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Waste from the agricultural sector in the European Union countries in the context of the bioeconomy development

Odpady z sektora rolnego w krajach Unii Europejskiej w kontekście rozwoju biogospodarki

Summary. The aim of the study was to identify and assess the spatial diversity of generating of animal and vegetal waste by entities from the agricultural sector in the EU countries along with the determination of the importance of this type of waste in total waste generated in individual countries. Statistical data used in the study were obtained from EUROSTAT. The research period was 2016, while the research area covered 25 EU countries. The data was subjected to quantitative analysis using descriptive and parametric statistics. It was found that animal and vegetal waste has the largest share in the structure of waste from the agricultural sector (accounting for 81.6% of all waste in the agricultural sector in the EU in 2016). It has been shown that generating of vegetal and animal waste in agricultural sector in the EU countries is characterized by spatial diversity. Most of this waste type was generated in Spain and the Netherlands. The dominant position of Spain resulted from significant share of this country in the EU volume of animal faeces, urine and manure generation. High position of the Netherlands was associated with a large share of vegetal waste. France, Germany, Slovakia and Sweden ranked next. Nearly 80% of all analyzed groups of waste came from these countries, which indicates a high degree of spatial concentration of the studied phenomenon. In this context, it can be stated that these countries are predestined to base their development on the concept of the bioeconomy. It is a challenge for the research and development sphere regarding development of innovative ways of managing agricultural vegetal and animal waste.

Key words: bioeconomy, agriculture, biomass, waste, European Union countries

INTRODUCTION

The expression of human activity is a progressive increase in the impact on the Earth's resources and, as a result, an increase in the scale of threats to social welfare related to climate change and a range of other changes occurring within terrestrial and aquatic ecosystems [Rechkemmer and Falkenhayn 2009]. An important issue in this context is the problem of rapidly growing amount of waste and their management. At the same time, "waste means any substance or object which the holder discards or intends or is required to discard" [Directive 2008/98/EC… 2008]. Due to the fact that waste generation is an inherent feature of both production and consumption processes, it therefore applies to all societies and economies [Poskrobko and Poskrobko 2012]. Undoubtedly, it is associated with increasing importance to the issue of hazards posed by waste for the quality of groundwater and surface water resources, atmospheric air or maintaining the proper condition of soils. Their nuisance is also evident through the harmful effect on vegetation, aesthetic and landscape values of the environment, as well as an increase in the risk of sanitary and epidemiological threat. In addition, the increasing amount of waste at a rapid rate urges the exclusion of agricultural and forest areas from the use and to locate landfills on them [Pyłka-Gutowska 2004]. Generating an excessive pool of waste is an inevitable aftermath of progressive economic development and a steady increase in the standard of living. Therefore, it is essential to undertake all actions aimed at introducing mechanisms to reduce negative effects of waste on individual components of the natural environment and man. Initiatives to prevent the production of waste, as well as to maximize their treatment and use leading to the reduction of their quantity and harmfulness are part of the European Union model of the bioeconomy [Communication from the Commission... 2012] and its development in the form of a circular bioeconomy [Chyłek et al. 2016]. In this context, the circular economy is of particular importance, as part of which it is important to recycle and cascade use of resources that benefits both the environment and the economy [Directorate-General for Environment… 2019]. Among the economic goals of implementing the bioeconomy, stimulation and maintenance of sustainable economic growth and creation of jobs with the support of the research and development sphere in the area of creating innovative solutions applied to business practice, can be mentioned. As a consequence, it is to contribute to an increase in the income of the population and an increase in the quality of life [Godlewska-Majkowska and Komor 2014]. As a result, this will allow the bioeconomy sector to become more competitive, including production of renewable biological resources, and transform those resources and waste streams into value-added products such as food, feed, bio-based products and bioenergy [Communication from the Commission... 2012].

The agriculture is included in the bioeconomy sector, which is not an exception and just like every branch of the economy, it is a source of various types of residues and waste. First of all, it is organic material (biomass), that due to its properties and potential, and at the same time using the right conversion technologies, can be turned into useful (valuable) products [Sabiiti 2011]. It should be noted that biomass is one of the basic factors determining the possibility of creating development based on the concept of bioeconomy. The importance of biomass, including agricultural biomass, in the bioeconomy is associated with the production of raw materials that, using appropriate processes

(e.g. fermentation or combustion) are transformed into bioenergy and bioproducts with widespread use in the economy [Komor 2018].

Agricultural waste biomass can take the form of liquid, semi-solid and solid (cereal straw, corn and cotton waste, vine stalks, litter, urine and feces of animals, fallen poultry, etc.) [Kacprzak et al. 2018]. Among the rational ways of its management, it is possible to indicate the allocation for fertilizing purposes and the improvement of biological, physical and chemical properties of agricultural land. Waste vegetal mass can be used directly, mainly by plowing (post-harvest residue) or processed and treated using the optimal technology. Composting is the most common practice. The aforementioned process enables the simultaneous disposal of several wastes and ensures their hygienization. In addition, it leads to limit the pool of generated waste and obtain a valuable product (compost) [Wytyczne... 2010, Łabętowicz et al. 2019]. It is perceived as an organic fertilizer and a multifunctional soil improver [Saveyn and Eder 2014]. Residues and wastes from agricultural production are also used for bedding and fodder purposes (e.g. straw, tipping) [Wytyczne... 2010]. Moreover, the specificity of organic waste biomass also predestines it for the use for energy purposes. Under native conditions, a possible option is to convert it into usable energy (heat) in direct combustion or co-incineration processes [Lewandowski et al. 2010]. This type of biomass is a good raw material, from which biogas can be obtained. Biofuel is obtained as a result of decomposition of organic matter by microorganisms under anaerobic conditions, the main component of which is methane. A good source for agricultural biogas plants are waste products from agriculture, including liquid and solid animal waste (manure, slurry, dry manure). Under conditions of low concentration of organic matter, to ensure optimal fermentation process, it is reasonable to introduce the right amount of organic co-substrates (from greenhouse, agricultural, biomass from special crops, food industry waste, sewage sludge, organic fraction of municipal waste) [Kowalczyk-Juśko 2008, Sadecka and Suchowska-Kisielewicz 2016]. The resulting biogas can be used for the production of electricity, heat, as well as associated in the cogeneration system or power for vehicles [Owczuk et al. 2013]. Installations using biogas while maintaining a decentralized character and a regional investment structure can significantly shape sustainable development of rural areas as well as create new income prospects for agricultural producers [Gradziuk 2017]. The profitability of energy use of biogas energy is also of great importance [Bartoszczuk 2012]. In EU countries, the most electricity from biogas was produced in Germany, Italy and Great Britain, while heat energy – in Italy, Germany and Denmark [Biogas Barometer 2017]. The largest number of agricultural biogas plants per million inhabitants in 2017 operated in Germany, Luxembourg, the Czech Republic and Latvia. The electric capacity of installed agricultural biogas plants per million inhabitants was the highest in Germany, the Czech Republic, Latvia and Slovakia [EBA Statistical Report 2018].

Examples of practices mentioned above refer to a significant problem that is a need, in the face of improperly managed natural resources and generation of excessive waste, an effective, comprehensive and rational use of waste biomass arising in agriculture. In this context, a proper selection of methods for its processing into bioproducts in accordance with the assumptions of circular bioeconomy, is of particular importance. Cooperation between the R&D sphere and enterprises to implement the innovative solutions for biomass processing into business practice is of key importance.

A stream of unnatural waste is also created on the farm grounds as a result of the operation of equipment and buildings and modernization works carried out. These are primarily: overworked lubricating oils, packaging, residues of plant protection products, used tires, batteries, ash, slag, debris, used parts of electronic equipment, machines and tools, etc. These wastes should be collected selectively and transferred to recovery or disposal in accordance with the recommendations contained in the applicable regulations [Wytyczne… 2010].

DATA AND METHODS

Statistical data used to identify and assess the spatial diversification of waste generation by the agricultural sector were obtained from EUROSTAT. Waste generation statistics are compiled for all activities classified by NACE Rev. 2, sections A to U. These sections cover all economic activities as well as waste generated by households and arising from recovery or disposal operations. The research covered the total waste produced in agriculture, as well as waste categories characteristic for Section A – they are animal and vegetal waste [Commission Regulation (EU) No 849/2010... 2010]:

– 09.1 – Animal and mixed food wastes other than hazardous,
– 09.2 – Vegetal wastes other than hazardous,
– 09.3 – Animal faeces, urine and manure other than hazardous.

It should be emphasized that all the aforementioned wastes are entirely included in the biomass [ANNEX – Correspondence of waste… 2019] as one of the four main categories of materials defined and used in general economic material flow accounts (EW-MFA). In addition to biomass, metal ores (gross ores), non-metallic minerals and fossil energy materials/carriers are also mentioned. The EW-MFA system is one of the elements of European environmental economic accounts [Regulation (EU) No 691/2011... 2011]. All the above categories of waste are non-hazardous. It is worth noting that waste of this type is not generated exclusively by entities of Section A, but they also arise in other types of activity.

Regarding the waste recovery and disposal processes, statistics are available for individual categories of waste [Directive 2008/98/EC… 2008]. However, there is a lack of information on the business section, from which the waste subject to recovery or disposal come from. Therefore, in this study, the issue of agricultural waste generation was subjected to research, neglecting – due to the lack of statistical data – the problem of their further processing.

The research period covered the year 2016. As part of the information, there are no statistical data for three EU countries, i.e. Ireland, Greece and Finland. The total share of the discussed countries in the generation of waste by the agricultural sector was 0.5% of the value for all EU countries. Hence, it was decided to omit these countries in the analyses. Results were presented in tabular and graphical form. The data was subjected to quantitative analysis using descriptive statistics (tabular description) and parametric statistics (r-Pearson correlation ratio). The analysis of structure, density and intensity indicators as well as r-Pearson correlation ratio, that is used to verify whether two quantitative variables are related to each other by a linear relationship, were analyzed. The r-Pearson ratio assumes a value from –1 to 1, the coefficient is “further” from 0, the stronger the relationship.

RESULT AND DISCUSSION:
WASTE GENERATION BY THE AGRICULTURAL SECTOR IN EU COUNTRIES IN 2016

In the first stage of the research, the analysis covered the total waste generation by the agricultural sector. In 2016, a total of 2 535 130 000 t of waste were generated in the European Union, of which 20 690 000 t in the agricultural sector, accounting for 0.82% of all waste generated in EU countries (Tab. 1). It should be said that agriculture is a sector generating relatively small amount of waste in comparison to the importance of agriculture in the national economy (in 2016, the share of agriculture in the creation of gross value added in the EU amounted to 1.56%). The largest share of the agricultural sector in waste generation was recorded in Latvia – waste from Section A accounted for 14.31% of all waste generated in this country. Relatively high level of this indicator was recorded for Croatia (9.40%) and Slovakia (7.43%).

In 2016, the largest amount of waste was generated by entities from the agricultural sector operating in Spain – 6 271 464 t, which accounted for 30.3% of all agricultural waste produced in the European Union (Tab. 1). The Netherlands came second with its share in the production of agricultural waste in the EU in 24.6% in 2016. It is worth noting that in these two countries, more than half of all agricultural waste generated in the EU is produced. Relatively large share in the generation of waste in the agricultural sector was recorded in France (6.4% of the EU value) and in Germany (5.4%). In total, the countries discussed generate two thirds of agricultural waste produced in the European Union, which indicates a relatively high degree of spatial concentration of the analyzed phenomenon. These are countries with many years of tradition in the field of agricultural production, with relatively large share in the value of agricultural production in the EU (in 2016, the share of agricultural production value in basic prices of the discussed countries amounted to 49.3% of the EU value in total). The listed countries (except the Netherlands) also belong to countries with relatively large population, total area and arable land.

EU countries constitute a very diverse group, differing significantly both in population potential and the importance of agricultural sector in the structure of national economy. Therefore, the amount of agricultural waste generated per capita and per hectare of arable land was analyzed. In 2016, in the EU, the volume of agricultural waste per capita was on average 40 kg (Tab. 1). The highest value of this indicator was recorded in the Netherlands (299 kg), Latvia (185 kg), Slovakia (145 kg), Spain (135 kg), and Croatia (119 kg). High value of the indicator in relation to Latvia was related to relatively small share of this country in the EU population. In other countries, this value did not exceed 100 kg per capita.

Taking into account the volume of generated waste from the agricultural sector per unit area of agricultural land, it should be noted that the average for EU countries in 2016 was 119.6 kg/ha. Most of this type of waste was generated in the Netherlands (2831.0 kg/ha), in Malta (944.8 kg/ha), in Slovakia (417.3 kg/ha), in Croatia (317.4 kg/ha), in Spain (270.0 kg/ha), in Sweden (266.2 kg per capita) and in Luxemburg (237.2 kg/ha). In other countries, this value did not exceed 200 kg per hectare of arable land. It is worth noting, however, that high value of the indicator in reference to Malta and Luxemburg was due to relatively small share of these countries in the structure of arable land in the EU.

Table 1. Total waste generation by entities of Section A – Agriculture, forestry and fishing – in EU countries in 2016

Countries/EU	National economy	Section A – Agriculture, forestry and fishing				
	t	t	share of agriculture in total waste generation (%)	%, UE28 = 100	kg per capita	kg/ha of arable land
European Union (28)	2 535 130 000	20 690 000	0.82	100.0	40	119.6
Belgium	63 152 384	269 190	0.43	1.3	24	198.8
Bulgaria	120 508 475	617 689	0.51	3	87	138.2
Czechia	25 381 426	114 575	0.45	0.6	11	33.2
Denmark	20 981 931	201 648	0.96	1	35	77.1
Germany	400 071 672	1 126 134	0.28	5.4	14	67.4
Estonia	24 277 879	113 946	0.47	0.6	87	114.5
Ireland	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Greece	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Spain	128 958 523	6 271 464	4.86	30.3	135	270.0
France	323 474 270	1 315 214	0.41	6.4	20	47.3
Croatia	5 277 598	496 153	9.40	2.4	119	317.4
Italy	163 995 048	320 928	0.20	1.6	5	25.5
Cyprus	2 462 503	19 453	0.79	0.1	23	173.8
Latvia	2 532 684	362 303	14.31	1.8	185	187.6
Lithuania	6 644 315	252 305	3.80	1.2	88	86.3
Luxemburg	10 130 076	30 986	0.31	0.1	53	237.2
Hungary	15 938 077	484 320	3.04	2.3	49	103.7
Malta	1 965 514	10 563	0.54	0.1	23	944.8
Netherlands	141 024 020	5 085 249	3.61	24.6	299	2831.0
Austria	61 225 037	129 834	0.21	0.6	15	48.6
Poland	182 005 677	534 931	0.29	2.6	14	37.1
Portugal	14 739 135	55 520	0.38	0.3	5	15.2
Romania	177 562 905	507 712	0.29	2.5	26	40.6
Slovenia	5 517 004	62 959	1.14	0.3	30	128.9
Slovakia	10 606 966	788 559	7.43	3.8	145	417.3
Finland	122 869 183	n.d.	n.d.	n.d.	n.d.	n.d.
Sweden	141 625 718	804 382	0.57	3.9	81	266.2
United Kingdom	277 281 039	602 258	0.22	2.9	9	36.9

Source: own study based on EUROSTAT [2019a]

Agricultural sector generates various types of waste. In the second stage of the research, the waste categories characteristic for the agricultural sector were analyzed, which are of key importance in the context of possibilities of bioeconomy development (i.e. waste biomass). This type of agricultural waste is animal and vegetal, which includes the following types of waste [Commission Regulation (EU) No 849/2010... 2010]:

09.1 – animal and mixed food wastes, including animal wastes from food preparations and products (animal waste tissue, washing and cleaning sludges, raw materials and products unfit for consumption and processing) and mixed wastes of preparations and food products (preservative waste, fats and oil mixtures from oil/water separation containing only edible oils and fats, biodegradable kitchen waste, edible oils and fats),

09.2 – vegetal wastes, including: green waste (waste from forest management, biodegradable waste), vegetable waste from food preparations and products (washing and cleaning sludges, vegetable waste mass, sludges from washing, cleaning, peeling, centrifuging and separation of raw materials, waste post-extraction, raw materials and products unfit for consumption and processing, waste from washing, cleaning and mechanical comminution, waste from spirits distillation),

09.3 – animal faeces, urine and manure (animal excrements, liquid manure and solid manure – including straw waste, sewage collected and treated separately from the site).

In 2016, in the agricultural sector of the EU countries, a total of 16 890 000 t of vegetal and animal waste was generated, which constituted 81.6% of all waste generated in the agricultural sector in the European Union (Tab. 2). The largest share of vegetal and animal waste in the structure of waste from agriculture was recorded in Croatia (98%).

Most agricultural vegetal and animal waste was generated in Spain (5 730 082 t, which accounted for 33.93% of all such waste in the EU), as well as in the Netherlands (4 647 019 t, which was 27.51% of the EU value). In the two analyzed countries, 61.44% of all waste biomass produced in the EU was generated. The dominant position of Spain resulted mainly from significant share of this country in the EU volume of animal faeces, urine and manure generation. High position of the Netherlands was associated mainly with large share in the generation of vegetal waste. The following positions were followed by France (4.66%), Germany (4.54%), Slovakia (4.43%) and Sweden (4.42%). France was characterized by significant share in the EU volume of animal waste and mixed food waste generation – 53.7% of all this waste type in the EU was generated in France. Germany had relatively large share in generating of vegetal waste, while Slovakia and Sweden were characterized by significant share in generating of animal faeces, urine and manure. In total, almost 80% of the agricultural waste biomass produced in the European Union was generated in the discussed countries, which indicates a high degree of spatial concentration of the analyzed phenomenon. In this context, it can be stated that these countries are predestined to base their development on the concept of the bioeconomy. It is a challenge for the research and development sphere regarding finding innovative ways of managing the agricultural waste.

In 2016, in the EU, the volume of agricultural vegetal and animal waste per capita was on average 33 kg. The highest value of the analyzed index was recorded in the Netherlands (273 kg), in Slovakia (138 kg), in Spain (123 kg), in Croatia (117 kg). In other countries, this value did not exceed 100 kg per capita.

Table 2. Generating of animal and vegetal waste by entities of Section A – Agriculture, forestry and fishing – in EU countries in 2016

Countries/EU	Section A – total waste	Section A – vegetal and animal waste				
	t	t	share of vegetal and animal waste in total agricultural waste (%)	%, UE28 = 100	kg per capita	kg/ha of arable land
European Union (28)	20 690 000	16 890 000	81.6	100.00	33	97.6
Belgium	269 190	139 972	52.0	0.83	12	103.4
Bulgaria	617 689	578 000	93.6	3.42	81	129.3
Czechia	114 575	28 647	25.0	0.17	3	8.3
Denmark	201 648	110 732	54.9	0.66	19	42.4
Germany	1 126 134	766 369	68.1	4.54	9	45.8
Estonia	113 946	79 759	70.0	0.47	61	80.2
Ireland	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Greece	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Spain	6 271 464	5 730 082	91.4	33.93	123	246.7
France	1 315 214	787 038	59.8	4.66	12	28.3
Croatia	496 153	486 305	98.0	2.88	117	311.1
Italy	320 928	78 487	24.5	0.46	1	6.2
Cyprus	19 453	9 336	48.0	0.06	11	83.4
Latvia	362 303	23 284	6.4	0.14	12	12.1
Lithuania	252 305	218 637	86.7	1.29	76	74.8
Luxemburg	30 986	29 501	95.2	0.17	51	225.8
Hungary	484 320	450 723	93.1	2.67	46	96.5
Malta	10 563	10 034	95.0	0.06	22	897.5
Netherlands	5 085 249	4 647 019	91.4	27.51	273	2587.1
Austria	129 834	59 072	45.5	0.35	7	22.1
Poland	534 931	467 314	87.4	2.77	12	32.4
Portugal	55 520	20 359	36.7	0.12	2	5.6
Romania	507 712	482 285	95.0	2.86	24	38.6
Slovenia	62 959	52 466	83.3	0.31	25	107.4
Slovakia	788 559	748 060	94.9	4.43	138	395.8
Finland	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Sweden	804 382	745 977	92.7	4.42	75	246.9
United Kingdom	602 258	124 300	20.6	0.74	2	7.6

Source: own study based on EUROSTAT [2019a]

When analyzing the volume of vegetal and animal waste generated in the agricultural sector per one unit of agricultural area, it should be noted that the average for EU countries in 2016 was 97.6 kg. The largest amount of such waste was produced in the Netherlands (2587.1 kg), Malta (897.5 kg), Slovakia (395.8 kg), Croatia (311.1 kg), Spain (246.7 kg), Sweden (246,9 kg) and Luxemburg (225.8 kg). In other countries, this value did not exceed 200 kg per hectare of arable land. It is worth noting, however, that high value of the indicator in reference to Malta and Luxemburg was due to relatively small share of these countries in the structure of arable land in the EU.

The study showed very high correlation between the volume of vegetal and animal waste generation in the agricultural sector of EU countries and the value of vegetable and horticultural production expressed in Purchasing Power Standards (PPS) – the r-Pearson correlation ratio amounted to 0.7256. Purchasing Power Standards (PPS) is an artificial currency unit. Theoretically, for one PPS, the same amount of goods and services can be bought in any country [EUROSTAT 2019b].

In addition, there was a high correlation between the volume of generating of vegetal and animal waste in the agricultural sector of EU countries was identified and:

– value of fruit production expressed in PPS – r-Pearson correlation ratio was 0.6360;

– value of pig production expressed in PPS – r-Pearson correlation ratio was 0.6001;

– net added value of agricultural production in total expressed in PPS – r-Pearson correlation ratio was 0.5720.

Figure 1 presents the relationship between the volume of generating of vegetal and animal waste by entities from the agricultural sector (which corresponds to the area of circles) and size of the country (measured by the share in the EU population) and size of agricultural sector in the country (measured by the share of net value added at basic prices in agricultural production in EU). In this way, graphically presented division of EU countries allows for the determination of groups of countries:

– countries with a significant share of the agricultural sector in the EU and high population potential – Spain, Italy, France and Poland. These countries are characterized by a diversified share of agricultural sector in the generation of waste biomass;

– countries with relatively small share in the EU size of agricultural sector and significant population potential – Germany and the United Kingdom. Germany's share in generating of agricultural vegetal and animal waste was at the level similar to the size of agricultural sector in this country, the corresponding share of Great Britain was definitely lower than the size of agricultural sector;

– countries with relatively small share in the EU size of agricultural sector and low population potential – the remaining countries surveyed. In this group, the Netherlands is distinguished by a high share in the generation of vegetal and animal waste by the agricultural sector.

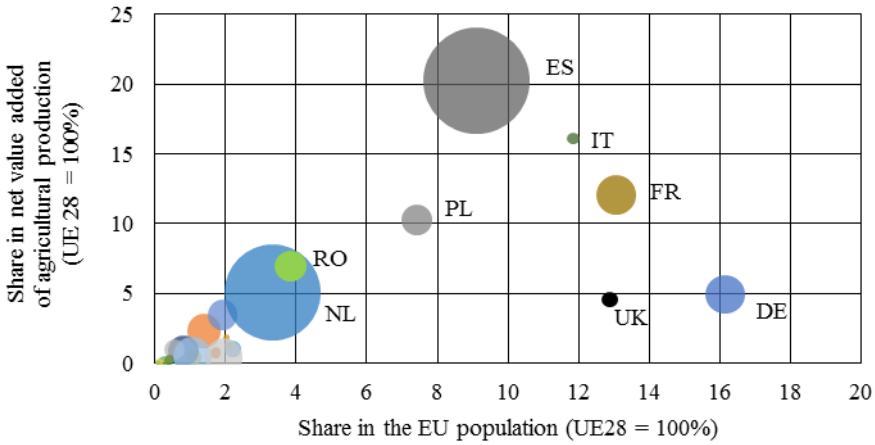

Fig. 1. Generating of vegetal and animal waste by agricultural sector of the EU countries against background of the share in the net value added structure of agricultural production and in the population structure in 2016

The area of a circle corresponds to the share of a given country in generating of agricultural vegetal and animal waste in the EU (UE28 = 100%)
Source: own study based on EUROSTAT [2019a]

CONCLUSIONS

The aim of the study was to identify and assess the spatial diversity of generating of animal and vegetal waste by entities from the agricultural sector in the EU countries along with the determination of the importance of this type of waste in total waste generated in individual countries.

All described waste groups are biomass, the effective, comprehensive and rational use of which is the basis for the bioeconomy concept. Among directions for the economic use of this type of waste, mainly the use for fertilizer purposes and soil quality improvement, feed and bedding goals and energy targets are mentioned. The use of waste biomass created in agriculture is one of the conditions for implementing the concept of a circular bioeconomy, in which renewability, climate-friendliness and the circularity of resources used are important. The application of innovative solutions regarding new possibilities of using the biomass from the research and development sphere to economic practice plays a key role. This will contribute, on the one hand, to reducing the burden on the natural environment with waste, and on the other hand, to reduce production costs, increase the number of jobs and income, and thus improve the quality of life of the population mainly in rural areas, peripheries and protected areas due to the natural or landscape features.

As a result of the conducted research, it was shown that in 2016, the agricultural sector generated 0.82% of all waste produced in the EU. Therefore, it is a sector that generates relatively little waste, while some of them are important for the development of bioeconomy. They are animal and vegetal waste, constituting the biomass. As a result of the conducted research, it was shown that waste biomass had the largest share – among

various waste groups – in the structure of waste from the agricultural sector (in 2016, they accounted for 81.6% of all waste generated in the agricultural sector in the EU). Vegetal and animal waste includes: animal and mixed food waste, vegetal waste, as well as animal faeces, urine and manure. It is worth emphasizing that the subject of the study were animal and vegetal waste generated by the agricultural sector – i.e. the part of organic substances from agriculture that was not used economically (e.g. animal excrements used as fertilizer in agriculture or as a raw material for biogas production are not shown in waste statistics).

The research showed that generating of vegetal and animal waste in the agricultural sector of EU countries is characterized by spatial diversity. In 2016, the most of this type of waste was generated in:

– Spain – 30.3% of the EU value (which was associated with large share of this country in the EU volume of animal faeces, urine and manure generation),

– The Netherlands – 24.6% (which resulted from significant share in the generation of vegetal waste in the EU).

France, Germany, Slovakia and Sweden ranked next positions. In total, almost 80% of all analyzed waste groups were generated in these countries, which indicates a high degree of spatial concentration of the studied phenomenon. In the light of the above, it can be stated that these countries are predestined to base their development on the concept of bioeconomy. This is a challenge for the research and development sector regarding the development of innovative ways of managing the agricultural vegetal and animal waste.

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Streszczenie. Celem opracowania była identyfikacja i ocena przestrzennego zróżnicowania wytwarzania odpadów roślinnych i zwierzęcych przez podmioty z sektora rolnego w krajach UE wraz z określeniem znaczenia tego typu odpadów w odpadach ogółem generowanych w poszczególnych krajach. Dane statystyczne wykorzystane w opracowaniu zostały pozyskane z EUROSTAT. Okres badawczy stanowił 2016 r., natomiast obszar badawczy obejmował 25 krajów UE. Dane poddano analizie ilościowej, wykorzystując w jej trakcie statystykę opisową i parametryczną. W toku badań stwierdzono, że odpady zwierzęce i roślinne mają największy udział – spośród różnych grup odpadów – w strukturze odpadów pochodzących z sektora rolnego (w 2016 roku stanowiły one 81,6% wszystkich odpadów wytwarzanych w sektorze rolnym w UE). Wykazano, że wytwarzanie odpadów roślinnych i zwierzęcych w sektorze rolnym w krajach UE cechuje się zróżnicowaniem przestrzennym. Najwięcej tego typu odpadów wytworzonych zostało w Hiszpanii i Holandii. Dominująca pozycja Hiszpanii wynikała ze znacznego udziału tego kraju w unijnym wolumenie wytwarzania gnojowicy i obornika. Wysoka pozycja Holandii związana była z dużym udziałem odpadów roślinnych. Na kolejnych pozycjach uplasowały się Francja, Niemcy, Słowacja i Szwecja. Łącznie na terenie omawianych krajów generowane było prawie 80% wszystkich analizowanych grup odpadów, co świadczy o dużym stopniu koncentracji przestrzennej badanego zjawiska. W tym kontekście można stwierdzić, że są to kraje predestynowane do oparcia rozwoju o koncepcję biogospodarki. Stanowi to wyzwanie dla sfery badawczo-rozwojowej dotyczące opracowania innowacyjnych sposobów zagospodarowania roślinnych i zwierzęcych odpadów rolniczych.

Słowa kluczowe: biogospodarka, rolnictwo, biomasa, odpady, kraje Unii Europejskiej

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