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EU27 Countries' Sustainable Agricultural Development toward the 2030 Agenda: The Circular Economy and Waste Management

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Abstract: An increasing population and increasing industrial demand for resources has created a need to ensure the supply can keep up. With sustainable development on the agenda, the European Union established the strategy 2030 Agenda with set goals to fulfil. Some of those are connected to the principles of the circular economy. This study aimed to identify the state of the circular economy based on the current level of waste management in the agricultural sector of EU27 countries in the context of the implementation of the 2030 Agenda. The main focus was on the 12th goal of the 2030 Agenda for sustainable development, for which countries are analyzed according to five indicators. The results showed heterogeneity between EU countries, and while we analyzed this in relation to countries' GDP, no relationship between the agricultural waste management and GDP was found. To confirm and develop the results obtained, we outline possibilities for future research and methodological improvements that will support more robust conclusions, such as expanding the research sample.

Keywords: circular economy; sustainable development; 2030 Agenda; agriculture

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1. Introduction

The world's population growth has led people to think about how to effectively use the resources that are currently available. Now that we are aware of the limited resources, the search for new directions for production is becoming highly important, and sustainability is coming to the fore in various areas of life, whether in the environmental, economic, or social [1] regards. Sustainability concerns all sectors of the economy, including agriculture [2], to which we must pay close attention.

Waste is a particular area of concern, and the foremost problem is dealing with waste. By reusing it through recycling, we can process at least part of the waste materials and use them to our advantage. In this regard, a new direction of the circular economy is coming to the fore.

The circular economy (CE), as a kind of new economic form, is based on the principles of diversity, resilience, and comprehensive thinking. The CE requires an intersection of the biological, technological, and material spheres. It supports a cyclical relationship and the transformation, distribution, utilization, and regeneration of available materials. It must be noted that there is no perfect and closed system that allows every resource to be reused; with notions such as the CE, there are both advantages and limits to their application [3].

The Industrial Revolution was associated with the rise of the idea of sustainable development. From the second half of the 19th century, Western countries began to realize that their economic and industrial activities had a significant impact on the environment and social balance. Natural resources such as land and water, have long been the main factor, substance for agriculture [2], and since the Industrial Revolution, when humanity has gone through several ecological and social crises, it has awakened the world's need for a more sustainable model. In specific, sustainable development is a way of organizing society so that it can exist in the long term [4]. It is often claimed that it represents the ability to ensure long-term development on the basis of sustainability, while the needs of the present are ensured in such a way, that the ability of future generations to meet their own needs is not endangered [5,6]. This means taking into account current and future imperatives such as the protection of the environment, natural resources, or social and economic equality, according to Youmatter [7]. Diaz-Sarachaga [8] argues, that sustainable development strives for economic growth to achieve social progress without damaging the environment, which can only be achieved through the fundamental support of institutions.

Within environmental protection, waste management plays a key role, because it affects people's daily lives and business activities. This trend may be attributed to current economic and environmental factors that affect sustainability [9]. It is a way, that in Europe, waste management is determined and guided by the waste pyramid [10], which sets out that we should manage, dispose of, recycle, recover, and (re)use wastes [11].

Castillo-Diaz et al. [12] points to the fact, that in some cases, agricultural waste can provoke a health crisis. Municipal solid waste, meanwhile, is largely made-up of kitchen and yard waste. Composting this waste is seen as a method of diverting organic waste materials from landfills while creating a product, at relatively low-cost, which is suitable for agricultural purposes. Composting municipal solid waste thus has potential as a beneficial recycling tool. The production of high-quality compost for use in agriculture must take into account, that such compost must be sufficiently matured with a low metal and salt content.

Sustainable development seeks to achieve economic growth. In 2015, the 17 Sustainable Development Goals (SDGs) were released and ratified by the United Nations as part of the 2030 Agenda, an agreement by the United Nations to improve global sustainability [13]. Under this, various projects and efforts at the international level aim to support sustainable development [14]. The SDGs should be achieved by the EU countries by 2030 [14]. The aim is not only the fulfilment of the stated goals but also the advancement of social, economic, and environmental aspects of the participating countries' lands and systems, to further their development. Bioeconomy is essentially understood as an economic production model. Currently, it provides innovative ideas on how, to successfully achieve the goals of the 2030 Agenda, especially in the areas of socio-economic and environmental, such as the increase in agricultural production to meet the needs of the world's population [2]. The SDGs represent goals that are interconnected by strategy. The strategy is primarily focused on the main problems that our society is currently facing. It uses sustainable practices to solve these problems [15]. Suchek et al. [16] points out, that the 2030 Agenda goals highlight how social and economic development depend on sustainable management of the natural resources.

Two connected but separate challenges for development cooperation and results are the content of the 2030 Agenda for Sustainable Development.

1. First, the Agenda contains 17 goals with 169 tasks to be achieved by 2030. They represent targets, deadlines, indicators, and data points, which are the prerequisites for the expected results;
2. Second, the 2030 Agenda emphasizes leaving no one behind as a political imperative, even for goals that are set high. The idea of leaving no one behind needs no goals, deadlines, indicators, or data [17].

According to Dantas et al. [15], the 17 SDGs may be classified into one of three main areas, namely the economy, society, or biosphere. In the context of the issue we are investigating, we are most interested in goal 12—responsible consumption and production.

If we want to achieve economic growth of the country while simultaneously using the concept of sustainable development, we should definitely reduce the ecological footprint, e.g., by changing the way we produce and consume goods and resources. Agriculture is the largest consumer of water in the world and irrigation currently requires almost 70% of all freshwater involved in human consumption. However, while some of us are throwing food away, much of the world's population still consumes too little to cover even their basic needs. There is a need to significantly reduce global food waste, especially at retailers and consumers. This will be administered by newly created more efficient production and supply chains, that can help with food security. At the same time, they will move us towards a more efficient economy in terms of resources [18].

Food waste is one of the biggest global challenges. SDG 12 is related to food waste and commits the global community to halve food waste generation at the consumer and retail levels, while aiming to reduce food losses along the supply chain [19]. For the area of Circular economy, SDG 12 is the most suitable in terms of content. The European Union published an action plan that clearly states that the CE is a system-wide solution strongly directed to promoting sustainable consumption and production modalities, and, therefore, contributing to the achievement of the targets set for this particular SDG [15].

The circular economy (CE) is a kind of new economic form and economic development model [3,20] aimed at the efficient use of resources [14] through waste minimization, long-term value retention, reduction of primary resources, and closed loops of products, product parts, and materials within the boundaries of environmental protection and socioeconomic benefits [21]. Suchek et al. [16] argues, that the CE provides a reliable structure for radically improving the current business model within the scope of developing a preventive and regenerative eco-industry, as well as boosting wellbeing based on recovered environmental integrity.

The circular economy is an important support tool for economic growth, and it is in line with sustainable environmental and economic development [22]. The transition to CE is not easy for any economy. It represents a systemic change, that seeks not only to reduce the impacts of the linear economy, but also to strengthen long-term resilience and create economic and business opportunities while returning environmental and social benefits [16].

According to Corvellec et al. [23], the circular economy is not a theory but an emerging approach to industrial production and consumption. In general, this term means the activities of reducing, reusing, and recycling in production, circulation, and consumption. This is in contrast to the natural economy and traditional economy. The traditional economic pattern is a one-way linear flow, namely "resources → products → waste". Among the characteristics resulting from the nature of the circular economy, we can mention low consumption of materials and resources in the course of production, a low pollution level, high efficiency, and high circulation rates, thus enabling resources to be put to full use during production [24]. A logical answer to the problem of the linear flow model is a cyclical flow of materials (Figure 1) [22] and energy, as can be seen in the concept of the CE.

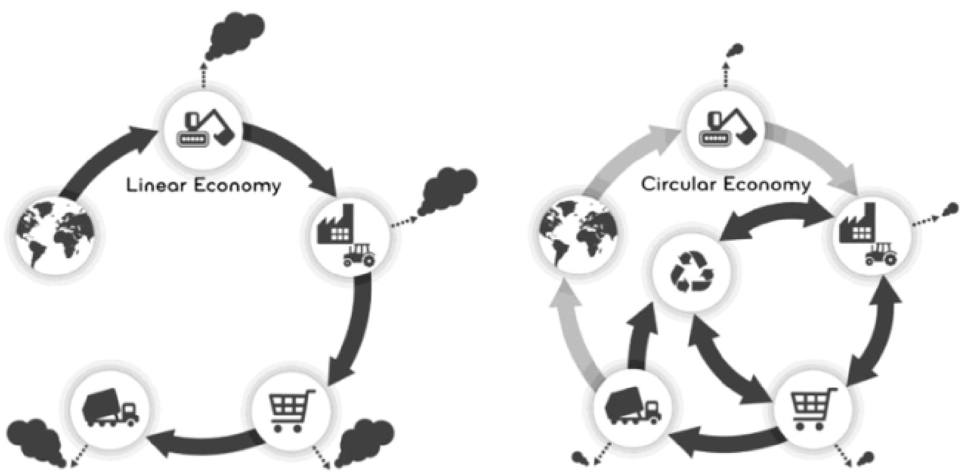

Figure 1. Circular economy vs. linear economy [20,25].

According to Suchek et al. [16], CE is based on three principles:

1. Natural capital—An important fact is mainly the preservation and enhancement of natural capital, as well as the control of limited stocks and equalization of flows and renewable resources;
2. Optimization of returns from resources—through the use of products, components and materials at the highest level of utility, we can optimize returns from limited resources for the longest possible time in technical and biological cycles;
3. Efficiency of systems—it is necessary to stimulate the efficiency of systems by identifying and excluding negative externalities at the very beginning in order to avoid undesirable phenomena.

Schroeder, Anggraeni and Weber [26] point out the fact, that the CE practices apply not only to manufacturing and municipal waste management but also to sectors such as forestry and agriculture, which are greatly important for many countries. Their effect is to reduce the adverse effects of economic activities on nature as much as possible, as can be seen also in Figure 2. If it succeeds, the CE will achieve economic development, environment protection, and resource saving all in one [24]. In 2008, China became the first country in the world to adopt a law bringing in the circular economy, which represents a landmark moment in the adoption of the concept [22].

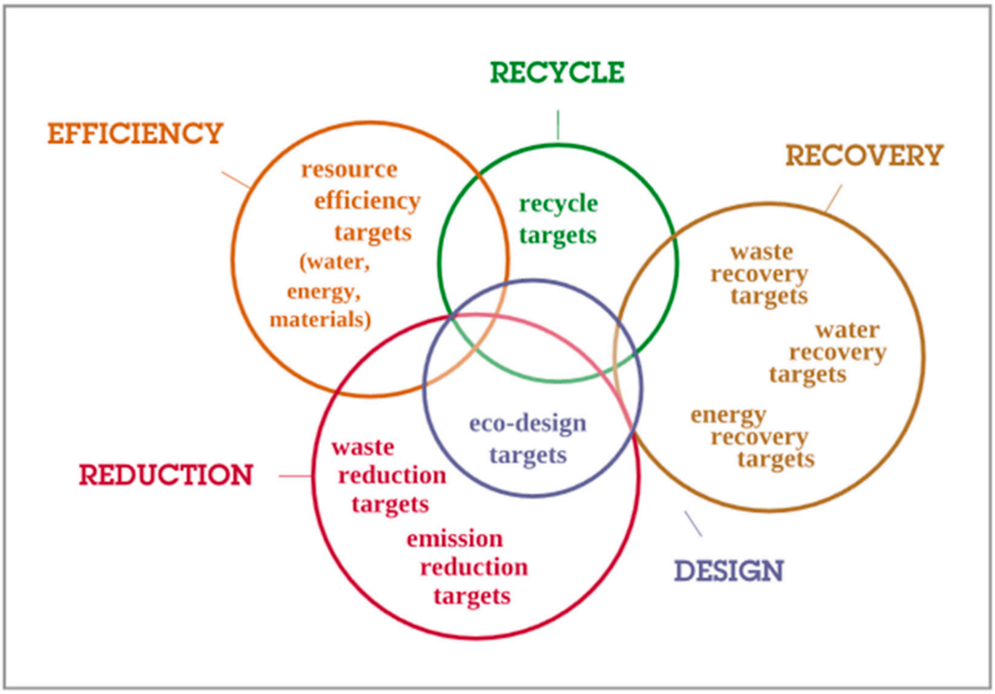

Figure 2. Main existing CE targets [21].

Implementing the CE seems inevitable if we are to foster sustainable agricultural development:

- The CE is the key approach proposed thus far for transforming national economic and social systems by establishing a recycling society;
- Problems that arise in agriculture and are connected with its essence, such as environmental pollution, ecological damage and resource depletion, need to be solved using CE principles and methods [24].

The circular economy contains elements of green growth. This represents the decoupling of economic growth from its impact on the environment. However, this potential decoupling effect has been questioned, e.g., by Corvellec, Stowell and Johansson [23], while some have suggested that it is not an end in itself.

Furthermore, the circular economy is presented as the solution to the sustainability challenge, but some suggest that its share in the global performance is very small, or focuses on a small fraction of materials. Since this is a relatively new approach, the long-term effects on the environment remain unquantified. This is problematic because the environmental benefit of the circular economy rests largely on the premise that most materials will be recycled [23].

According to Skene [27], another problem of the circular economy is the uneven geographical involvement of countries in these processes, which leads to extensive transfers of resources around the world. In the future, the reuse of waste in a given region will require a demanding global reorganization of consumption and production [23]. Thus, as highlighted here, those bringing in the CE need to overcome several problems, including technical barriers, and promote political regulation, economic incentives for implementation, and self-interest in environmental issues [3].

If those can be overcome, CE approaches could have important benefits in the form of cost savings, new job creation, innovations, higher productivity, and resource efficiency. The planned benefits mainly concern improvement of the environment, higher accessibility to resources, energy savings, and reduction of land filling, and thus also the reduction of greenhouse gas emissions [26].

Many authors [14,15,28,29] presented sustainable development and the circular economy as coherent disciplines and even interdependent, i.e., "the circular economy is becoming a tool for sustainable development" [30]. Sauvé et al. [25] argued that there is a clear relationship between the two concepts, while also identifying the following key connections:

- The CE is necessary prerequisite for sustainable development;
- The CE is beneficial for sustainable development;
- The CE and sustainable development have a compensatory relationship.

On this topic, Suárez-Eiroa, et al. [30] concluded that there is a close relationship between the two, while Bonciu [31] proposed that sustainable development is focused on the current state, and therefore solves current problems, but not the causes. Solving the causes is the task of the CE. Thus, sustainable development creates the goals to be achieved to solve the problems and minimize their consequences, while the CE is a tool, that can be used to address selected causes that cause these problems.

Both approaches, the circular economy and sustainable development, point to the need to internalize the costs of environmental damage caused by production activities. The standard linear production model focuses only on waste collection and recycling. In comparison, the circular economy offers a more comprehensive approach in this area [25].

Corona et al. [29]. claimed, that CE will be the optimal choice for managing sustainable development. The essence of most circulation strategies is to increase the material circulation of the system. At the same time, however, such circulation should be sustainable for the environment, also for the economy and for society as a whole.

2. Materials and Methods

This paper presents an analysis of 27 countries of the European Union from 2004 to 2018, excluding the UK (even though it was still a member of the EU in the given period, due to data limitations). The year 2018 is the last year of monitored period, because the more recent data for analyzed indicators were not available. Not all indicators had the necessary data available for the whole study period; in cases of missing data, we indicate the period where data were not available.

In our analyses, we focused on indicators of the circular economy in the given countries. We monitored both the production of waste nationally and the production of waste in the agriculture sector. The listed indicators are a typical representative of waste management.

This study aimed to identify the state of the circular economy through waste management in the agricultural sector of EU27 countries in the context of the implementation of the 2030 Agenda, specifically the 12th goal.

After studying several articles on the topic, several questions and areas of interest arose that we wanted to verify on a sample of EU countries.

Based on theoretical analyzes and comparisons of several goals within the 2030 Agenda, which we can find, e.g., in these works [15,17,18,26], we decided to focus on the area of waste production when creating Hypothesis 1. In the field of waste production, we investigated Hypothesis 1 using cluster analysis.

H1: *EU countries are homogeneous in the development of waste production in agriculture.*

In doing so, we sought to determine whether countries that produced little waste per capita showed the same trend in agriculture, to prove or disprove Hypothesis 2.

H2 : *Countries with the lowest volume of waste per capita also produce the least amount of waste (per capita) in agriculture.*

Furthermore, according to Korhonen et al. [22], the circular economy is linked to economic growth. Thus, we investigated whether there was a relationship between agricultural waste production and GDP, verifying Hypothesis 3 based on a correlation coefficient.

H3: *There is a statistically significant relationship between the agricultural waste production and GDP.*

We also analyzed the indicators of progress toward achieving the 12th goal of the 2030 Agenda and compared individual EU27 countries based on those.

In addition to the methods already mentioned, descriptive statistics, comparisons, analyses, and deduction were also used in the work. For cluster analysis and other statistical calculations, we used analytical software Statistica 12.0, made by StatSoft, sourced by University of Prešov. The main source of data was Eurostat, as well as resources dedicated to the 2030 Agenda. In addition, we studied the proposals of various authors in the areas of sustainable development, the circular economy, and the 2030 Agenda. The different opinions, attitudes, and results of individual authors who have analyzed the issue were the starting point for our investigations.

3. Results and Discussion

3.1. Waste Generation in Total Industries and Households per Capita

First, we will focus on the total production of waste in the analyzed countries. For comparability, we chose values expressed in kg per capita. To show the development, we present the value from the beginning of the monitored period (2004) to that in 2018. As can be seen in Figure 3, the biggest producers of waste per capita were Bulgaria, Estonia, and Luxembourg. In 2004, Romania was also included among these countries, but its production decreased in the monitored period, so in 2018, it was no longer among the largest producers of waste. On the contrary, the situation in Finland was different. In the case of this country, waste production was increasing, and thus, in 2018, it ranked among the countries with the highest volumes of waste in the EU. Luxembourg and Finland are countries that did not appear in Girotto, Alibardi, Cossu [32] research as the largest producers of waste. He indicated low-income countries as the biggest producers.

Latvia, Croatia, Portugal, and Hungary represented the smallest producers of waste per capita by 2018.

We can see big differences among the EU countries. These were caused on the one hand by the amount of waste produced and the number of inhabitants, and on the other hand, by the character and industry specialization of the given country. While the big producers of waste (expressed in absolute values), Germany and France, had low per capita values, Malta, with its lowest absolute values, assumed an average position per capita.

For a closer look at waste production, especially in agriculture, let's focus on the data in Figure 4. The minimum and maximum values of waste production in agriculture are listed there, as well as the latest data from 2018. Since the production of waste in agriculture in EU countries did not have a clear trend, but varied, we chose this form of data presentation. Overall, the highest levels of agricultural waste per capita were produced by Romania in 2006 and Finland in 2012. Greece, Spain, Cyprus, and Hungary had unstable volumes of waste production in agriculture per capita, as we can see from the large spread between the minimum and maximum values. Previous studies [33,34] pointed out particular to Cyprus, Lithuania, the Netherlands and Spain as the largest producers of agricultural waste. However, it should be noted here that these are studies of older data, from 2010 and 2014.

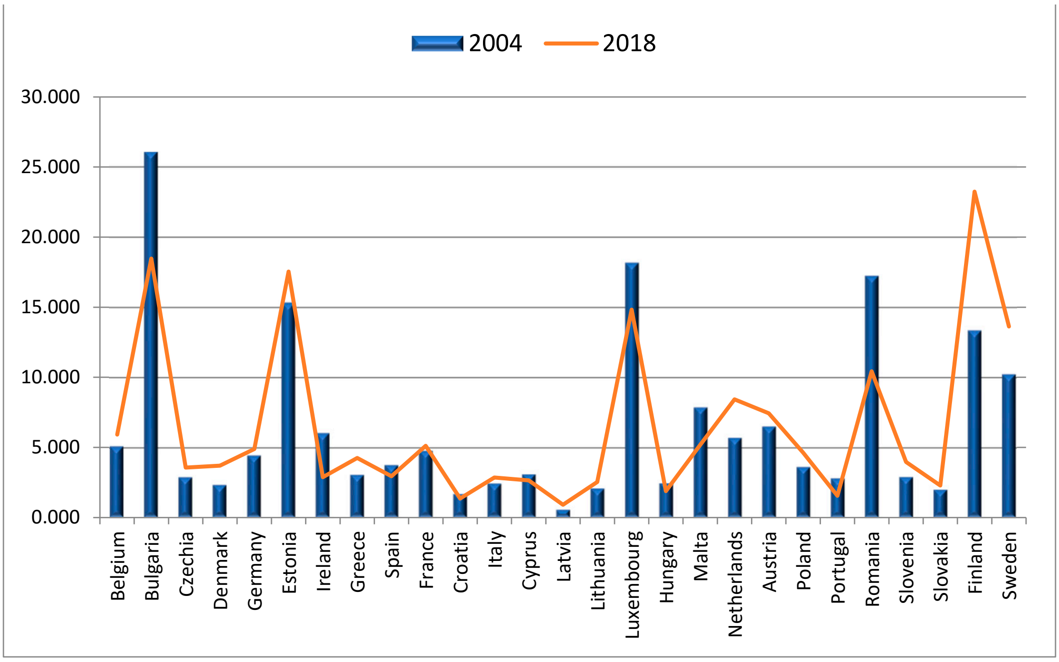

Figure 3. Waste generation in total industries and households (in kg per capita).

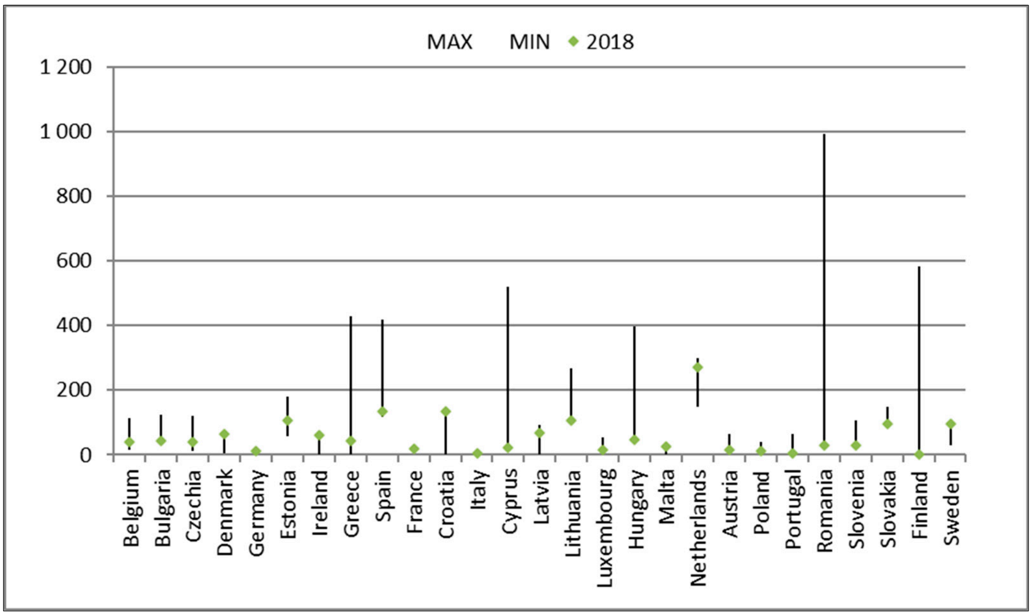

Figure 4. Generation of waste in agriculture, per capita (2004–2018).

Meanwhile, we can consider the development in other countries to have been more balanced. With the exception of a few countries (Croatia, Sweden, Denmark, Ireland, and Malta), in 2018, values lower than the maximum (for the entire monitored period) were achieved. Thus, we can confirm there was an overall trend of reducing the amount of waste, the agricultural sector.

Here, we focus on the development of agricultural waste production in the period 2004–2018, expressed in kg per capita, presenting our related results from a statistical verification. From the results of the cluster analysis presented in the dendrogram (Figure 5), certain groups of countries emerge. We can see that more than half of the EU countries were concentrated in three separate clusters, with great similarity of data. The first cluster consisted of Belgium, the Czech Republic, and Latvia. The second largest was made up of Denmark, Ireland, Greece, Italy, France, Malta, Poland, Luxembourg, Portugal, and Austria. The third cluster consisted of Croatia, Sweden, and Slovenia. There was no great similarity of the analyzed data among the other countries. Among the highly individualized economies were the Netherlands, Finland, and Romania.

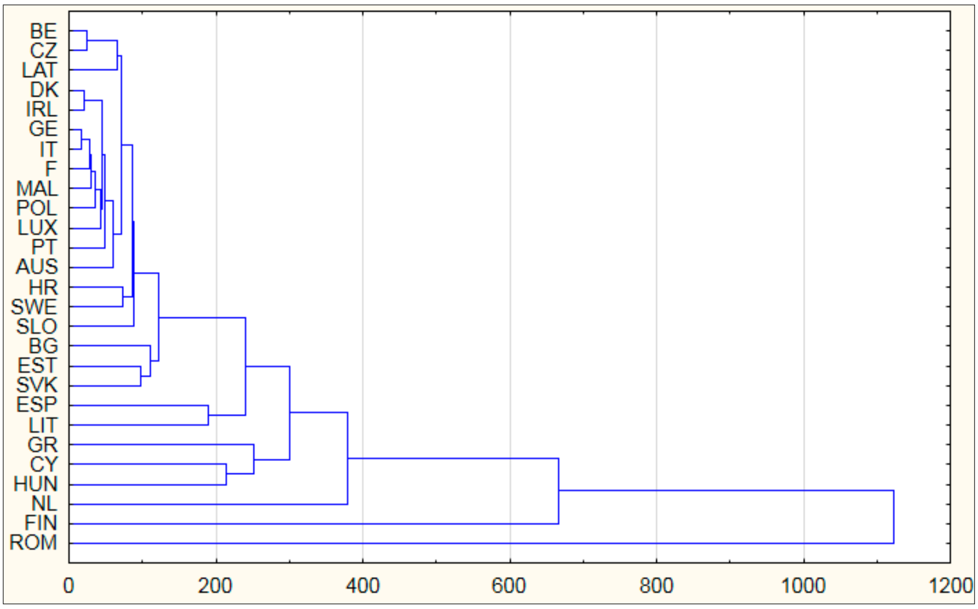

Figure 5. Cluster analysis.

In summary, the results of the country similarity analysis showed that more than half of the countries had a degree of similarity with more than one other country. On the other hand, three countries were highly differentiated from the other EU countries, meaning they could not be classified in clusters with other countries based on the identified parameters. Accordingly, Hypothesis 1, that EU countries are homogeneous in the development of waste production in agriculture, was not confirmed.

For the comparison and verification of Hypothesis 2, we created Table 1, where we listed the three largest and smallest countries for waste production in kg per capita, for all NACE (Nomenclature of Economic *Activities*) activities and households, and for agriculture. Apart from Portugal in 2018, when it was among the three smallest producers both for all NACE activities and for agriculture, no other country has achieved such a position. To give an example, Croatia was among the smallest producers of waste for all NACE activities, but for agriculture, on the contrary, it was among the largest producers. Overall, based on the analysis, Hypothesis 2 could not be confirmed.

The national volume of waste production is a good indicator to use to compare countries, and the proportion of agricultural waste production has an even higher informative value. Those values are given in Table 2. In the monitored period, the share of agriculture within the countries' total waste production was mostly decreasing and generally low. It did not exceed 10% until 2010. In 2018, Croatia and Latvia had the highest values, of about 9.93% and 7.48%, respectively.

Table 1. Comparison of smallest and biggest waste producers.

	Rank	All NACE Activities and Households		Agriculture	
		2004	**2018**	**2004**	**2018**
Smallest producers	1.	Latvia	Latvia	Malta	Finland
	2.	Croatia	Croatia	Ireland	Italy
	3.	Slovakia	Portugal	Denmark	Portugal
Biggest producers	25.	Romania	Estonia	Greece	Spain
	26.	Luxembourg	Bulgaria	Cyprus	Croatia
	27.	Bulgaria	Finland	Romania	Netherlands

Table 2. Waste generation (in agriculture, as total %).

	2004	2006	2008	2010	2012	2014	2016	2018
Belgium	2.25	0.61	0.59	0.37	0.31	0.54	0.43	0.65
Bulgaria	0.36	0.39	0.45	0.37	0.56	0.46	0.51	0.24
Czech Republic	4.25	1.28	1.00	0.48	0.85	0.58	0.45	1.09
Denmark	0.19	0.19	0.27	1.17	0.45	0.57	0.96	1.74
Germany	0.34	0.42	0.36	0.07	0.18	0.11	0.28	0.24
Estonia	0.88	0.63	1.23	0.58	0.35	0.56	0.47	0.60
Ireland	0.04	0.00	0.09	0.51	0.76	0.63	0.69	2.12
Greece	14.13	9.18	0.00	0.01	0.01	0.02	0.35	1.06
Spain	11.19	9.41	7.61	4.23	4.64	5.26	4.86	4.54
France	0.41	0.39	0.38	0.39	0.37	0.39	0.40	0.38
Croatia	1.68	1.33	0.45	0.45	2.23	7.23	9.24	9.93
Italy	0.44	0.36	0.19	0.20	0.26	0.20	0.20	0.19
Cyprus	16.88	10.53	6.87	5.44	0.97	1.00	0.79	0.86
Latvia	16.58	5.17	4.99	4.54	0.12	1.38	7.54	7.48
Lithuania	12.47	13.74	12.41	8.17	8.48	6.79	4.20	4.15
Luxembourg	0.14	0.14	0.03	0.02	0.02	0.04	0.31	0.09
Hungary	16.22	8.96	1.99	2.91	2.82	3.13	3.04	2.45
Malta	0.00	0.00	0.13	0.21	0.19	0.18	0.54	0.49
Netherlands	2.59	2.68	3.38	3.87	3.81	3.60	3.61	3.22
Austria	0.88	0.94	0.82	1.18	0.37	0.23	0.21	0.21
Poland	1.11	0.99	0.97	0.38	0.54	0.27	0.29	0.25
Portugal	2.37	0.61	0.44	0.50	0.47	0.35	0.38	0.39
Romania	5.69	6.10	10.15	0.30	0.19	0.32	0.29	0.29
Slovenia	1.33	3.55	2.62	2.36	3.62	2.19	1.15	0.75
Slovakia	5.68	5.12	6.88	5.60	6.52	6.48	7.43	4.27
Finland	2.20	2.82	3.35	2.66	3.44	0.00	0.00	0.00
Sweden	0.34	0.33	0.36	0.26	0.17	0.39	0.57	0.69

These data were one input used for the verification of Hypothesis 3. They were paired with the data expressing the share of agriculture within the countries' GDP. Both groups had a normal distribution. In a Shapiro–Wilk test, the p value ($p = 0.69684$) was greater than 0.05 so we did not reject the normality of the dataset.

The results of the correlation analysis (Figure 6) confirmed a relationship between both indicators ($r = 0.37263$; $p < 0.05$). Yet, there was only a weak direct linear relationship between the variables. Thus, Hypothesis 3—that of a statistically significant relationship between the shares of agriculture in the national waste production and national GDP—was not confirmed.

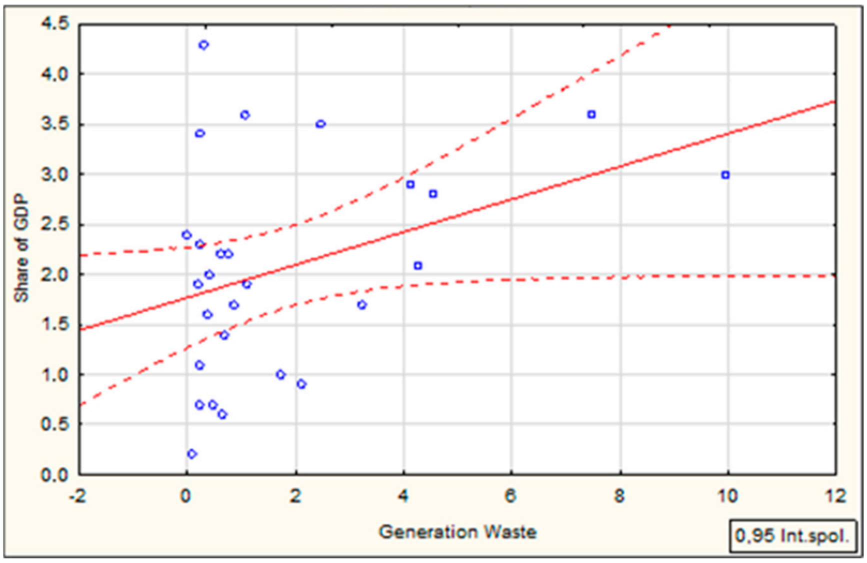

Figure 6. Correlation analysis.

3.2. Fulfilment of the 12th Goal of the 2030 Agenda Strategy

Since the EU countries were selected for the analysis, it is appropriate to focus attention also on the standards and recommendations related to the given region. For this reason, it is appropriate to focus on the 2030 Agenda. Within this strategy, in the context of the issue analyzed by us, the 12th Goal was analyzed. It deals with responsible consumption and production. Within this goal, there are several indicators that we examined. The 2030 Agenda is a frequently researched area by many authors. The authors either focus on one of its parts, e.g., Tutak, Brodny and Bindzar [35] on the field of energy and climate sustainability, Dantas et al. [15] how are SDGs affected by the combination of CE and Industry 4.0 or they examine it as a whole, but on example of one country—Mexico [36], China [37].

Next, we analyzed the sampled countries' fulfilment of some indicators of progress toward achieving the 12th goal of the 2030 Agenda. For comparison, we expressed some indicators in the form of an index capturing the change in 2018 compared to 2004.

In Table 3, the first three indicators of the 12th goal are listed. For energy productivity, this indicator increased in all countries. The highest values were achieved by Ireland and Denmark. Ireland also showed the second largest increase in this value after Romania. The next indicator, raw material consumption, decreased. Only in a few countries was the value rising. Yet, for this indicator, fluctuations in values can be seen between individual years. So, the positive values charted may not be problematic for the fulfilment of this indicator in the long term. For the third indicator, there was a problem with missing data for the year 2004. To solve this situation, in some cases, we used the oldest available data for comparison, as indicated in Table 3. Overall, the average CO_2 emissions decreased in 2018, demonstrating the technological improvements made with new cars.

3.3. Circular Material Use Rate

This indicator measures the share of material recycled and fed back into the economy. It is necessary to save extracting so many primary raw materials to support the overall production. A higher degree of circularity indicates that more secondary materials are replacing primary raw materials. As a result, the volume of extraction of primary materials is reduced and the impact on the environment is also reduced [38].

Table 3. Selected indicators of the 12th goal of the 2030 Agenda.

	Energy Productivity	Raw Material Consumption	Average CO_2 Emissions per km from New Passenger Cars
Belgium	29.65	−24.71	−23.71
Bulgaria	47.47	8.05	−26.11 (2007)
Czech Republic	53.68	8.09	−18.18
Denmark	36.14	−6.93	−33.94
Germany	36.50	2.25	−25.96
Estonia	32.26	3.23	−26.03
Ireland	83.91	−11.11	−32.40
Greece	7.31	−57.01	−34.00
Spain	27.75	−49.04	−23.95
France	27.66	−11.40	−26.71
Croatia	30.75	−33.26	−9.28 (2013)
Italy	17.52	−35.69	−22.73
Cyprus	15.82	−37.55	−28.84
Latvia	36.72	−2.73	−33.06
Lithuania	82.42	−1.03	−31.41
Luxembourg	48.30	−9.30	−22.57
Hungary	27.47	18.46	−19.31
Malta	20.00	53.75	−27.62
Netherlands	36.90	−29.55	−38.30
Austria	20.25	2.10	−24.03
Poland	43.38	20.61	−15.77
Portugal	19.33	−32.51	−27.87
Romania	90.19	16.07	−21.51 (2007)
Slovenia	35.39	−45.82	−20.83
Slovakia	79.71	−46.30	−18.93 (2005)
Finland	25.82	−28.05	−35.09
Sweden	37.81	13.62	−38.03

Every country tries to achieve the highest possible values for this indicator. In this study, we evaluated only the period from 2010 due to the absence of older data. The values we found fluctuated for individual countries, meaning we could not identify a clear growing or decreasing trend. Therefore, we calculated the average values for the monitored period and compared them with the values achieved in 2018 (Figure 7).

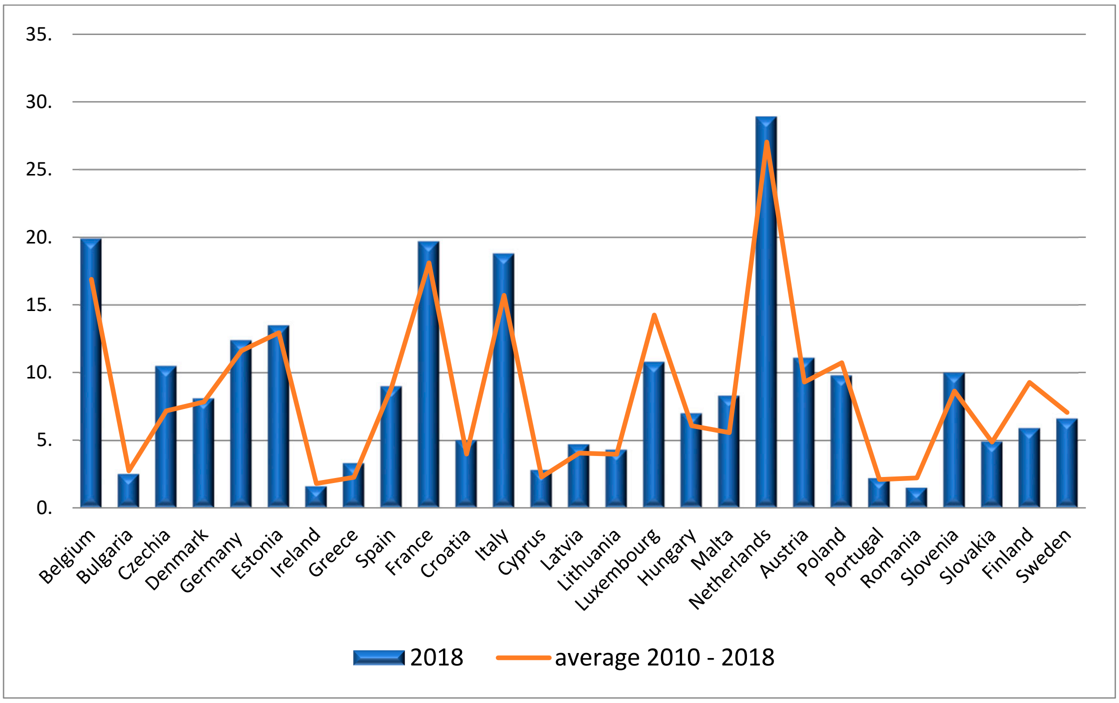

Figure 7. Circular material use rate.

In some countries (e.g., Netherlands, Czech Republic, Italy, etc.), higher than average values were achieved for this indicator in 2018. Yet, in Luxembourg, Romania, and Finland, the situation was opposite. Based on the findings, we consider the Netherlands, Belgium, France, and Italy to be among the countries with the highest circular material use rates. On the other hand, Romania, Portugal, Ireland, and Bulgaria have the lowest rates.

The next indicator measured the volume of aggregated consumption of toxic chemicals, expressed in million tons [38]. The total hazardous and non-hazardous chemical consumption levels we found are shown in Figure 8. The data were processed together for all Member States of EU. The long-term downward trend for this indicator is positive. Despite the slight increase in values in 2018, a significant decrease in the chemical consumption can be seen compared to the beginning of the monitored period.

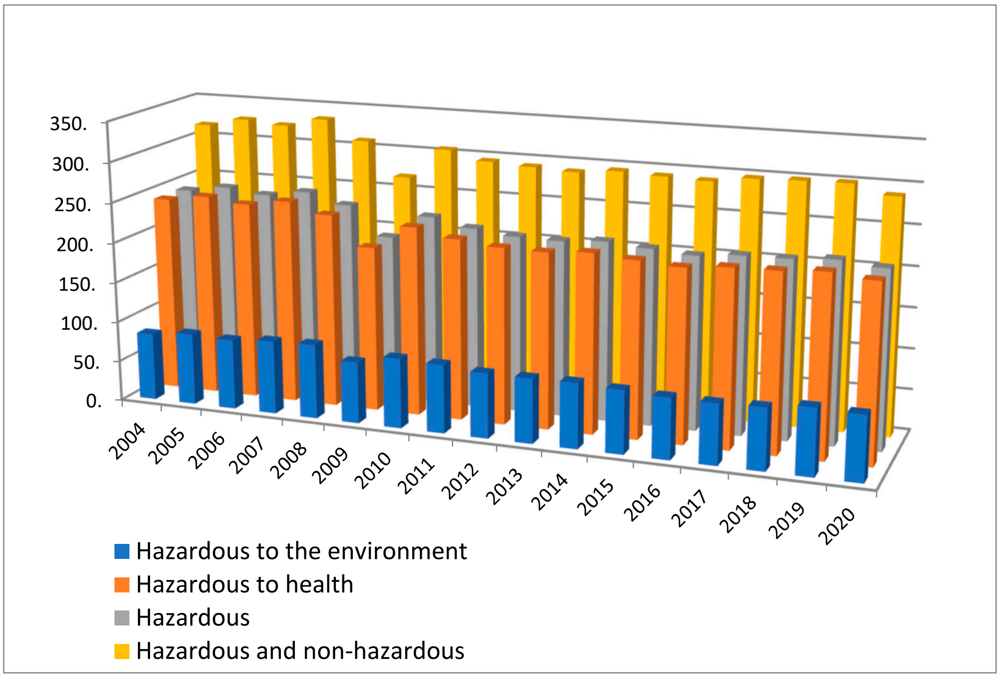

Figure 8. Consumption of chemicals.

With a closer specification, we can also monitor the development in individual categories. It should be noted here that individual groups of toxic chemicals are collectively contained in individual categories. This means that, e.g., chemicals hazardous to the environment are also, among other forms, hazardous to health. From Figure 8, we can also see one negative, namely that most of the toxic chemicals are hazardous.

Overall, the 12th goal of the 2030 Agenda had been met up to 2018 in the countries analyzed. The analyzed indicators showed positive trends, such as increasing the energy productivity and decreasing both the volume of chemicals consumed and the CO_2 emissions per km from new passenger cars.

Agricultural sector is though not a major energy user relative to other sectors of the economy, but energy efficiency creates a main aspect in development of sustainable agricultural procedures in the context of world pressures resulting from population and income growth [39]. In elimination of energy use, the energy efficiency is main step of sustainable energy saving. As a result, agricultural energy efficiency growth is key for lower energy demand and lower prices of energy. Level of energy efficiency and agricultural production expenses is dependent on location of companies, their activity, production processes and also energy import for production. Therefore, energy and resource allocation in production planning is crucial step in order to achieve agricultural productivity growth [40]. According to study of Rokicki et al. [41] the EU countries various in terms of the scheme of the energy sources used. On the first place were liquid fuels, while traditional gaseous fuels were gradually changed in favor of electricity and renewable source. Result was confirmed a gradual diversification of energy sources used in agriculture, with a systematic growth in the need of idea of renewable energy sources.

The concept of circular economy has emerged as a idea that supports more responsible production and consumption models, over the past decades. The increase in global consumption has resulted in the excessive use of natural resources. Thusly, model of CE creates the answer to the need to dissociate the environmental aspect from economic growth using consolidation of a system focused on recycle, reduction and recovery of materials in the area of consumption, distribution, and production as well as in the area of waste management [42]. Mazur-Wierzbicka [43] argued that the concept of CE is a important part of the development of European Union countries and it is crucial aspect of the EU industrial strategy. The transition to a more circular economy is a necessary step of the EU's effort to develop a competitive, resource-efficient and sustainable economy. Her research showed the existence of a "two-speed Europe" from the view of advancement of EU countries towards CE. First countries, those most advanced in implementation and realization processes according to circular economy principles, include Germany, Belgium, Spain, France, Italy, the Netherlands and the United Kingdom. The opposite area includes the EU countries in which the processes of transformation to the circular economy concept is taking place the slowest; mainly countries of the Central, Eastern and Southern Europe. Variable levels of advancement of individual countries towards CE can be a consequence of differences their development strategies transitioning their economies to CE and also from the differences in their economic growth. These differences can be seen most between countries EU15 and EU13.

The identification of the main priorities in the area of waste management in agriculture is difficult due to the interdisciplinary character of the problem. The question regarding the importance of waste management is result of the growth of the population in cities, speed industrial development, and also the separation of livestock farming from plant production, and all this has led to an accumulation of waste that needs to be dealt with [44]. The creation of waste policy and management of by-products in agriculture is significantly different from waste management in other sectors. The handling and processing of waste in agriculture was exempted from the European framework directive on waste. In the last decade, a visibly rapidly growing interest in the given topic has caused a change in traditional waste management with the setting of systemic approaches rather than more conventional ones. It is therefore important that circularity in agriculture becomes a key priority of EU policy making [45].

4. Conclusions

Overall, the 12th goal of the 2030 Agenda was being met in the countries analyzed up to 2018. The development of the analyzed indicators showed positive trends, such as increasing the energy productivity and decreasing both the volume of chemicals consumed and the CO_2 emissions per km from new passenger cars. Countries with the lowest/worst values could be seen to have tried to follow the best countries but faced the difficulties that meant their progress was slower.

The study of Grdic et al. [46] confirmed that realization the idea of a circular economy supports protection of environment, economic well-being and supports sustainable economic growth. The economic decline as a result pandemic COVID_19 helped the idea of a speeder transition to the concept of sustainable production, distribution and consumption, which is significantly related to the concept of the CE. However, for realization of this transition is necessary to have financial resources that allow easier transition to a new way of doing business. The results of this study showed that countries that are more economically developed and have a stronger environmental awareness have better indicators for the implementation of the CE.

Waste as a result from many human activities is a very crucial issue, regarding with the growth in quantity, but types, too. The problems of waste are not only environmental problems but also represent economic loss. The EU creates the legislative framework which would help better implementation of waste management in the context prevention, recycling, recovery, preparation for reuse, and disposals. The main goal of the legislation is to reduce the generation of waste as much as possible, to support the transformation of generated waste into other economic resources, as well as to minimize the volume of waste in landfills. This solution represents a fundamental concept that can significantly reduce environmental pollution [47].

The 2030 Agenda was created as an instrument to promote worldwide action to tackle the most important, pressing issues, with the objective to leave no one behind. The 17 SDGs, an interconnected list of goals, targets, and indicators, were created to guide governments, institutions, and civil society toward sustainable development [15].

We recommend that future studies seek to determine what factors impact the lowest results scored by some countries, and with what intensity, as well as how to mitigate those factors. Further studies should also investigate how energy productivity is related to the circular material use rate, and further indicators.

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