research

The higher the neuroticism score is, the lower the reported life satisfaction (p = 0.000). The higher the degree of extroversion and conscientiousness is, the higher the reported satisfaction with life (p = 0.000; p = 0.002). We did not find a relationship between openness and the overall level of satisfaction with life.

Using the questionnaire of life situations, we have evaluated the consumers' satisfaction with life in 8 areas (1. health, 2. work and employment, 3. housing, 4. own person, 5. financial situation, 6. friends, acquaintances and relatives, 7. free time, 8. marriage and partnership). Although we do not evaluate the overall quality of life through the mentioned tool, we use its scales because they provide a more comprehensive picture of satisfaction in individual areas compared to the LISAT-11 questionnaire.

Because 258 respondents did not answer the questions related to their partner's life (they are single and divorced respondents and respondents whose life partner died), we work only with seven dimensions of life satisfaction in the following models.

We have found that satisfaction with work life and their financial situation predict consumers' overall rate of food waste (Table 2).

Table 2: Tobit model for life satisfaction dimensions as predictors of food waste rates

Total	*b*	*Std. Err.*	*t*	*p > t*
Health	- 0.0406869	0.0750563	-0.54	0.588
Work and Employment	0.186856	0.0838246	2.23	0.026*
Housing	0.0050662	0.084255	0.06	0.952
Own person	0.1416405	0.0922273	1.54	0.125
Financial situation	- 0.1944319	0.0765153	-2.54	0.011*
Friends, acquaintances, and relatives	0.0335146	0.0822831	0.41	0.684
Free time	0.1253679	0.0743978	1.69	0.092
const.	61.60248	3.18212	19.36	0.000

Note: * means p < .05. Health, Work and employment, Housing, Own person, Financial situation, Friends, acquaintances and relatives, and Free time acquire values from 7 to 49, with a lower value indicating low satisfaction in the given area and a higher value indicating high satisfaction in the given area. The total represents the total rate of food waste by individual consumers. Higher values indicate a lower rate of wastage.

Source: Results of the own research

The higher the satisfaction with life in the work area, the lower the overall rate of food waste. On the contrary, the higher the satisfaction with life in the financial area, the higher the overall food waste rate. We did not find a relationship between the other dimensions of life satisfaction and the overall rate of food waste.

We have also investigated the relationship between the dimensions of life satisfaction and individual indicators of the overall rate of food waste, i.e., the categories that result from factor analysis. These are 1. Personal attitudes and beliefs concerning food waste, 2. The influence of the immediate social environment on food waste, 3. Planning of food purchases, 4. We perceived health risks.

Similar to the overall rate of food waste, job satisfaction and financial satisfaction are predictors of personal attitudes and beliefs about food waste (Table 3).

Table 3: Tobit model for life satisfaction dimensions as predictors of personal attitudes and beliefs about food waste (Factor 1)

F1	*b*	*Std. Err.*	*t*	*p > t*
Health	- 0.0467522	0.0512253	-0.91	0.362
Work and Employment	0.1368134	0.0572097	2.39	0.017*
Housing	- 0.0462382	0.0575034	-0.80	0.422
Own person	0.0751194	0.0629444	1.19	0.233
Financial situation	- 0.1550829	0.0522211	-2.97	0.003*
Friends, acquaintances, and relatives	0.0008876	0.0561576	0.02	0.987
Free time	0.0691712	0.0507759	1.36	0.174
const.	41.26223	2.171772	19.00	0.000

Note: * means p < .05. Health, Work and employment, Housing, Own person, Financial situation, Friends, acquaintances and relatives, and Free time acquire values from 7 to 49, with a lower value indicating low satisfaction in the given area and a higher value indicating high satisfaction in the given area. F1 represents the obtained raw score within the factor "Personal attitudes and beliefs concerning food waste." Higher values indicate attitudes toward not wasting food (lower waste rate).

Source: Results of the own research

The higher the respondents' satisfaction with life in the work area is, the higher the scores they achieved on the statements related to personal attitudes and beliefs concerning food waste, which also indicates a lower rate of food waste. On the contrary, the higher the respondents' satisfaction with life in the financial area is, the lower their score for statements regarding personal attitudes and beliefs concerning food waste, which also indicates a higher rate of food waste. We did not find a relationship between other dimensions of life satisfaction and personal attitudes and beliefs concerning food waste.

We have also found that satisfaction with life in leisure activities predicts the level of food waste determined through statements focused on the influence and cooperation of the closest social environment (Table 4).

Table 4: Tobit model for dimensions of life satisfaction as predictors of the influence of the immediate social environment on food waste (Factor 2)

F2	*b*	*Std. Err.*	*t*	*p > t*
Health	0.0267497	0.0188286	1.42	0.156
Work and Employment	0.0333959	0.0210282	1.59	0.113
Housing	0.0261176	0.0211362	1.24	0.217
Own person	0.0292047	0.0231361	1.26	0.207
Financial situation	- 0.0368232	0.0191946	-1.92	0.055
Friends, acquaintances, and relatives	0.0343704	0.0206415	1.67	0.096
Free time	0.0802228	0.0186634	4.30	0.000**
const.	7.436621	0.7982666	9.32	0.000

Note: ** means p < .01. Health, Work and employment, Housing, Own person, Financial situation, Friends, acquaintances and relatives, and Free time acquire values from 7 to 49, with a lower value indicating low satisfaction in the given area and a higher value indicating high satisfaction in the given area. F2 represents the achieved raw score within the factor "Impact of the immediate social environment on food waste." Higher values indicate a lower influence of the social environment on consumer behaviour related to food waste (and a lower rate of waste).

Source: Results of the own research

The higher the respondents' satisfaction with life in the area of free time is, the lower the influence of their immediate social environment on their behaviour in the context of food waste (they achieved a higher score here), which, given the wording of the statements, indicates a lower level of waste. We did not find a relationship between the other dimensions of life satisfaction and the influence of the immediate social environment on food waste.

Table 5: Tobit model for dimensions of life satisfaction as predictors of planning food purchases (Factor 3)

F3	*b*	*Std. Err.*	*t*	*p > t*
Health	- 0.0309652	0.0136723	-2.26	0.024*
Work and Employment	0.0027801	0.0152726	0.18	0.856
Housing	0.0121168	0.015346	0.79	0.430
Own person	0.0236796	0.0168024	1.41	0.159
Financial situation	- 0.0098132	0.0139369	-0.70	0.482
Friends, acquaintances, and relatives	- 0.0016401	0.0149871	-0.11	0.913
Free time	0.002621	0.0135574	0.19	0.847
const.	6.348142	0.5797461	10.95	0.000

Note: * means p < .05. Health, Work and employment, Housing, Own person, Financial situation, Friends, acquaintances and relatives, and Free time acquire values from 7 to 49, with a lower value indicating low satisfaction in the given area and a higher value indicating high satisfaction in the given area. F3 represents the achieved raw score within the factor "Planning food purchases." Higher values indicate lower levels of food shopping planning (and higher levels of wastage).

Source: Results of the own research

The higher the respondents' satisfaction with their life in the area of health is, the lower their score on statements related to planning food purchases, which, given the wording of the statements, indicates a higher rate of food waste. We did not find a relationship between other dimensions of life satisfaction and food shopping planning.

We also did not find a relationship between the fourth category – perceived health risks – and individual dimensions of quality of life.

In the last model, we have included all eight areas of quality of life (including the area of partner relations). We have filtered out respondents who stated they lived in a marital or partnered relationship (N = 425), leaving out single, divorced, and widowed respondents. Thus, the respondents were not randomly selected. We have once again investigated whether the individual dimensions of life satisfaction are predictors of the overall rate of consumer food waste or individual indicators of the rate of food waste. We achieved the same results as when only the seven dimensions of life satisfaction were included. The difference occurred only in the case of the consumers' closest social environment (Table 6).

Table 6: Tobit model for dimensions of life satisfaction (including marriage and partnership) as predictors of the influence of the immediate social environment on food waste (Factor 2)

F2	*b*	*Std. Err.*	*t*	*p > t*
Health	0.0387099	0.0244161	1.59	0.114
Work and Employment	0.0538119	0.0259152	2.08	0.038*
Housing	0.0093601	0.025781	0.36	0.717
Own person	- 0.0116339	0.0305716	-0.38	0.704
Financial situation	- 0.0588176	0.0234425	-2.51	0.012*
Friends, acquaintances, and relatives	0.0332613	0.0274679	1.21	0.227
Free time	0.046061	0.0231827	1.99	0.048*
Marriage and partnership	0.0454257	0.0205851	2.21	0.028*
const.	8.795495	1.068855	8.23	0.000

Note: * means p < .05. Health, Work and employment, Housing, Own person, Financial situation, Friends, acquaintances and relatives, Free time, and Marriage and partnership take on values from 7 to 49, with a lower value indicating low satisfaction in the given area and a higher value indicating high satisfaction in the given area. F2 represents the achieved raw score within the factor "Impact of the immediate social environment on food waste." Higher values indicate a lower influence of the social environment on consumer behaviour related to food waste (and a lower rate of waste).

Source: Results of the own research

We have found a statistically significant relationship between the four dimensions of life satisfaction and the influence of the immediate social environment on food waste. The higher the satisfaction with life in the work area is, the lower the influence of their immediate social environment on their behaviour in the context of food waste, which, considering the wording of the statements, indicates a lower rate of taste. The higher the respondents' satisfaction with the financial situation, the higher the influence of the social environment, and therefore the higher the food waste. The more satisfied the consumers are (with spending their free time and with their partner life), the lower the influence of

their immediate social environment on their behaviour in the context of food waste, which, given the wording of the statements, indicates a lower rate of the waste.

4. Conclusion and Discussion

Quality of life and satisfaction with life is the subject of much economic, psychological, and medical research because how we feel, how we experience our life, whether we are happy or at least satisfied, affects our behaviour and also most of our decisions, behaviour on the market for products and services and consumption decisions without exception. Consumer behaviour in the context of food waste is currently at the centre of interest of developed countries' governmental and non-governmental sectors because excessive consumption, waste, and the subsequent excessive generation of waste represent some of the most severe environmental problems of today.

Researches dealing with the impact of the environment on the quality of life, e.g., De Hollander & Staatsen (2003), Ward Thompson & Aspinall (2011), and Keles (2012) prove that the environment is one of the most critical factors affecting the life satisfaction – the more the environment around us is damaged, the lower is the overall quality of life. The environment affects satisfaction with life in all its dimensions because the environment touches every aspect of our lives.

The presented research aimed to find out how the quality of life affects the behaviour of consumers in the purchase and consumption of food, especially in the context of food waste, and thus to indirectly find out how the consumer affects (or is willing to affect) the environment through his consumption behaviour.

We found no statistically significant relationship between consumers' socioeconomic characteristics and the overall food waste rate, as determined through the created attitude test. Based on existing research, we believe that food waste could depend on age or the amount of income and the number of household members. A similar study conducted in Denmark and Spain (Grasso et al., 2019) showed that older consumers and consumers who did not work full-time wasted less (in both countries); in Denmark, men wasted more and cohabiters less with more than four people. The relationship between consumer behaviour and the rate of wastage was particularly evident in the items "shopping habits" and "preparation of meals." Also, in our research, food purchase planning plays an important role and is associated with the rate of the waste. However, socioeconomic characteristics did not turn out to be statistically significant factors influencing the rate of food waste. We believe that the reasons may be different. One of them may be the different wording of the statements in the attitude test for determining behaviour concerning waste or the different lifestyles of Slovaks.

We have also found no statistically significant differences in the food waste rate depending on consumers' personal characteristics. However, we have found out that personality characteristics predict the overall level of satisfaction with life determined using the LISAT-11 questionnaire. The higher the score of the respondents in the measure of neuroticism, the lower their subjectively perceived satisfaction with life. The higher their level of extroversion and conscientiousness is, the higher their satisfaction with life.

Personality research has been going on for several decades in various spheres, and our results confirm the findings of domestic and foreign authors. Extroversion as a predictor of life satisfaction is confirmed by several researchers, e.g., Costa & McCrae (1980), Herringer (1998), Schimmack et al. (2004), Gale et al. (2013) and Hyunji et al. (2017). People who manage interpersonal communication and functioning in society more easily feel a higher satisfaction with life compared to introverts, which in some cases, perceive routine matters as demanding situations for extroverts. Neuroticism, by its very nature, includes more frequent and intense experiences of adverse effects; therefore, people who

achieve higher scores in neuroticism report lower satisfaction with life (Costa & McCrae, 1980; Gale et al., 2013). Conscientious people generally achieve higher life satisfaction compared to people with lower levels of conscientiousness. In case of significant life problems, e.g., losing their job, their quality of life declines faster than less conscientious people (Boyce et al., 2010).

A study in Switzerland in 2015 (Visschers et al., 2016) investigated which determinants (taken from the theory of planned behaviour, whose central element is the intention to behave in a certain way) best explain household food waste. They classified the determinants into nine categories: 1. Intention to avoid food waste, 2. Personal attitudes, 3. Financial attitudes, 4. Perceived health risks, 5. Perceived behavioral control, 6. Subjective norms, 7. Personal norms, 8. The identity of a good host, 9. They were planning in the household. The study's authors found that people who scored higher in the "intention to avoid food waste" also reported a lower rate of food waste in their households. However, personal standards and attitudes, subjective standards, and perceived health risks did not significantly impact the amount of food thrown away. The authors also found that different predictors were relevant for discarding different food groups. They concluded that to prevent food waste, we need to focus mainly on increasing perceived behavioral control in the context of waste as consumers become increasingly aware of the environmental impact of their behaviour.

In our research, we have investigated whether the subjectively perceived quality of life (satisfaction with life) has an effect on the total rate of food waste, determined in a similar way as the authors of the Swiss study, or on individual indicators of the total rate of waste, which we divided into four groups.

We have found that consumers' satisfaction with their work life and their satisfaction with their financial situation predict the overall rate of food waste. The higher their subjectively assessed satisfaction with life in the work area is, the lower the overall rate of food waste. On the contrary, the higher their satisfaction with life in the financial area, the higher the overall food waste rate. We did not find a significant relationship between how much consumers earn and waste. So we can assume that it is not important how much money the consumer has at his disposal, but how much he is satisfied with it. His other behaviour on the market depends on this.

Similar to the overall rate of food waste, job satisfaction, and financial satisfaction are predictors of personal attitudes and beliefs regarding food waste. In a study by Visschers et al. (2016), the authors found that the intention to behave responsibly is the most significant indicator of the amount of wasted food. Our results show that the more satisfied consumers are with their work, their beliefs about the necessity of responsible consumption are stronger. However, the more satisfied they are with their financial situation, the less they care about responsible consumption.

An essential indicator of the food waste rate is the cooperation and influence of the immediate social environment. The more the respondents are satisfied with how they spend their free time, the lower the influence of their immediate social environment on their behaviour in the context of food waste, which means they waste less. Although we have a separate dimension related to family and friends in the life satisfaction questionnaire, we believe that family and friends are often an essential part of leisure activities. We can therefore assume that if the consumer is satisfied, what his friends and relatives think, does not influence his decisions in the context of food waste (e.g., if he is convinced that he does not want to waste food, he will not do so, even if his family and friends behave differently, or they will try to influence his decisions) (Rybanská et al., 2021).

When we added satisfaction with partner life to the model, we found that satisfaction with work, satisfaction with the financial situation, satisfaction with spending free time, and satisfaction with partner life are also significant predictors of how the social environment enters into decisions about

food waste. Satisfaction with free time, work, and partner relationships indicate a lower social environment influence on consumer behaviour.

The higher the satisfaction of the respondents with their life in the area of health, the lower their score on the statements related to planning food purchases. However, this finding does not mean that consumers with a higher quality of health waste more overall. We believe that, unlike consumers who report lower health satisfaction, consumers with a higher quality of health are not forced to plan their purchases in detail because, e.g., they are not limited by diseases of the digestive tract or other diseases that limit the possibilities of eating.

Based on the results, we can assume that quality of life is a significant predictor of responsible consumer behaviour. However, we are aware of many limitations of our research. In order to definitively confirm the results achieved, further investigations are necessary. In the present study, we also agree with other authors who found a significant relationship between life satisfaction (or its indirect indicators) and environmentally acceptable consumption (Welsch & Kuhling, 2010; Roodhuyzen et al., 2017).

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References

[1] Abeliotis, K., Lasaridi, K., & Chroni, C. (2014). Attitudes and behaviour of Greek households regarding food waste prevention. *Waste Management & Research*, 32(3), 237-240. 10.1177/0734242X14521681

[2] Aka, S., & Buyukdag, N. (2021). How to prevent food waste behaviour? A deep empirical research. *Journal of Retailing and Consumer Services*, 61, 102560. https://doi.org/10.1016/j.jretconser.2021.102560

[3] Boyce, C. J., Wood, A. M., & Brown, G. D. A. (2010). The dark side of conscientiousness: Conscientious people experience greater drops in life satisfaction following unemployment. *Journal of Research in Personality*, 44(4), 535–539. https://doi.org/10.1016/j.jrp.2010.05.001

[4] Costa, P. T., & McCrae, R. R. (1980). Influence of extraversion and neuroticism on subjective well-being: happy and unhappy people. *Journal of Personality and Social Psychology*, 38(4), 668–678. DOI: 10.1037//0022-3514.38.4.668

[5] De Hollander, A. E. M.,& Staatsen, B. A. M. (2003). Health, environment, and quality of life: an epidemiological perspective on urban development. *Landscape and Urban Planning*, 65(1-2), 53-62. https://doi.org/10.1016/S0169-2046(02)00237-2

[6] Diaz-Ruiz, R., Costa-Font, M., & Gil, J. M. (2018). Moving Ahead from Food-Related Behaviours: An Alternative Approach to Understand Household Food Waste Generation. *Journal of Cleaner Production,* 172, 1140-1151. https://doi.org/10.1016/j.jclepro.2017.10.148

[7] Evans, D. (2011). Blaming the consumer – once again: The social and material contexts

[8] of everyday food waste practices in some English households. *Critical Public Health*, 21(4), 429-440. https://doi.org/10.1080/09581596.2011.608797

[9] FAO. (2011). *Global Food Losses and Food Waste. Extent, Causes and Prevention*. http://www.fao.org/3/i2697e/i2697e.pdf

[10] FAO. (2013). *Food wastage footprint. Impacts on natural resources – Summary report*. http://www.fao.org/3/i3347e/i3347e.pdf

[11] FAO. (2019). *The State of Food and Agriculture. Moving Forward on Food Loss and Waste Reduction*. http://www.fao.org/3/ca6030en/ca6030en.pdf

[12] Gale, C. R., Booth, T., Mõttus, R., Kuh, D., & Deary, I. J. (2013). Neuroticism and Extraversion in Youth Predict Mental Wellbeing and Life Satisfaction 40 Years Later. *Journal of Research in Personality*, 47(6), 687-697. https://doi.org/10.1016/j.jrp.2013.06.005

[13] Graham-Rowe, E., Jessop, D. C., & Sparks, P. (2014). Identifying motivations and barriers to minimising household food waste. *Resources, Conservation and Recycling*, 84, 15-23. https://doi.org/10.1016/j.resconrec.2013.12.005

[14] Grasso, A. C. Olthof, M. R., Boevé, A. J., Dooren, C., Lähteenmäki, L., & Brouwer, I. A. (2019). Socio-Demographic Predictors of Food Waste Behavior in Denmark and Spain. *Sustainability*, 11(12), 32-44. https://doi.org/10.3390/su11123244

[15] Green, M., Harmancek, J., & Krylova, P. (2020). *Social Progress Index – Executive Summary*.https://www.socialprogress.org/static/37348b3ecb088518a945fa4c83d9b9f4/2020-social-progress-index-executive-summary.pdf

[16] Greenberg, E. (2007). *Introduction to Bayesian Econometrics.* Cambridge University Press.

[17] Hebrok, M., & Heidenstrøm, N. (2019). Contextualising Food Waste Prevention – Decisive Moments Within Everyday Practices. *Journal of Cleaner Production*, 210, 1435-1448. https://doi.org/10.1016/j.jclepro.2018.11.141

[18] Herringer, L. G. (1998). Facets of Extraversion Realted to Life Satisfaction. *Personality and Individual Differences*, 24(5), 731-733. https://doi.org/10.1016/S0191-8869(97)00194-3

[19] Hyunji, K., Schimmack, U., Oishi, S., & Tsutsui, Y. (2017). Extraversion and life satisfaction: A cross-cultural examination of student and nationally representative samples. *Journal of Personality*, 86(4), 604-618. https://doi.org/10.1111/jopy.12339

[20] Keles, R. (2012). The Quality of Life and the Environment. *Procedia – Social and Behavioral Sciences*, 35, 23-32. https://doi.org/10.1016/j.sbspro.2012.02.059

[21] Lincényi, M., Bulanda, I. & Světlík, J. (2022). Comparative analysis of development trends in the internet media market in the Czech Republic and the Slovac Republic, In: Gawroński, S., Szewczyk, M. & Bis, Ł. (Eds.), *New technologies in social and marketing communication*, WSIiZ, Rzeszów.7-38.

[22] Miléniové rozvojové ciele. (2015). https://unis.unvienna.org/unis/sk/topics/2013/mdg.html

[23] Ministerstvo životného prostredia Slovenskej republiky. (2020). *Sprievodca neformálnou environmentálnou výchovou a vzdelávaním pre udržateľný rozvoj na Slovensku. Inšpirácie pre učiteľov a pracovníkov s mládežou*. Ministerstvo životného prostredia Slovenskej republiky. https://www.minzp.sk/files/sprievodca-neformalnou-environmentalnou-vychovou-slovensku.pdf

[24] OZ Free Food. (2021). *Plytvanie v číslach*. https://free-food.sk/problem/ake-su-statistiky/

[25] Quested, T. E., Marsh, E., Stunell, D., & Parry, A. D. (2013). Spaghetti soup: The complex world of food waste behaviours. *Resources, Conservation and Recycling*, 79, 43-51. https://doi.org/10.1016/j.resconrec.2013.04.011

[26] Revilla, B. P., & SALET, W. (2018). The Social Meaning and Function of Household Food Rituals in Preventing Food Waste. *Journal of Cleaner Production*, 198, 320-332. https://doi.org/10.1016/j.jclepro.2018.06.038

[27] Roodhuyzen, D. M. A., Luning, P. A., Fogliano, V., & Steenbekkers, L. P. A. (2017). Putting together the puzzle of consumer food waste: Towards an integral perspective. *Trends in Food Science and Technology*, 68, 37-50. https://doi.org/10.1016/j.tifs.2017.07.009

[28] Rybanská, J. (2020). Preventing Food Waste and the Psychological Phenomenon of the „Best-Before-Date". *International Scientific Days*, 514-522. https://doi.org/10.18515/dBEM.ISD.P01.2020

[29] Rybanská, J., Kollár, B. & Košičiarová, I. (2021). *Kvalita života ako prediktor udržateľného spotrebiteľského správania*. Nitra SPU.

[30] Schanes, K., Dobering, K., & Gözet, B. (2018). Food Waste Matters - A Systematic Review of Household Food Waste Practices and Their Policy Implications. *Journal of Cleaner Production*, 182, 978-991. https://doi.org/10.1016/j.jclepro.2018.02.030

[31] Světlík, J. & Bulanda, I. (2019). The shift of value types of the czech population and its influence on the formation of creative advertising strategy. In *Marketing Identity.* Offline Is the New Online. 323-334.

[32] Schimmack, U., Oishi, S., Furr, M., & Funder, D. C. (2004). Personality and Life Satisfaction: A Facet-Level Analysis. *Personality and Social Psychology Bulletin*, 30(8), 1062-1075. https://doi.org/10.1177/0146167204264292

[33] Stancu, V., Haugaard, P., & Lähteenmäki, L. (2016). Determinants of Consumer Food Waste Behaviour: Two Routes to Food Waste. *Appetite*, 96, 7-17. https://doi.org/10.1016/j.appet.2015.08.025

[34] Stefan, V., Van Herpen, E., Tudoran, A. A., & Lähteenmäki, L. (2013). Avoiding food waste by Romanian consumers: The importance of planning and shopping routines. *Food Quality and Preference*, 28(1), 375-381. https://doi.org/10.1016/j.foodqual.2012.11.001

[35] The Baltic University Programme. (2021, January 12). Implementing Sustainability at Universities - Part 2, with Dr. Shepherd Urenje [Video]. YouTube. https://www.youtube.com/watch?v=KDJ2e-9SF54

[36] United Nations. (2015). *The 17 Goals.* https://sdgs.un.org/goals

[37] United Nations. (2015). *We Can End Poverty. Millennium Development Goals and Beyond 2015.* https://www.un.org/millenniumgoals/

[38] Úrad podpredsedu vlády Slovenskej republiky pre investície a informatizáciu. (2015). *2030 Agenda.* https://www.vicepremier.gov.sk/wp-content/uploads/2018/10/20131Agenda2030_VNR_Slovakia.pdf

[39] Úrad podpredsedu vlády Slovenskej republiky pre investície a informatizáciu. (2018). *Voluntary National Review of the Slovak Republic on the Implementation of the 2030 Agenda for Sustainable Development.* https://sustainabledevelopment.un.org/content/documents/20131Agenda2030_VNR_Slovakia.pdf

[40] Visschers, V. H. M., Wickli, N., & Siegrist, M. (2016). Sorting out food waste behaviour: A survey on the motivators and barriers of self-reported amounts of food waste in households. *Journal of Environmental Psychology*, 45, 66-78. http://dx.doi.org/10.1016/j.jenvp.2015.11.007

[41] Ward Thompson, C., & Aspinall, P. A. (2011). Natural Environments and Their Impact on Activity, Health and Quality of Life. *Applied Psychology: Health and Well-Being*, 3(3), 230-260. https://doi.org/10.1111/j.1758-0854.2011.01053.x

[42] Welsch, H., & Kühling, J. (2010). Pro-environmental behavior and rational consumer choice: Evidence from surveys of life satisfaction. Journal of Economic Psychology, 31(3), 405-420. https://doi.org/10.1016/j.joep.2010.01.009

[43] World Commission on Environment and Development. (1987). *Our Common Future*. Oxford University Press.

Social Marketing as a Way to Address Excessive Food Waste at the Consumer Level

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Abstract

Food waste is one of the serious global and societal problems falling under the issue of sustainable development. All member states of the European Union are dedicated to preventing food waste, which is also one of the current priorities of the European Commission and its activities. Although many of the Earth's inhabitants suffer from hunger and deprivation, consumers in developed countries prefer a consumerist way of life, wasting limited resources and overburdening the environment. The presented paper aims to determine how the selected social marketing tool (social advertising) affects conscious and subconscious consumer reactions and behaviour concerning food waste. The research is divided into two parts and was carried out on two independent research sets – consumers in Research Set X (171 respondents aged from 20 to 46) answered questions in a prepared questionnaire and evaluated two social advertisements; consumers in Research Set Y (59 respondents aged from 17 to 50) rated the same social ads as consumers in Research Set X, and at the same time their emotional reactions from facial expressions (micro-mimics) were assessed using the Face Reader software. In the research, we have worked with two social audio-visual advertisements on the social networks TikTok and Youtube. The results of our research show that social advertising with emotional appeals, which evoke complex emotions, such as sympathy or emotion, has great potential to educate consumers and influence (in the desired direction) their behaviour and decision-making in the food market. It creates a counterpoint to commercial advertising and helps consumers realize the seriousness of the consequences of their behaviour in the context of food waste.

Keywords: *food waste, social advertising, consumer reactions, emotions*

JEL Classification: *M37, M39, L66, Q18*

1. Introduction

Food waste is a significant environmental problem that occurs throughout the food chain. It means that it concerns us all. Approximately 1/3 of the total amount of food produced ends up in waste. Because of this, we need about ½ more agricultural land and consume about ½ more fertilizers, pesticides, and energy than would be needed to feed all the people on Earth (WWF Deutschland, 2015). Animal food is a particular problem. Of the stated amount of wasted food, roughly ½ is thrown

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away in households because too much is bought or cooked (Smarticular, 2020). The real reasons for excessive food waste are complex, and there is no universal model to explain consumer behaviour in this context. However, we have a large amount of partial research at our disposal, so we can assume that environmental damage occurs mainly due to people's consumerist way of life in developed countries.

We can define consumerism as a way of life that brings an excessive interest in consumption. Consumption is at the centre of a person's attention. Consumerism as a way of life is accompanied by the belief that our life is just a series of problems and solving them is the personal responsibility of each of us. Every problem has a solution that we can "buy" from professionals. Thus, consumerism as a lifestyle means that one has to run one's life like a small business (Shaw and Aldridge, 2003).

Marketing communication has a significant influence on the opinions and behaviour of consumers. This is also confirmed by the fact that more than 400 billion dollars are spent on advertising annually worldwide. If marketing communication, and especially advertising, did not work, companies would never spend such large sums on marketing activities. Hand in hand with such a massive sphere of influence should also go the responsibility for what kind of consumer behaviour marketing communication creates, alternatively, strengthens because it is the only way to a long-term sustainable society and a sustainable environment (Paulík, 2021).

The consumer society prioritizes material values, and its pillars are a large volume of production and sales and excessive consumption that outweighs other human needs. Fashion trends and rapid technological development primarily drive consumer society. Products wear out quickly and go out of fashion before they stop working. Consumers do not buy new things because they need them but because they want them, even though the "old" ones could still serve them reliably. The time of average use of products (until buying a new one, the next one) is getting shorter, for example, for clothes it is one year, for mobile phones about two years, we buy cars for about four years, etc. (managementmania.com, 2021; Fišerová et al., 2018). The result of the consumer society is the excessive generation of waste, including food waste.

The opposite of consumerism is the so-called anti-consumerism, which focuses on reducing excessive consumption and waste production, reducing factors that damage the environment, promoting quality over quick and easy profit, and regulating unethical business. Anti-consumerism as a sociopolitical ideology criticizes unlimited consumption and materialism (Fišerová et al., 2018). Anti-consumerism is subsequently associated with the concept of anti-materialism, representing the opposite of the materialism we associate with consumerism. While materialism focuses on acquiring and accumulating possessions, anti-materialism rejects such behaviour. However, a complete rejection of consumption is not possible - we need material things to live, and therefore instead of anti-materialism, as a more appropriate contrast to materialism, we use the term anti-consumerism (Lee and Ahn, 2016; Mladá, 2021).

Food waste is a global problem that occurs throughout the food supply chain. Although we have a wealth of information on global food loss and waste, there are still serious gaps. FAO states in a report from 2011 that up to 1/3 of food intended for final consumption ends up as waste. This represents 1.3 billion tons of food annually, even though every ninth person in the world (almost 900 million people) suffers from a lack of food (free-food.sk, 2021). About 45% of fruits and vegetables, 35% of fish and seafood, 30% of cereals, 20% of dairy products, and 20% of meat are thrown out of the whole food intended for humans. Food losses vary in different countries' food chains (Valmorbida Moraes et al., 2021). In developing countries, for example, significant losses already occur in the cultivation and

processing of agricultural products, mainly due to outdated technology and processing methods. In developed countries, most of the waste is in households (Fusions, 2016; Wisschers et al., 2016).

Utilizing leftover food is not difficult, but since we live in a hectic time, it is easier and faster to throw unused food and leftovers into the trash than to think about what to do with them. Consumers who keep pets have an easier decision. Food leftovers can be creatively processed instead of disposed of. For example, the remaining pasta, rice, potatoes, or other vegetables can be used as the basis of other dishes. Some parts of the food (for example, leaves and peels) can be further used to produce other valuable products (for example, apple cider vinegar from apple peels, food for California earthworms producing compost, home cosmetic products, etc. (Rybanská et al., 2021).

Excessive production of waste and its removal is currently among the biggest challenges for society and the environment. As consumers, we must realize that our comfortable lifestyle and food waste also contribute to waste creation. This is not only an ethical waste problem; food waste also represents a significant burden on nature and is one of the significant causes of environmental degradation (Rybanská et al., 2021).

Currently, we observe an increase in social, health, environmental and other social problems, which significantly reduce our subjective satisfaction and quality of life. Therefore, new methods are constantly being sought to alleviate these problems. One of the effective ways to draw attention to existing problems and solve them is social marketing. Social marketing campaigns can help educate and educate the consumer, thereby contributing to the mitigation or elimination of harmful factors. In professional literature, social marketing is a relatively discussed topic in both commercials, moreover, in non-commercial marketing, in recent decades, several different definitions of the term social marketing have been created (Galandová, 2021; Bačuvník and Harantová, 2014; Lincényi et al., 2022).

Although it might seem that the concept of social marketing is the domain of the 21st century, its roots go much more profound. The first mention of the use of social marketing can be found

in the fifties of the twentieth century (Kaňuchová and Čábyová, 2018). Social marketing is a separate discipline that mainly seeks to influence consumer behaviour leading to improved health, injury prevention, and environmental protection, contributing to community well-being, and enhancing financial well-being (Lee and Kotler, 2011).

The purpose of the submitted contribution is not only to point out the problem of food waste but, above all, to find out how this problem can be solved, primarily with the help of social marketing, which in this case can serve as an educational framework and help "educate" the next generations in a "better" way.

2. Data and Methods

The presented paper aims to find out how the selected social marketing tool (social advertising) affects conscious and subconscious consumer reactions and behaviour concerning food waste.

The research was divided into two parts and was carried out on two independent research sets – consumers in Research Set X (171 respondents aged from 20 to 46) answered questions in a prepared questionnaire and evaluated two social advertisements; consumers in Research Set Y (59 respondents aged from 17 to 50) rated the same social ads as consumers in Research Set X, and at the same time their emotional reactions from facial expressions (micro-mimics) were assessed using the Face Reader software.

In the research, we have worked with two social audio-visual advertisements on the social networks TikTok and Youtube.

The first video (Figure 1) was created primarily for research purposes. It was published on the social network TikTok on February 17, 2021, so we can create a hypothesis about its characteristics. The author of the video is influencer YUWAC (https://www.tiktok.com/@yuwac?). On the TikTok social network, its audience consists mainly of children, teenagers, and young adults between the ages of 8 and 35 from the Slovak and Czech Republic. At the time of the publication of the video, he had 50 thousand followers. The average age of the follower was approximately 16 years. In the investigated social advertising, the Slovak audience comprised approximately 53% and the Czech audience 46%. The average video viewing time during the monitored period (from February 17, 2021, to April 24, 2021) was 17.5 seconds.

Figure 1: Social Advertising Warning about Food Waste

Source: https://www.tiktok.com/@yuwac?

The second video (Figure 2) is posted on the YouTube social network and is not primarily related to the issue of food waste. It is a Norwegian social campaign created in 2017 called The Lunchbox and was created for the Norwegian Directorate for Children, Youth, and Family Affairs. It draws attention to the fact that every child deserves to grow up in a family and the need for substitute family care. The social campaign hit the social network in the summer of 2017 and reached more than 3 million views in Norway (more than half of the Norwegian population) in 3 days. By September 1, 2017, the video had been viewed by more than 270 million people (Smith and Burnett, 2017). She is relatively unknown in Slovakia; only 7 of the respondents in the research knew her.

Figure 2: Norwegian Social Advertising Used in the Research

Source: https://www.youtube.com/watch?v=pYHZhoESs_8

3. Results

3.1 Evaluation of the questionnaire (1st part of the research)

We presented five selected environmental problems to 171 respondents in the questionnaire survey. Their task was to rank these problems from the most serious to the least serious, according to how

they perceived them. As we assumed, the consumers consider the least serious environmental problem among the presented problems to be food waste. Deforestation follows. The respondents consider the amount of plastic waste and air pollution to be approximately equally serious, moreover, they consider water pollution the most serious of the presented problems.

We asked the respondents where along the food chain, according to them, most food is wasted. They chose four categories: agricultural production and food processing, food retailers, restaurants and services, and households. Respondents considered stores, supermarkets, and food sellers the most frequent source of food waste (40.3%). Despite the established assumption, up to 39.7% of respondents said that households and individuals waste most food. Not a single consumer thought that the most waste was at the level of agricultural production.

Based on the knowledge of the colour semantic differential test and the psychology of colours, we evaluated the representation of colours in selected ten food categories. The respondents' task was to assign three colours from the 12 available colours to each food category according to their subjective feeling. At the end of the questionnaire, respondents ranked these 12 available colours according to popularity. Based on the popularity of colours, we evaluated whether consumers assigned more or less popular colours to a given food category. The most popular colours among consumers are generally white, black and light blue (ranked by consumers from 1 to 12, so more popular colours have lower numbers). However, there are significant inter-individual differences among consumers.

From evaluating the representation of colours in selected food categories, we can conclude that the most assigned colours correspond to the most prevalent colours in the given food category (e.g., vegetables – dark green, light green; meat – brown, red, etc.). In the categories of sweets, diet food, healthy food, and fast food, we believe

that the respondents could assign colours to them according to their subjective preferences and the popularity of specific products (e.g., pink and purple predominate in the case of sweets, which corresponds to the colours of the packaging of many popular candies; in the case of diet food, white and light green, which corresponds to the colours most often used on the packaging of diet foods; in fast food, red and black colours prevail, which correspond to the colours used in the marketing communication of fast food chains).

Despite the explicit instruction that the respondents should not assign colours to foods according to the colour of the specific food, but according to their feelings, the assigned colours correspond to the colours of the foods. We can therefore assume that consumers assigned colours to individual food categories based on unconscious associations.

Based on respondents' answers, we compiled a list of foods consumers often throw away. Consumers often throw away baked goods, followed by ready (cooked) meals, milk and milk products, fruit, vegetables, and meat and meat products. As many as 66 respondents (38.6%) said that they do not waste food at all; that is, they do not throw away any food. Ownership of domestic animals and home composting plants were most often mentioned. Nevertheless, we did not find statistically significant differences in food waste behaviour between urban and rural consumers. For some consumers, we assume the provision of socially desirable answers.

We also asked respondents about their favourite most popular foods among consumers in research set X are pasta, pizza, and pancakes. The most popular fruits include strawberries, bananas, and apples, and the most popular vegetables are tomatoes. We can state that the results found to copy the pan-European trend based on the obtained data and information. However, we cannot confirm the research assumption that consumers throw away foods they have a positive attitude toward less often.

Differences in consumer behaviour concerning food waste according to gender, age, education, and marital status were not detected. However, we found differences in consumer behaviour concerning waste among consumers with dietary restrictions (gastrointestinal disease, food allergy, or intolerance). Thirty-four respondents with dietary restrictions took part in the research.

We found that compared to consumers without dietary restrictions, they throw away food more often, p = 0.036 (Table 1, Table 2).

Table 1: Consumer Responses According to Whether They Have Any Dietary Restrictions

		Food waste				Total
		None	Low level	Mid level	High level	
Allergy or intolerance IBS, IBD	yes	57	10	34	36	137
	well	6	6	9	13	34
Total		63	16	43	49	171

Source: own processing

Table 2: Mann-Whitney U test

	Food Wasting
Mann-Whitney U	1812.000
Wilcoxon W	11265.000
FROM	-2.098
Asymp. Sig. (2-tailed)	0.036

Source: own processing

Food allergies are life-threatening, so consumers must be cautious when choosing and consuming food. Food intolerances and histamine intolerance are usually not life-threatening, but they can cause significant difficulties. There is currently no effective treatment for irritable bowel syndrome; the symptoms can only be alleviated by proper lifestyle and stress and anxiety management. Inflammatory diseases of the digestive tract are lifelong diseases, the treatment of which is difficult and tiring. We believe that consumers who suffer from some form of allergy, intolerance, or have IBS, IBD, or celiac disease choose their food very carefully moreover, they are much more careful than regular consumers. This may also be the reason why they throw away more food. They are not willing to take risks and prefer to throw away food whose freshness and properties they are not sure about.

Respondents in the questionnaire evaluated two social advertisements. In the following section, we present the results of evaluating these ads on bipolar scales and graphs of the semantic differential. The respondents evaluated the first social advertisement (video No. 1) on eight bipolar scales. Social advertisement No. 1 is considered by the respondents to be averagely interesting, pleasant, and fun. They believe it is not emotional, but they perceive it positively. It is good but weaker.

We also found differences in the evaluation of social advertising between men and women, between consumers depending on their place of residence and jobs, and we also investigated differences in evaluation according to the number of points achieved in a short empathy test.

Men evaluate social advertisement No. 1 as more optimistic and interesting than women who find it funnier. We can assume that the style of humour used in the video appealed to them more.

Between consumers, depending on their place of residence, there is a statistically significant difference only on the bipolar scale - social advertising appears more moving to consumers living in rural areas.

From the respondent's employment perspective, it can be said that consumers who do not have a job consider video No. 1 as more interesting, positive, better, and stronger. Unemployed respondents are mostly younger students who do not yet have a job or a part-time job. As we mention in the ad's description, it targets teenagers and young adults. Thus, we can assume that unemployed respondents evaluate social advertising more positively because they fall into the target category.

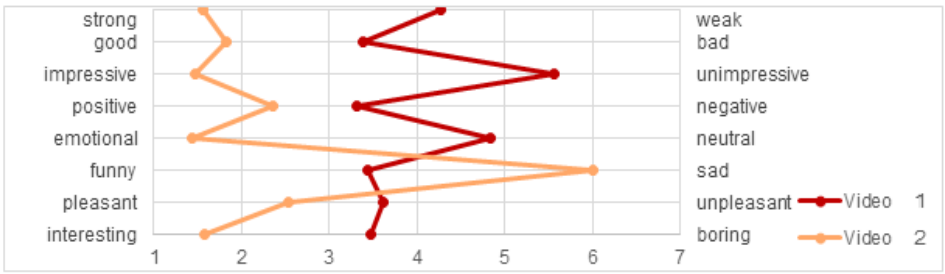
Respondents scored 3 to 9 points in a short empathy test. Accordingly, we divided them into two groups. Respondents who scored lower points on the test (3-5) rate the advertisement more positively on the three SD scales. Video No. 1 was liked by the majority of respondents (57%), and the majority of respondents (54%) also answered that social advertisement No. 1, according to them, sufficiently draws attention to the problem of food waste.

The respondents rated the second social advertisement (video No. 2) equally on eight bipolar scales. Social advertisement No. 2 is considered by the respondents to be very interesting, sad, and emotional but pleasant and positive. According to them, she is very touching, good, and strong. In social advertisement No. 2, we investigated the differences in ratings between men and women among consumers according to their marital status. We also investigated the differences between women on maternity leave and women who study or work. Finally, we verified differences in consumer evaluations of social advertising based on whether they scored lower or higher on the empathy test. Between men and women, statistically significant differences in the evaluation were found only on the bipolar scale. Men rate video No. 2 compared to women as better.

Differences in the evaluation of social advertising No. 2 among consumers according to selected characteristics were not detected. Advertising carries a strong emotional charge, so we believe strong emotional stimuli affect all consumers. Social advertisement No. 2 was disliked by only two respondents. 58% of respondents said that, in their opinion, the advertisement draws enough attention to the issue of food waste.

We compared the average ratings of both social ads (Figure 3), where we made sure that social ad No.2 was evaluated significantly more positively and appealed to more consumers. Social advertisement No. 2 carries a strong emotional charge, the emotional stimuli he works evoke negative emotions (e.g., sadness, worry, regret). However, the story presented ends with a "happy ending," which significantly positively affects consumers and evokes emotion.

Figure 3: Comparison of Ratings of Both Social Ads



Source: own processing

Based on the obtained results, we can conclude that a social advertisement that carries a strong emotional charge (and combines positive and negative emotions) is likely to appeal to more consumers than a social advertisement that contains humour. More research is needed to confirm this conclusion,

as more types of humour need to be included and to compare which type is liked by consumers of different ages.

3.2 Evaluation of emotional reactions of consumers (2nd part of research)

Fifty-nine respondents (research set Y) who took part in the second part of the research were presented with the same two social ads as respondents in research set X. All respondents gave their consent to participate in the research electronically and were instructed on collecting, evaluating, and using the obtained data.

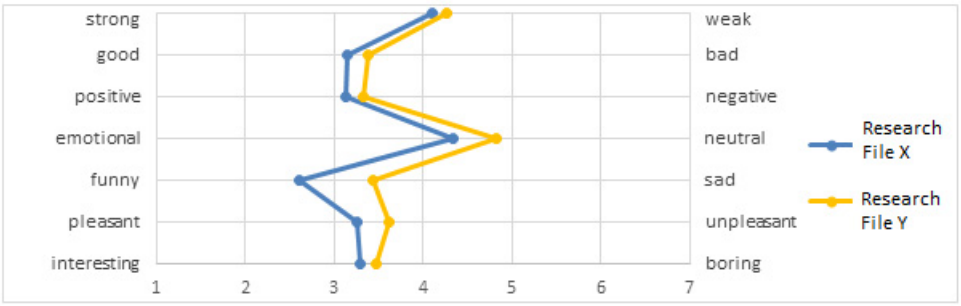
Based on the obtained data from the facial biometrics of the respondents, we found the prevailing emotions that the respondents experienced while watching the selected social ads.

In both social advertisements, it was found that a neutral expression prevails the most, which is natural, especially if the respondent knows that he is being observed. In video No. 1, emotions of joy and sadness prevail. Joy appears when the respondent smiles; therefore, we can conclude

that the respondents smiled while watching the video on average. Grief is recorded, e.g., if the respondent frowns. In video No. 2, sadness prevails because the emotional appeals that the ad contains are intended to evoke pity and compassion. The consumer is usually not aware of his micromimicry. When he knows he is being watched, he consciously pays more attention to his expressions, but some expressions are unconscious.

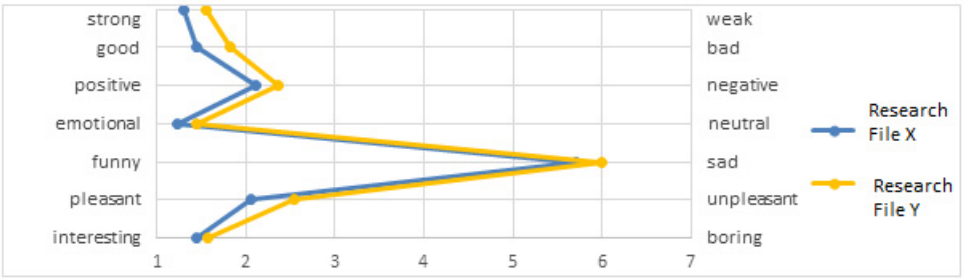
Respondents in research group Y rated two social advertisements also on seven bipolar scales of semantic differential. We also compared the ratings with those of the X research set (Figure 4 and Figure 5).

Figure 4: Evaluation of Video No. 1 on Bipolar SD Scales – Comparison of Research Files X and Y



Source: own processing

Figure 5: Evaluation of Video No. 2 on SD Bipolar Scales – Comparison of Research Files X and Y



Source: own processing

When evaluating social advertising No. 1, we found only one statistically significant difference in the evaluation by respondents from research sets X and Y. Respondents from research set Y rated the advertisement as funnier than research set X. When evaluating social advertising No. 2, we did not find statistically significant differences between respondents' evaluations from both research groups.

The interpretation of the obtained biometric data is quite tricky, mainly because we do not only experience simple but mostly complex emotions, which can be reflected in different ways in our micro-mimicry. Even negative emotional stimuli can cause an emotional response, which in micro-mimic shows itself as joy or happiness. Therefore, e.g., in advertisement No. 2, we see how joy and sadness develop very similarly. Touching is not a negative emotion but carries elements of both sadness and joy. It is stimuli that evoke a complex emotional response that has great potential to appeal to the consumer or change consumer behaviour.

When we compare the simple conscious ratings of ads "liked/disliked" with ratings on semantic differential scales and biometric data, we see more minor or significant differences. In a simple evaluation, the consumer states what he thinks, but we must consider that he can provide socially desirable answers. With semantic differential scales, the consumer evaluates the presented advertisements using adjectives that often have an unconscious subjective meaning for him. Based on such evaluations, we get broader information about the consumer's feelings. For example, when he states that he did not like the video but simultaneously states on the SD scale that he sees the video as funny but unfavourable, we can assume that it did appeal to him on some level after all. If we add facial biometrics to the conscious evaluations, we get a comprehensive picture of the emotions that the presented stimuli evoked.

4. Conclusion and Discussion

The subject of the research was social advertising as a potential tool for influencing consumer behaviour in the context of food waste.

We make countless decisions every day, many without being fully aware. Such decisions often include whether or not to throw away food. We often treat food as an unlimited resource. A significant environmental problem has arisen from developed countries' abundance (an excess) and our attitude. Today, it is essential to educate in this area and to constantly draw attention to the fact that throwing away food and wasting it represents a significant environmental and ethical problem. Therefore, the paper aimed to provide an image of the issue of food waste and to find out which emotional stimuli in social advertising most influence consumer behaviour in the context of food waste.

We found that Slovak consumers do not consider food waste a serious problem and do not realize that households and individuals, i.e., the consumers themselves, are, to the greatest extent, responsible for food waste. We believe that the country's overall approach to environmental issues is responsible for the lack of awareness of the issue. We need to involve environmental education in schools to a much greater extent; we need to provide students with new scientific knowledge and teach them to think critically (minzp.sk, 2020). We also need more social communication tools for food waste and consumer education. There are several initiatives in Slovakia, but their activities are mainly invisible to the average consumer.

The findings of many authors, e.g., Bagozzi and Gopinath (1999), Passyn and Sujan (2006), Phelps et al. (2014), Achar et al. (2016), Janssen (2018), Světlík and Bulanda (2019) show that emotional stimuli largely influence consumer behaviour and decision-making. The evoked emotions subsequently influence the ongoing cognitive processes, thus, also the consumers' decision-making processes. Decision-making is also an emotional process. Selected studies also indicate that conscious consumer

reactions differ from unconscious ones, so we can assume that many evaluations and decision-making processes occur on an unconscious or partially unconscious level. Consumers are often unaware of how they react to specific stimuli and cannot express their feelings in words (Rybanská, 2017). Therefore, we investigated various dependencies between consumer behaviour and emotional stimuli in the present study.

We found, like the authors Ščepichin et al. (1992), Lindstrom (2011), and Dannhoferová (2012), that colours have a significant impact on how the consumer perceives a particular stimulus. Colours have different popularity among consumers; each consumer has specific colours associated with specific objects and experiences and has a built-up relationship with them. For some foods, we found that consumers could assign colours to them according to subjective preferences and the popularity of specific products and brands. We can therefore assume that consumers assigned colours to individual food categories based on unconscious associations.

We also found that consumers in poor health (have some digestive problems or illness) throw away food at a higher rate. We believe that such a consumer is more rational and carefully considers what he will consume. He is probably more afraid of consuming products nearing their use-by date and is much less willing to take risks. However, even such a consumer is not resistant to emotional stimuli in marketing communication if it is focused on a product of interest to him (Vukmirovic, 2015) (e.g., diet foods, health food products). We reached similar results in the past when we discovered that consumers who evaluate their health more positively behave more responsibly concerning food waste (Rybanská et al., 2020). Abdelradi (2018) found that consumers who are more concerned about their health and a healthy lifestyle produce more food waste.

Respondents who participated in the research evaluated two specific social advertisements containing emotional stimuli. One was specially created for research purposes, and the other, foreign, was chosen so that it was not known to consumers. The created social ad contains humour; the goal of the second social ad is to evoke emotion, pity, and compassion. All listed are strong emotional stimuli influencing human behaviour (Phelps et al., 2014; Achar et al., 2016). For example, humour and laughter subconsciously trigger positive thoughts and feelings. Negative stimuli, on the contrary, evoke fear, sadness, feelings of guilt, and other complex emotions, which are likely to influence consumer reactions (Janssen, 2018).

Based on the obtained results, we can conclude that social advertising that carries a strong emotional charge (that is, contains emotional stimuli) has a high potential to influence and change consumer behaviour in the desired way. Ads that evoke multiple emotions

moreover, complex emotions (e.g., guilt, shame, fear, regret, compassion, etc.) are more effective than ads that only make the consumer laugh, although they evoke positive feelings and emotions.

Food waste is a serious ethical and environmental problem. In our opinion, it is possible to change consumer behaviour and mitigate its negative impact on society and the environment with appropriately set social marketing tools.

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References

[1] Abdelradi, F. (2018). Food Waste Behaviour at the Household Level: A Conceptual Framework. *Waste Management*, 71, 485-493. https://doi.org/10.1016/j.wasman.2017.10.001

[2] Achar C., So J., Agrawal N., & Duhackek A. (2016). What we feel and why we buy: the influence of emotions on consumer decision-making. *Current Opinion in Psychology*, 10,166-170. https://doi.org/10.1016/j.copsyc.2016.01.009

[3] Bačuvčík, R., & Harantová, L. (2014). *Sociální marketing*. VeRBuM.

[4] Bagozzi, R. P., & Gopinath, M. (1999). The role of emotions in marketing. *Journal of the Academy of Marketing Science*, 27(2), 184-206. https://doi.org/10.1177/0092070399272005

[5] Dannhoferová, J. (2012). *Velká kniha barev. Kompletní průvodce pro grafiky, fotografy a designéry.* Computer Press.

[6] Fišerová, R., Šmaková, K., Šulová, G, & Tlolková, M. (2018). Anti-consumerism. In *Propagace a média.* Studijní materiál PEF Mendelu v Brně.

[7] Fusions. (2016). *Estimates of European food waste levels*. http://www.eu-fusions.org/phocadownload/Publications/Estimates%20of%20European%20food%20waste%20levels.pdf

[8] Galandová, Ľ. (2021). *Sociálny marketing a zero waste životný štýl.* [Bakalárska práca]. Slovenská poľnohospodárska univerzita v Nitre.

[9] Janssen, D. (2018). *Emotions: an important factor driving consumer behaviour.* https://neurofied.com/emotions-important-factor-driving-consumer-behaviour/

[10] Kaňuchová, J., & Čábyová, Ľ. (2018). Sociálny marketing a jeho využitie v reklamných kampaniach na Slovensku. In Jánošová, D., Fašiang, T., & Grešková, P. (Eds.), *Zborník ŠVOaUK* (pp. 90-113). Univerzita sv. Cyrila a Metoda v Trnave. https://fmk.sk/download/SVOaUK-2017-Sekcia-marketingovej-komunikacie.pdf

[11] Konzumní společnost (Consumer Society). (2021). https://managementmania.com/cs/konzumni-spolecnost-consumer-society

[12] Lee, M. S. W., & Ahn, C. S. Y. (2016). Anti-Consumption, Materialism, and Consumer Well-being. *Journal of Consumer Affairs*, 50(1), 18-47. doi:10.1111/joca.12089

[13] Lee, N. R., & Kotler, P. (2011). *Social Marketing: Influencing Behaviours for Good.* SAGE Publications.

[14] Lincényi, M., Bulanda, I. & Světlík, J. (2022). Comparative analysis of development trends in the internet media market in the Czech Republic and the Slovac Republic, In: Gawroński, S., Szewczyk, M. & Bis, Ł. (Eds.), *New technologies in social and marketing communication*, WSIiZ, Rzeszów.7-38.

[15] Lindstrom, M. (2011). *Brandwashed: Tricks Companies Use to Manipulate Our Minds and Persuade Us to Buy.* Crown Business.

[16] Ministerstvo pôdohospodárstva a rozvoja vidieka Slovenskej republiky. (2020). *Až polovica peňazí, ktoré Slováci minú na potraviny, končí v kontajneri*. https://www.mpsr.sk/aktualne/az-polovica-penazi-ktore-slovaci-minu-na-potraviny-konci-v-kontajneri/15003

[17] Mladá, M. (2021). *Anti-konzumerizmus ako nový trend v marketingovej komunikácii na trhu potravín*. [Diplomová práca]. Slovenská poľnohospodárska univerzita v Nitre.

[18] OZ Free Food. (2021). *Plytvanie v číslach*. https://free-food.sk/problem/ake-su-statistiky/

[19] Passyn K., & Sujan M. (2006). Self-accountability emotions and fear appeals: motivating behaviour. *Journal of Consumer Research,* 32, 583-589. https://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.824.3146&rep=rep1&type=pdf

[20] Paulík, T. (2021). *Je marketing len o umelom vytváraní potrieb alebo dokážu značky robiť dobro?* https://www.marketinger.sk/free-times/analyze/je-marketing-len-o-umelom-vytvarani-potrieb-alebo-dokazu-znacky-robit-dobro

[21] Phelps E. A., Lempert K. M., & Sokol-Hessner P. (2014). Emotion and Decision Making: Multiple Modulatory Neural Circuits. *Annual Review of Neuroscience*, 37, 263-287. DOI: 10.1146/annurev-neuro-071013-014119

[22] Rybanská, J., Tkáč, F. & Kádeková, Z. (2021). *Sociálny marketing ako spôsob riešenia nadmerného plytvania potravinami na úrovni spotrebiteľa.* Nitra SPU.

[23] Rybanská, J. (2017). *Vplyv nástrojov marketingovej komunikácie na vedomé a podvedomé reakcie spotrebiteľa na trhu s potravinami.* [Dizertačná práca]. Slovenská poľnohospodárska univerzita v Nitre.

[24] Rybanská, J., Poláček, M., Košičiarová, I., & Kádeková, Z. (2020). The Relationship between Health-Related Quality of Life and Responsible Consumption. In Mazur, S. (Ed.), *Current Development of Society: Integration of Analytic and Synthetic Approaches* (pp. 76-83). Logophon Verlag GmbH.

[25] Shaw, I., & Aldridge, A. (2003). Consumerism, Health and Social Order. *Social Policy and Society*, 2, 35--43. doi:10.1017/S147474640300109X

[26] Smarticular. (2020). *Konec plýtvání jídlem*. KAZDA, s.r.o.

[27] Smith, K., & Burnett, K. L. (2017). *Inside the Norwegian Advert That Went Viral – and Broke a Hundred Million Hearts.* https://www.lbbonline.com/news/inside-the-norwegian-advert-that-went-viral-and-broke-a-hundred-million-hearts

[28] Světlík, J. & Bulanda, I. (2019). The shift of value types of the czech population and its influence on the formation of creative advertising strategy. In *Marketing Identity.* Offline Is the New Online. 323-334.

[29] Ščepichin, V., Ščepichinová, G. J., & Kolářová, H. (1992). *Test barevně sémantického diferenciálu*. Vadim České Budejovice.

[30] Valmorbida Moraes, N., Lermen, F. H., & Soares Echeveste, M. A. (2021). A systematic literature review on food waste/loss prevention and minimization methods. *Journal of Environmental Management*, 286, 112268. DOI: https://doi.org/10.1016/j.jenvman.2021.112268

[31] Vukmirovic, M. (2015). The Effects of Food Advertising on Food-Related Behaviours and Perceptions in Adults: A Review. *Food Research International*, 75, 13-19. https://doi.org/10.1016/j.foodres.2015.05.011

[32] Wisschers, V. H. M., Wickli, N., & Siegrist, M. (2016). Sorting out food waste behaviour: A survey on the motivators and barriers of self-reported amounts of food waste in households. *Journal of Environmental Psychology*, 45, 66-78. http://dx.doi.org/10.1016/j.jenvp.2015.11.007

[33] WWF Deutschland. (2015). *Das große Wegschmeißen*. http://mobil.wwf.de/fileadmin/fm-wwf/Publikationen-PDF/WWF_Studie_Das_grosse_Wegschmeissen.pdf.

Quantifying and visualizing access to food in the areas with dispersed settlements in Slovakia: case study Novobanská štálova area

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Abstract
Dispersed settlement is a residential area that has been preserved in the mountainous and sub-mountainous regions of Slovakia. In this paper, we will focus on the analysis of food retailing as a subsystem of the local food system in an environment where residents are socially and geographically disadvantaged when purchasing food. The aim of the research was to find out the state of the food retail network, to quantify it through traditional indicators of the sales area, areal and service parameters, and to visualize the time availability to food stores in the Novobanská štálova region. The retail network of food stores in this area can be evaluated as very logically distributed. There is at least one grocery store in every village. The most numerous sales network in the region is the Slovak chain Coop Jednota, which is represented by up to 20 stores out of a total of 38. In terms of the size of the stores, small shops with a sales area of 51 to 200 m² predominate. As many as 1038 inhabitants of the studied region live within walking distance of more than 20 minutes, i.e. at an unfavorable distance to the nearest food, this represents 4.15%, but up to 52.4% of the inhabitants of settlements (štály). The biggest problems were surprisingly evident in the centers of Nová Baňa and Žarnovica, where, in addition to some of the dispersed settlements, their urban areas also found themselves in food deserts.

Keywords: *rural economics, food access, food deserts, healthy food, spatial analysis, dispersed settlements*

JEL Classification: *R32, R39, R41*

1. Introduction

Tolmáči and Tolmáči (2020) refer to the group of all processes and relationships between people and food taking place in a certain geographical space as a food system. It has three subsystems – production, distribution and consumer (Sobal et al., 1998, Ericksen 2008; Rutten et al, 2011, Reid et al, 2012; Marsden and Morley, 2014; Tolmáči and Tolmáči, 2020). Global population growth, rising incomes and increasing urbanization are putting enormous pressure on food systems (Quynh Lê., et al. 2015). Food systems all over the world are under enormous pressure, and that is why they are penetrating even smaller towns and villages.
In Slovakia, there are five main areas with a dispersed form of settlement (Myjavské kopanice, Novobanská štálová region, Detvianska laznícka region, Javornícko-Beskydská kopaničiarska region and the region of kopaničiar settlement in Strážovské vrchy (Valašsko-belianska region). These scattered settlements were created after three waves of migration from the 12th to the

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17th century during the period of German, Wallachian, Horal and Kopaničiar colonization (Dubcová et al. 2008). Today, they create a marginalized territory in a cultural landscape with a specific environment with disturbed functional and spatial relations, which result from the uneven functioning of mutually conditioned political, economic, social, cultural and environmental factors (Szczyrba et al., 2013; Ira, 2019; Vaishar and Šťastná, 2019). The access to public amenities such as schools, hospitals, municipal and state offices and shops are another challenge faced by people living in scattered settlements, including the access to food. Living in a dispersed settlement, its isolation also brings advantages, which was significantly manifested in the previous covid period (Vaishar and Šťastná, 2021). With the change of life in these territories, there is also a change in the procurement of food. The majority of the population procures food of the broadest nature in retail establishments through self-supply. Food self-sufficiency in the shortest food chain is represented by the movement from the garden to the house. It is characteristic of the post-socialist countries of Central and Eastern Europe, and especially Slovakia, where the so-called concept of silent sustainability is developed.
According to Križan et al., (2020, p. 77), grocery stores are essential service facilities of rural municipalities. In connection with the ongoing globalization processes and the entry of multinational chains into the Slovak market after the year 2000, there were also organizational changes in the countryside, the allocation of investment funds (also to small towns and large municipalities) in the form of large-scale retail formats such as supermarkets (Križan et al. ., 2020). In many rural locations, not only as a result of the decrease in the number of inhabitants and especially the existence of supermarkets in the towns, but also in villages, food stores have disappeared. The goal of our research is the analysis of the conditions of the food consumer subsystem in the dispersed settlement of Novobanská štálová area.

2. Data and Methods

The basic methods of geospatial analyses include the field research. It was implemented in the subject area in the months of June and July 2021. In addition to the exact location of food stores, we determined the sales area in m² as part of the data collection matrix, from which standard indicators of retail equipment can be calculated, specifically PAFS, i.e. area parameter (Population to the Admissible Floor Space, abbreviated as PAFS). It expresses the size of the sales area in m² per 1000 inhabitants. In accordance with the methodology of Trembošová (2010), we divided the PAFS levels into four hierarchical levels: local, city, regional and supra-regional level. The second indicator is the service parameter of retail facilities, calculated as the ratio of the number of inhabitants per 1 store.
In order to gain the geo-spatial visualizing access to food stores, it was necessary to proceed in four logical steps described in the article Trembošová and Jakab (2021). The spatial data in the table containing the addresses of food stores has been geocoded into the point vector layer via the MMQGIS plugin in QGIS software (www.qgis.com). MMQGIS is a set of Python plugins for manipulating vector map layers in Quantum GIS: CSV input/output/join, geocoding, geometry conversion, buffering, hub analysis, simplification, column modification and simple animation. We have used a Geocodes CSV with Web Service tool to geocode addresses to a point output file (Minn, 2021). Grass GIS 7.8.0 (Grass) was used to calculate the density of food stores. With this method (Moore, 2008 and Guagliardo, 2004) each food shop is represented on a map surface by a cone (kernel), centred on the food store location. The radius of the cone base was set at 1,666 m and represents the distance a person walks in 20 minutes at an average speed of 4 km/h. The Gaussian kernel method Wisnievski (2016), Goliszek (2017) and Golizsek and Polom (2020) allocates the capacity of food stores to the cell underlying the cone in such a way that cells near the cone centre receive higher values of service capacity (i.e. accessibility), and those near the periphery of the cone receive very little. For the purpose

of identifying the food desert, the resulting values were reclassified into two parts: walking availability within 20 minutes and walking availability over 20 minutes (at 4 km/h). There is no agreement in terms of the border of the food desert, but distances of around 1000 metres (approximately a 12-minute walk for an adult in a city – a walking speed of 5 km/h) are common e.g. (Inagami et al., 2006, Russel and Heidkapm, 2011) and (Cushon et al., 2013 and Apparicio et al. 2008). The border of the food desert was defined by accessibility exceeding 15 minutes (distance of 1000 meters at a walking speed of 4 km/h).

3. Results and Discussion

3.1 Study site

The settlements of Novobanská štálova area together do not form one interconnected functional territory. The area covers three regions of Nitra, Banská Bystrica and Trenčín (Figure 1). According to the districts, we can therefore divide them into three parts, which are well connected by transport, but their main transport corridors lead to the relevant district town, in the area covered by the towns of Zlaté Moravce, Partizánske and Žarnovica. Physical and geographical obstacles are also responsible for this division of the region. The village of Jedľové Kostoľany (Zlaté Moravce district) separates the Pohronský Inovec massif from the rest of the settlements. The same applies to the villages of Radobica, Čereňany, Oslany and Horná Ves (Partizánske district). These villages are cut off from other settlements by the high ridge of the Vtáčnik mountain range. We can observe a single functional region only around the town of Nová Baňa, which administratively belongs to the district of Žarnovica: the town of Žarnovica and the villages of Veľká Lehota, Malá Lehota, Horné Hámre, Župkov, Hrabičov, Píla, Veľké Pole.

Figure 1: Study area.

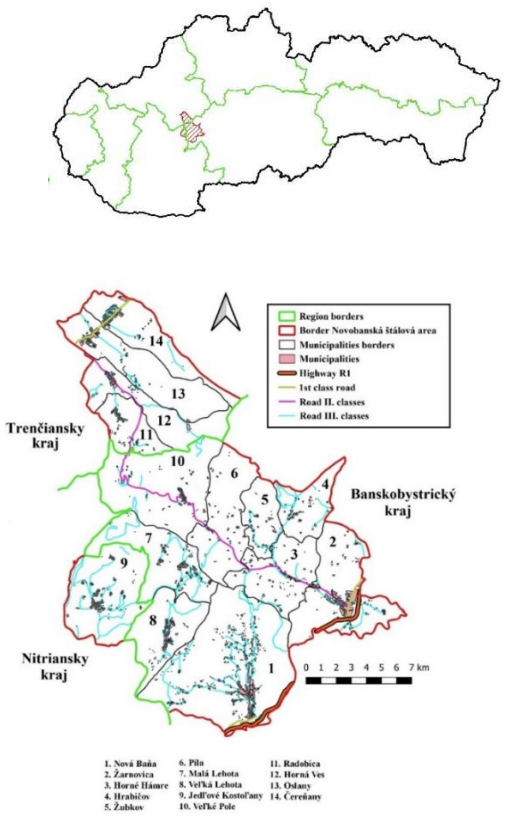
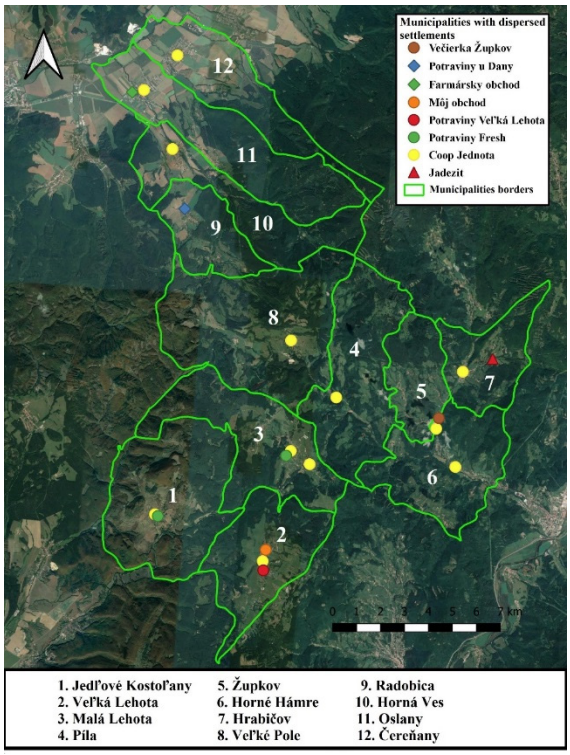


Figure 2: Food localization in 2021. Source: authorś



Disintegrated settlements were created in rugged terrain from 200 m up to 800 m above sea level in volcanic mountains with low-fertile soils, and therefore pastoralism prevailed here over the cultivation of agricultural crops. The scattered residences are called "štale" here, which is of German origin and proves that they were founded by Germans as well as Slovaks. They were originally inhabited by miners, coal miners, glass workers, woodcutters and shepherds, later, predominantly agricultural population. Today, many houses on "štale" are becoming important weekend residences for city dwellers.

3.2 Quantifying retail network in Novobanská štálova area

In the Novobanská štálova area, most of the villages have a formed core where activities accumulate, except for the villages of Župkov and Hrabičov. And it is in the cores that the majority of food stores are concentrated. On the basis of field research, 38 food stores were operating in the Novobanská štálova area. Of this number, 18 stores were located in the cities and 20 stores in 12 villages in the Štál region. There is at least one grocery store in every municipality (Figure 2). The dominant position among them is held by the Slovak chain of Coop Jednota (12 stores). The chain of Fresh stores (headquarters of the Košice company) is represented by two stores in the villages of Jedľové Kostoľany and Malá Lehota, and the retail chain Môj obchod (headquarters of the Nemecko company) is represented by only one store in the village of Veľká Lehota. The remaining five grocery stores belong to local vendors, namely Večierka in the village of Župkov, Potraviny u Dany in the village of Radobica, Farmársky obchod in the village of Oslany, a grocery store in Veľká Lehota and the Jadezit store in the village of Hrabičov. Larger villages with more than 1000 inhabitants, such as Oslany, Čereňany and Veľká Lehota, there are up to 5 stores. In the towns of Nová Baňa and Žarnovica, the representation of food stores is more numerous and of a wider range. Nová Baňa has 10 stores, including 1 Lidl supermarket, and Žarnovica has 8 stores, including 2 supermarkets - Billa and Tesco. The village of Píla has the largest food sales area (1,250) in m² per 1,000 inhabitants (PAFS). Together with the town of Žarnovica (678) and the village of Malá Lehota (905), they have a supra-regional level of food infrastructure. The town of Nová Baňa (579) and the village of Župkov (514) ensure the regional level of the food area. We evaluated Jedľové Kostoľany, Radobica and Hrabičov as municipalities with urban food facilities, and the remaining 6 municipalities reach the local level according to PAFS. There was not shown any dependence between the population and the sales area, calculated on the basis of their correlation.

Similarly, there was no dependence on another indicator of the retail network's amenities – the service parameter, which expresses the number of residents per store. According to the values of the level of service, the municipalities acquire a level from extremely low (601% and more), to very low (451 – 600%), low (301 – 450%), average (151 – 300%) to high (150 % and less). The municipalities of Čereňany (1730%), Horná Ves (1457%), Oslany (1187%) and Horné Hámre (665%) have the lowest service level. It is interesting that this category also includes the towns of Nová Baňa (730%) and Žarnovica (878%), which belong to the smaller towns in Slovakia (up to 10,000 inhabitants). They are not characterized by a high population concentration, which is limited by the natural and economic conditions of the territory and, consequently, by the low purchasing power of the population. The category with an average serviceability includes the municipalities of Malá Lehota (276%) and Hrabičov (287%). Only the smallest municipality of the Píla region (128%), which has only one store, which is used by a very small number of residents, has a high level of service.

3.3 Geospatial surveys

Spatial localization of food stores in the Novobanská štálova area is concentrated in the cores of the municipalities. The majority of their residents are now motorized. When going to work, they use stores in the towns or in the core to buy food. This creates a strong orientation towards the motorized customer. The dispersed settlements are at different distances from the core. The distance/availability of grocery stores of 20 minutes walking was taken as the threshold value. According to the results of the interpolation, difficult accessibility to food stores occurs in 13 municipalities, except for Hrabičov. In these villages, the area where food is more than 20 minutes away mainly includes their dispersed areas. Difficult availability of food was identified in 48 permanently inhabited settlements, where 1038 inhabitants live, which represents 4.15% of the population of the entire area and up to 52.4% of the population permanently inhabiting dispersed settlements (Table 1, Fig. 3).

Table 1: Basic characteristics of the municipalities of the Novobanská štálova region as of 31 December 2021

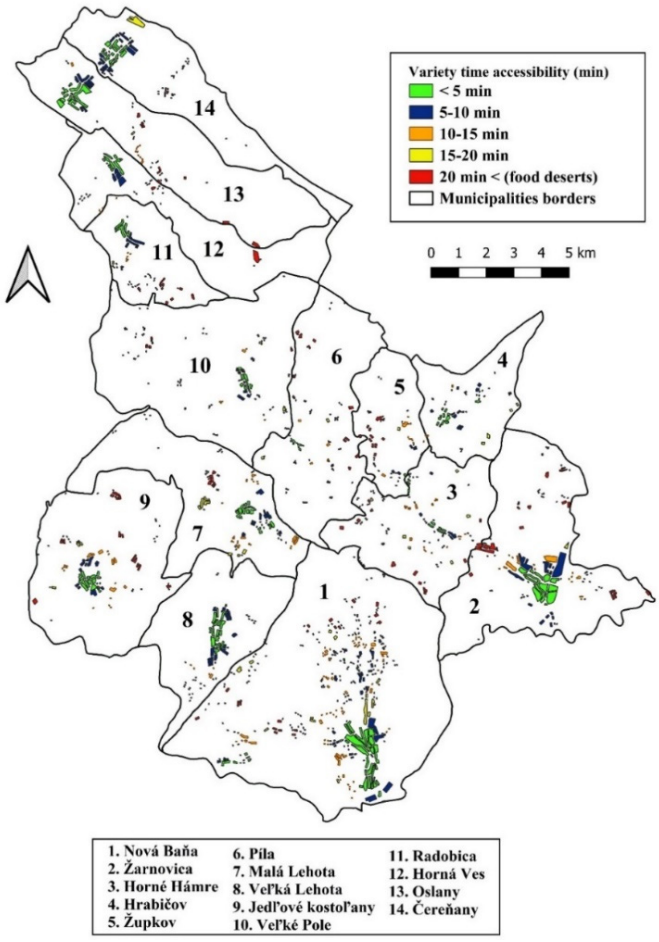
Title	A	B	C	D	E	F	G	H	I
Nová Baňa	7299	31	5955	1344	10	579	254	3.48	18.9
Žarnovica	6150	5	6033	117	8	678	531	8.63	100
Jedľové Kostoľany	896	11	851	45	2	489	17	1.89	37.78
Veľká Lehota	1089	8	1051	38	3	389	18	1.65	47.37
Malá Lehota	828	16	759	69	3	905	8	0.97	11.59
Veľké Pole	430	7	402	28	1	256	19	4.42	67.86
Píla	128	9	101	27	1	1250	13	10.16	48.15
Oslany	2375	1	2311	64	2	356	64	2.69	100
Horná Ves	1457	8	1407	50	1	283	24	1.65	48
Radobica	531	11	489	42	1	314	24	4.52	57.14
Horné Hámre	665	11	618	47	1	325	29	4.36	61.7
Župkov	871	8	840	31	2	514	11	1.26	35.48
Hrabičov	574	8	521	53	2	436	0	0	0
Čereňany	1730	2	1704	26	1	355	26	1.5	100
Summary	25023	136	23042	1981	38		**1038**	**4.15**	**52.4**

A - Population, B - Number of permanently inhabited dispersed settlements, C - Population in the center of the village,D - Population in settlements, E - Number of food stores, F - PAFS, G - Number of inhabitants living with limited access to food, H - Share of inhabitants with access to food over 20 min. of the total number in %, I - Share of residents with accessibility over 20 min. to food from the population living in settlements in %

Source: Internal documents of municipal/city offices, 2021

All residents of these settlements, except for two villages of Oslany and Čereňany, are over the limit. A high level of difficult accessibility to food stores is also shown by residents of the areas belonging to the municipalities of Veľké Pole (67.86%), Horné Hámre (61.7%), Radobica (57.18%), Píla (48.15%) and Veľká Lehota (47.37%). However, we also found poor accessibility in the towns themselves. For example in Žarnovica (in the district town), 8.63% of the population and up to 100% of the population in its dispersed settlements suffer from difficult access to food stores.

Figure 3: Accessibility to grocery stores on foot. Source: QGIS 3.18.3



4. Conclusion

The relief of mountainous and foothill areas creates the conditions for the emergence of dispersed settlements. The distance between the individual settlements makes it difficult for the inhabitants to access services such as the accessibility of retail food, which are located in every core of the settlement. The cores fulfill the most diverse functions for the inhabitants of the municipalities. Today, many settlements change their original agricultural function to become weekend residences for the urban population, who come with food bought in the towns. The availability of food is currently a very relevant topic. In many rural locations, due to the emigration of the population and the influence of foreign chains in the cities, food stores are disappearing. In the last two years, during the Covid-19 pandemic, people's movement was often restricted, so they were forced to buy food only in nearby stores. There are 48 permanently inhabited settlements (35%) within a time accessibility of more than 20 minutes to the nearest food where 1038 inhabitants live, i.e. up to 52.4% of the population of dispersed areas. The biggest problems were also seen in the towns of Nová Baňa and Žarnovica, where, in addition to some dispersed areas, their urban districts also found themselves in food deserts. We can evaluate the retail network of food stores in the Novobanská štálova region as very logically distributed in the centers of villages, with at least one food store located in each village. The most numerous sales network in the region is the Slovak chain of Coop Jednota. It represents up to 20 stores out of a total of 38. In terms of the size of the stores according to the sales area, small businesses up to 400 m² predominate. This is due to the fact that most of the settlements

in the region are small villages, where large-scale stores do not have enough customers to make a living.

According to Guy and David (2004, p. 223), the main features characterizing limited access to food in relation to residents can be considered: i) residents are physically disadvantaged in terms of mobility and accessibility, ii) they are also economically disadvantaged because they generally achieve lower incomes, iii) these facts lead to unfavorable nutrition/meals, they usually eat cheaper, iv) they are spatially disadvantaged due to the insufficient selection of food stores in their surroundings and v) local (small-scale) stores have a more limited selection of food and at higher prices than large-scale stores. In this context, we can consider local food systems in the sparsely populated areas of Slovakia as "ideal areas" for the occurrence of areas with limited access to food, also referred to in the literature as food deserts.

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References

[1] Apparicio, P., Abdelmajid, M., Riva, M., & Shearmur, R. (2008). Comparing alternative approaches to measuring the geographical accessibility of urban health services: Distance types and aggregation-error issues. *International Journal of Health Geographics 7*(7). doi: 10.1186/1476-072X-7-7

[2] Cushon, J., Creighton, T., Kershaw, T., Marko, J., & Markham, T. (2013). Deprivation and food access and balance in Saskatoon, Saskatchewan. *Chronic Diseases and Injuries in Canada*, *33*, 146-159. doi: 10.24095/HPCDP.33.3.05

[3] Dubcová, A., Lauko V., Tolmáči L., Cimra J., Kramáreková H., Krogmann A., Nemčíková M., Némethová J., Oremusová D., Gurňák D., & Križan F. Geografia Slovenska. Nitra : UKF, 2008. - 351 s. - ISBN 978-80-8094-422-3.

[4] Ericksen, P. J. (2008). Conceptualizing food systems for global environmental change research. *Global Environmental Change 18*(1), 234-245. doi: 10.1016/j.gloenvcha.2007.09.002

[5] Goliszek, S. (2017). Udział transportu zbiorowego w poprawie dostępności do usług w Gdyni. *Prace Komisji Geografii Komunikacji PTG*, *20*(1), 36-49. doi: 10.4467/2543859XPKG.17.003.6732

[6] Goliszek, S., Połom, M., Duma, P., (2020). Potential and cumulative accessibility of workplaces by public transport in Szczecin. *Bulletin of Geography. Socio-economic Series*, *50*(50), 133-146. doi: http://dx.doi.org/10.2478/bog-2020-0037

[7] GRASS Development Team: Geographic Resources Analysis Support System (GRASS) Software, Version 7.8.0. Open Source Geospatial, Foundation. Available online: http://grass.osgeo.org./ (accessed on 12 February 2021).

[8] Guagliardo, M. F. (2004). Spatial accessibility of primary care: concepts, methods and challenges. *International Journal of Health Geographic*, *3*(1), 1-3. doi: 10.1186/1476-072X-3-3

[9] Guy, C., & David, G. (2004). Measuring geographical accessto „healthy foods" in areas of socila deprivation: a case study in Cardiff. *International Journal of Consumer Studies* 28(3), 222-224.

[10] Inagami, S., Cohen, D. A., Finch, B. K., Asch, S. M. (2006). You are where you shop: grocery store location, weight and neighborhoods. *American Journal of Preventive medicine*, *31*(1), 10-17.

[11] Ira, V. (2019). Impact of Rural Restructuring on the Time.Space Behavioural Patterns in a Marginal Area. In W. Leimgruber & C. Chang (Eds.), *Rural Areas Between Regional Needs and Global Challenges, Perspective on Geographical Marginality* 4 (pp. 17-29). Springer Nature, Switzerland AG.

[12] Križan, F., Bilková, K., Hencelová, P., Danielová, K., Čuláková, K. & Zeman M. (2020). *Nákupné správanie spotrebiteľov na Slovensku*. Bratislava: Univerzita Komenského v Bratislave.

[13] Lê, Q., Nguyen, H. B., Terry, D., Dieters, S., Auckland, S., Long, G., (2013). Quantifying and visualizing access to healthy food in a rural area of Australia: A spatial analysis. 2015. Food Security: The Science, Sociology and Economics of Food Production and Access to Food, Springer: *The International Society for Plant Pathology*, *7*(5), 1017-1029. doi: 10.1007/s12571-015-0491-4

[14] Marsden, T., & Morley, A. (2014). Sustainable Food System. Building a New Paradigm. Londýn: Earthscan from Routlege, Oxon.

[15] Minn, M. QGIS. (2021). describes use of MMQGIS, a set of Python vector map layer plugins for Quantum GIS Available. online: http://michaelminn.com (accessed on 16 May 2021).

[16] Moore, L. V., Roux, A.V., Brines, S. (2008). Comparing perception-based and geographic information system (GIS)-based characterizations of the local food environment. *Journal of Urban Health, 85*(2), 206-216.

[17] QGIS. QGIS Geographic Information System. QGIS Association. Available online: http://www.qgis.org./ (accessed on 10 January 2021).

[18] Reid, N., Gatrell, J. D., & Ross, P.S. (2012). *Local Food Systems in Old Industrial Regions. Concepts, Spatial Context and Local Practices*. New York: Routlege.

[19] Russel, S.E., Heidkamp, C. P. (2011). "Food desertification": The loss of a major supermarket in New Haven, Connecticut. *Applied Geography*, *31*(4), 1197-1209.

[20] Rutten, L. F., Yaroch, A. L., & Story, M. (2011). Food system and Food security: A conceptual Model for Identifying Food Systems Deficies. *Journal of Hunger & Environmental Nutriotion, 6*(3), 239-246. doi: 10.1080/19320248.2011.597705

[21] Sobal, J., Khan, L. K, & Bisogni, C (1998). A conceptual model of the food and nutrition system. *Social Science & Medicine, 47*(7), 853-863. doi: 10.1016/s0277-9536(98)00104-x

[22] Szszyrba, Z., Fiedor, D., & Kunc, J. (2013). Služby ve venkovských regionech Česka – Kvantitativní hodnocenízměn v uplynulém transformačním období (příspěvek ke studiu venkova). In Klímová, V., Žítek, V. eds. XVI. Mezinárosní kolokvium o regionálních vědách; (212-222). Brno:Masarykova Univerzita.

[23] Tolmáči, A., & Tolmáči, L. (2020). Postavenie maloobchodu v potravinovom systéme a jeho vplyv na spotrebu potravín na lokálnej úrovni. In Križan, F. ed. Kde nakupujeme, čo nakupujeme a prečo nakupujeme: lokality maloobchodu a spotreby a správanie spotrebiteľov. (pp. 217-235). Bratislava: Univerzita Komenského v Bratislave.

[24] Trembošová, M., 2010. Vybrané aspekty transformácie maloobchodu v meste Nitra v rokoch 1992-2008. *Geografický časopis, 62*(1), 49-73.

[25] Trembošová, M., & Jakab, I. (2021). Spreading of Food Deserts in Time and Space: The Case of the City of Nitra (Slovakia). *Sustainability 13*, 7138, DOI 10.3390/su13137138.

[26] Vaishar, A., & Šťastná, M. (2019). Sustainable development of a peripheral mountain region on the state border: Case study of Moravské Kopanice microregion (Moravia). *Sustainability, 11*(19), 5540. doi: 10.3390/su11195540

[27] Vaishar, A., & Šťastná, M. (2021). Accessibility of Services in Rural Areas: Southern Moravia Case Study. *Sustainability*, *13*, 9103. doi: 10.3390/su13169103

[28] Wiśniewski, S. (2016). Dostepność mieszkańców województwa Łódzkiego do sklepów wielkopowierzchniowych. *Acta Universitatis Lodziensis Folia Geographica Socio-Oeconomica, 23*, pp. 25–38.

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