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ANALYSIS AND ASSESSMENT OF THE USE OF PESTICIDES AND FERTILIZERS IN THE RURAL TERRITORIES OF REPUBLIC OF BULGARIA

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Abstract

Modern agriculture poses new challenges related to the increase of the need of sustainable development of the agrarian sector, and rural territories, respectively. The use of large amounts of chemical preparations in agriculture inevitably hides a number of possibilities for dangers, both for all mankind and for the natural environment. The main goal of this article is to analyze and evaluate the current state of use of pesticides and fertilizers in Bulgaria, as part of the agro-ecological indicators affecting the climate and natural ecosystems.Asa result from the research carried out we found that the levels of pesticide use in Bulgaria are below the average, but the last years are marked by a tendency for gradual increase of the areas of the used quantities of nitrogen fertilizers, manure and organic fertilizer, and a deficit in the Phosphorous balance in soil was noted. We need lowering of the degree of ecological risks related to use of pesticides and fertilizers in Bulgaria. This way the results will be multiplied for achieving higher level of economic, social and ecological sustainability in the development of individual rural territories.

Key words**:** *pesticides, fertilizers, sustainable agricultural practices, indicators, rural regions*

INTRODUCTION

The modern agriculture poses new challenges related to increasing the need of sustainable development of the agrarian sector. The objective of the Farm to Fork Strategy is to change the present food supply system of the European Union, and turn it into a sustainable model of agriculture. Farmers look for and implement innovative agricultural practices, which will contribute not only for protection and preservation of the environment, but to render positive effect upon the climate and biological diversity, as well. Nevertheless, the improper use of excessive quantities pesticides and fertilizers in agriculture can lead to numerous dangers and a series of risks for human health, the environment and losses in preservation of the soil biodiversity. Reducing pesticide use by 50% and fertilizer use by at least 20% are the specific goals outlined in the Farm to Fork Strategy [13].

The priority of the Green Deal is the Farm to Fork Strategy, and its main goal is to introduce and move to a new model for improving environmentally friendly practices related to climate change, preserving the environment and restoring biological diversity [14].

One of the most important resources of Bulgaria are the soil ecosystems, which contribute to providing a large amount of the food products consumed by all of humanity. Regardless of the rich specific characteristics that soils possess, their quality characteristics are increasingly deteriorating due to a number of ecological processes. This damage is the result of unsustainable agricultural practices, applying unreasonable rates of pesticides and fertilizers, as well as a number of processes, such as erosion, compaction and sealing of soils, reduction of minerals and biodiversity. ***The main goal of the development*** is to analyze the level and assess the current situation in the use of pesticides and fertilizers in Bulgaria, as part of the agro-ecological indicators that are relevant in the field of

climate and environment. The following **research tasks** stem from the goal set above:
-theoretical review of scientific literary sources related to the sustainable development of the rural territories of Bulgaria;
-analysis of the state with the use of pesticides in the modern agriculture and the rural regions of Bulgaria for the period 2011-2021;
-analysis of the state and tracing of the tendencies with the use of fertilizers in the modern agriculture and the rural regions of Bulgaria for the period 2011-2021;
-deriving guidelines for the development of agriculture and rural territories.

According to FAO (Food and Agriculture Organisation) and WHO (World Health organisation), the term **„pesticide“** denotes a substance, which is applied for treatment of different enemies of the plants – diseases, weeds and pests, including protection, elimination, attraction, repellence and control [16]. The application of pesticides in agriculture by farmers is done in order to limit the impact of pests and diseases on agricultural plants. Use of pesticides plays an important role in the agricultural production, and they may render negative effect on the environment, affect the quality of waters, soils, biological diversity and ecosystems or accumulate in the form of residual substances in foods. Plant protection products come in a variety of forms and include herbicides, fungicides and insecticides (Sustainable use of plant protection products – there is a limited progress in measurement and reduction of risks. Special report, 2020).

The current Pesticides Directive 2009 (Directive 2009/128/EC) [3] outlines a framework for achieving sustainable use of pesticides by limiting the impact of permissible hazards and their impact on public health and the natural environment. In Bulgaria, in 2012, a National Action Plan (NAP) was developed for the sustainable use of pesticides, which considers effective actions on the application of alternative methods and means to achieve a reduced risk impact of the use of pesticides on people and nature. Therefore, it is necessary to encourage farmers to use environmentally friendly agricultural practices and to apply chemical preparations within reasonable limits, thereby preserving and protecting soil ecosystems [9].

Organic farming is a nature-saving model of agriculture that contributes to the promotion and development of the local economy on a local, regional and national scale [10].

Opportunities for sustainable management of soil resources in the rural regions of Bulgaria contribute to provision of the population with healthy and quality food products, striving to alleviate the consequences of the climate change and restricting the loss of biological diversity. Transition to sustainable systems of production outlined new challenges in front of the agricultural holdings with an opportunity to achieve sustainability in the rural territories.

The contemporary agricultural techniques usually require using great quantities of fertilizers. Nutrients, such as Nitrogen (N) and Phosphorous (P), are absorbed in the soil by the plants themselves. These are offered mainly in the form of mineral – inorganic – fertilizers, which are widely used in the agriculture to optimize the production, and organic fertilizers such as manure. Nitrogen is the most frequently used nutrient – by volume. As the main nutrient, nitrogen is used most often in practice, while phosphorus and potassium are used in more limited quantities [4].

Many farmers apply large quantities of mineral fertilizers, and the young plants cannot absorb even part of the Nitrogen. This way the Nitrogen is released in the environment. Accordingly, increase of usage of Phosphorous fertilizers results in accumulation of Phosphorous in the soil. This will inevitable create ecological risk of high concentrations of Phosphorous and pollution of the environment [6].

The effect of the use of chemical fertilizers and pesticides can be sought in two directions, for example, the lack of balance in the natural environment and human health, and on the other hand, it contributes to increasing the costs of farmers. Nitrates and nitrites are considered a risk factor for people's health, if they are consumed in quantities that exceed the limits highlighted by specialists. Their presence has been proven to be due to

uncontrolled application, especially in the case of fertilizers or organic nitrogen [2].

In time, it was found that the practice of a conventional agriculture, which implies that sometimes the excessive use of pesticides, contributes directly to the degradation of the environment, to the depletion of resources and the loss of biodiversity [15].

As a whole the attention must be drawn to the implementation of sustainable agricultural models, which will suggest focusing on agricultural practices based on knowledge, in order to provide opportunities for dealing with ecological, economic and social challenges of the conventional agriculture [7].

Nature-friendly agricultural practices and ecologically-oriented technologies for growing agricultural crops lead to stabilization of the agro-ecosystems and increasing their sustainability. The vision of the updated agricultural policy sets the foundations of a fairer and sustainable future for farmers and rural territories. An important accent are the sustainable models for production with a view to the ecological agricultural practices, the eco-sustainability and efficient organisation and management of biological holdings [11].

Balanced territorial development is an important aspect of the sustainable development of rural regions. It is well-known fact that the sustainable development looks for an answer to the needs of the today's generation, without questioning the opportunities of the future generations to meet and realize their needs. This does not only mean reasonable use of natural resources and restoration of the ecological balance. Application of innovative model of biological production is beyond doubt one of the opportunities with significant effect for achieving greater sustainability in the development of the rural economy on a territorial scale [12].

The studied literary sources and authors' opinions on the problems considered show that despite the unsustainable agricultural practices and over-exploitation of natural resources attention must be drawn to the encouragement of sustainable models and technologies for stimulation the development of rural territories on a national scale. It is crucially important for our national economy to find the sustainable solutions for prevention of reduction of chemical fertilizers and pesticides in agriculture with a contribution to restoration of the ecosystems and an opportunity to provide a new and better balance between sustainable food supply system, health status of the population and preservation of the environment on a territorial scale.

MATERIALS AND METHODS

Analysis is implemented on the basis of publicly accessible information on strategic, regulatory, European and national documents, data from the agro-statistics kept by the Ministry of agriculture and food, Annual reports of the Ministry of the environment and waters (MEW), Executive Environment Agency (ExEA) and Eurostat. The methods of study used include comparison, analysis, synthesis, induction, tabular and graphic representation of the tendencies.

The study is based on data of FAOSTAT by basic indicators, and namely: use of pesticides, insecticides, herbicides, fungicides and bactericides in Bulgaria and EU for the period 2011-2021; sales of pesticides in Bulgaria and EU for the period 2011-2021; used quantities mineral fertilizers in Bulgaria and against the used farm area for the period 2011-2021,areas fertilized with Nitrogen and Phosphorous fertilizers in Bulgaria and as a percentage of the used farm area for the period 2011-2021; used quantities and treated areas with manure in Bulgaria for the period 2011-2021, consumption of Nitrogen, Phosphorous and Potassium fertilizers in Bulgaria and EU for the period 2011-2021; sales of mineral fertilizers in Bulgaria and EU for the period 2011-2021.

In order to trace the present state and the place of Bulgaria on a country level we made comparison with the statistical data and on EU level.

The statistics presented herein refers to the used and sold quantities of different categories pesticides and mineral fertilizers, expressed as active ingredients, kg and absolute volumes

(tons) of Nitrogen, Phosphorous and Potassium, as well as used and treated areas with manure, expressed per hectare.

RESULTS AND DISCUSSIONS

For many years, enormous amounts of pesticides and fertilizers have been used quite in the agriculture. In the so-called conventional agricultural practice, due to the high level of various chemical preparations imported into agriculture, large quantities of the produced food products can be obtained, but at the same time there are also a number of risks, such as environmental pollution and deterioration of the biological balance in nature. On the basis of the published statistical data for Bulgaria regarding the applied quantities of pesticides and fertilizers in the past years, for the period after 1990, we can state that higher quantities have been used more intensively. In relation to the development of rural regions of Bulgaria particular attention is paid to the rural territories, where agriculture is predominantly being developed. Therefore, in the present period the most up-to-date regulatory strategic documents emphasize on the reduction by 50 % of the use of chemical pesticides and losses of nutrients, as well as reduction of use of fertilizers by at least 20 %, and at the same time 25 % of the total agricultural land in the EU should be occupied with biological agriculture. A need of reduction of the dependence on pesticides and antimicrobial products and reduction of the excessive mineral fertilization is outlined, by expanding the methods of the sustainable biological agriculture for improvement of the environment and preservation of the soil resource. In order to achieve a high degree of sustainability in the development of rural areas in Bulgaria, we will conduct a longer and more in-depth analysis of the use of pesticides and mineral fertilizers for the period 2011-2021 (a ten-year period).

Analysis of the present condition with the use of pesticides in the modern agriculture and rural regions of Bulgaria

To achieve the set goal, we will examine the general state of pesticides and some of their types, and the information about the data on their current state in Bulgaria is based on FAOSTAT data (Figure 1).

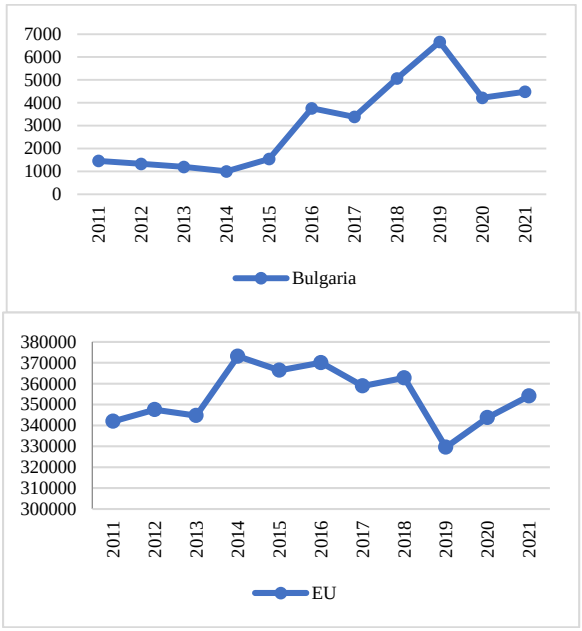

Fig. 1. Use of pesticides in Bulgaria and EU for the period 2011-2021 (tons of active ingredient)
Source**:** authors' figure based on data from Eurostat [5].

Pesticides are measured in tons of active ingredient. For the period 2011-2021, it became clear that the highest use of pesticides was registered in 2019 – 6,663 tons of active ingredients, and the lowest usage was 1,001 tons of active ingredients in 2014. For comparison, data in the EU show just the opposite, that the highest use of pesticides was in 2014 – 373,107 tons of active ingredients, and in 2019 was the lowest consumption - 329,560 tons of active ingredients. Tracing down the statistical data from the preceding reference period 2014-2020 against the present 2021, we can summarize that the tendency of the pesticide use in Bulgaria results in their increase.

From the data presented in Figure 2 about the total use of insecticides in Bulgaria we can say that the most significant quantity of insecticides used in the agriculture was in 2019 – 730 tons of active ingredients, and the least quantity used was 103.15 tons of active ingredients in 2011.

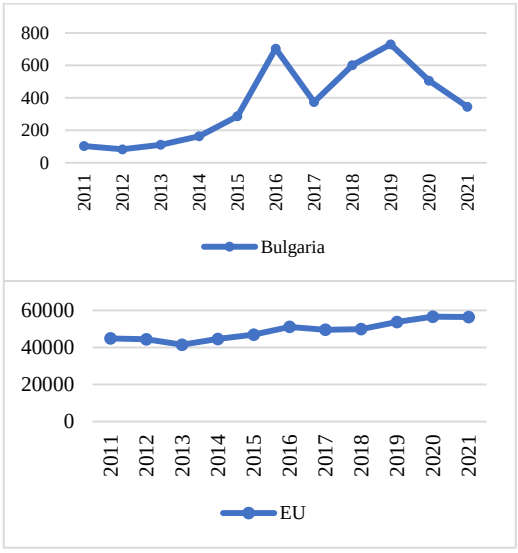

Fig. 2. Use of insecticides in Bulgaria and EU for the period 2011-2021 (tons of active ingredient)
Source: authors' figure based on data from Eurostat [5].

The consumption of insecticides in the EU marks comparatively sustainable tendency of increase for the period 2011-2021. The highest use rate was noted in 2020 – 56,544 tons of active ingredients, and the lowest one in 2013 – 41,444 tons of active ingredients.

From the data analysed on the use of herbicides in Bulgaria for the period 2011-2021 it can be seen that the maximum used quantity was registered in 2019 – 4,340 tons of active ingredients, and the minimum quantity is 636.2 tons of active ingredients in 2015 (Figure 3).

For comparison in the EU the highest use was seen in 2020 – 119,602 tons of active ingredients, and the lowest use - in 2019 – 107,933 tons of active ingredients.

According to published statistics, in 2018, the highest use of fungicides and bactericides was registered in Bulgaria - 1,817 tons, and in 2014, the lowest consumption was observed - 186 tons (Figure 4).

For comparison in the EU during the analyzed period, the data show that the maximum amount used was registered in 2018 – 160,438 tons of active ingredients, and the minimum amount used was observed in 2019 – 131,295.

The analysed statistical data for the use of pesticides in Bulgaria for the period 2011-2021 show that the levels are below the average in comparison with EU, but in the latest several years of the analysed 10-year period a tendency of increase was seen, and this increase can continue in the future, due to the unusual changes in the climate and the increase of the average annual temperatures in the atmosphere.

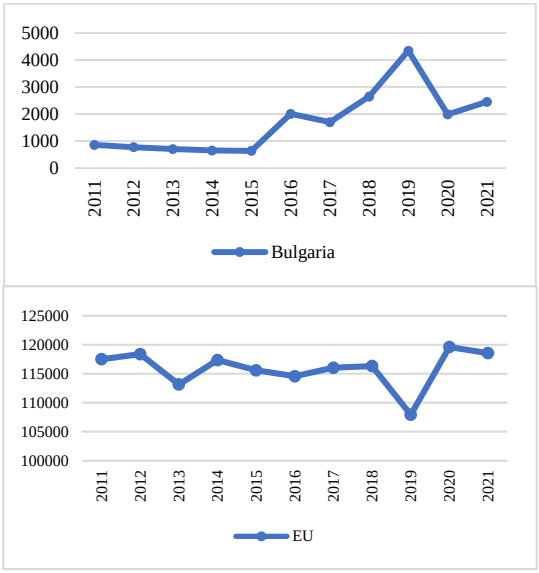

Fig. 3. Use of herbicides in Bulgaria and EU for the period 2011-2021 (tons of active ingredient)
Source: authors' figure based on data from Eurostat [5].

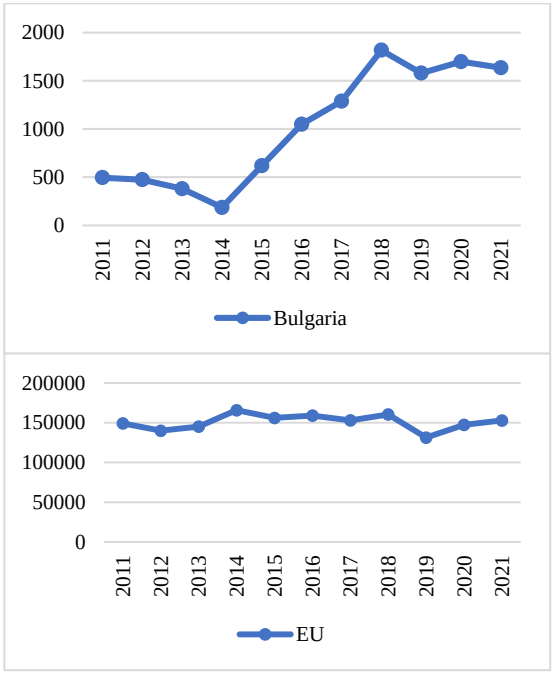

Fig. 4. Use of fungicides and bactericides in Bulgaria and EU for the period 2011-2021 (tons of active ingredient)
Source: authors' figure based on data from Eurostat [5].

Every year, Eurostat publishes up-to-date statistical information on the relevant quantities of plant protection products in rural areas to track trends in the development of pesticides in a territorial scope.

For the analysed 10-year period we can consider the sales of pesticides in Bulgaria, and for the period 2012-2014 they are decreased, but from 2015 to 2021 they mark a tendency of increasing (Table 1).

The lowest value was registered in 2014 – 1,002 tons, and the highest in 2018 – 5,000 tons. Tracing the last reference period 2014-2020 for development of the rural regions we assume 2014 as the baseline value or the so-called „standard", with which we will compare the respective years.

The change in the increase of the total amount of sales of pesticides in Bulgaria in 2021 against 2014 is +3,425.

Table 1. Total amount of sales of pesticides in Bulgaria and EU for the period 2011-2021 (tons)

Years	Country		Country	
	Bulgaria	Change against 2014	EU-27	Change Against 2014
2011	No data	-	359,468	-9,634
2012	1,331	+329	347,915	-21,187
2013	1,196	+194	349,591	-16,511
2014	**1,002**	**St**	**369,102**	**St**
2015	1,542	+540	203,530	-165,572
2016	3,759	+2,757	371,523	+2,421
2017	3,359	+2,357	359,878	-9,224
2018	5,000	+3,998	354,583	-14,519
2019	4,632	+3,630	333,356	-35,746
2020	4,186	+3,184	345,999	-23,103
2021	4,427	+3,425	355,175	-1,392

Source**:** authors' table based on data from Eurostat [5].

From the data presented in table 1 for the period 2011 - 2021, sales of pesticides in the EU maintain their levels. 350,000 tons is the registered total volume sold per year and is estimated to be around 355,000 tons in 2021. In the last analyzed year, compared to 2014, the change in the reduction of the total volume in sales of pesticides in the EU was -1,392.

Analysis of the present condition with the use of fertilizers in the modern agriculture and the rural regions of Bulgaria

Pesticides and fertilizers are immutable part of the modern agriculture, used for pest control and improvement of agricultural yields. Pesticide resistance in soil is usually changed by the fertilizers used. Fertilizers are widely used in agriculture in the form of mineral and inorganic fertilizers, as well as in the form of manure to provide nutrients important to agricultural crops. Nitrogen and Phosphorous fertilizers would significantly improve production of agricultural crops, but their excessive use can lead to losses of nutrients in the environment, which contributes to its pollution and destruction.

On the basis on data of Eurostat there is an updated statistical information published for Bulgaria on the quantities of mineral fertilizers used, and as kg/ha against the utilised farm area (UFA) for the period 2011-2021.Thus for example, in 2021 Nitrogen fertilizers (N) – 342,890 tons, Phosphorous fertilizers ($P_2 0_5$) – 72,964 tons and Potassium fertilizers (K_2O) – 42,917 tons (Table 2) were used. The highest use of Nitrogen fertilizers was registered in 2011 – 371,015 tons, and the lowest was seen in 2012 – 245,000 tons. The maximum quantity of Phosphorous fertilizers used was registered in 2016 – 82,623 tons, and the minimum quantity used was registered in 2013 – 52,123 tons. Regarding the Potassium fertilizers - four successive years are outlined with the highest usage rate, and namely, 2018-2021 – 42,917 tons, and the lowest rate was registered to 12,723 tons in 2011.On this basis we can calculate the relative share in % computed against the utilised farm area (kg/ha) of the total used fertilizers for each calendar year. For example, if we trace the last reference period 2014-2020 for development of rural regions we assume 2014 as the baseline value or the so-called „standard", in 2015 the relative share was 11.96% against the preceding (baseline) year. The relative share in the next 2016 against the preceding 2015 marks a drastic increase by 26.38%. It must be noted that in the next 4 years (2017, 2018, 2019, 2020) a gradual increase of the total mineral fertilizers used was seen in the rural territories of Bulgaria – by 19.37 %, 20.28 %, 23.94 %, 27.09 %, respectively. This increase can be explained by the increase in the area of cultivated land after the accession of our country to the EU, due to the abandoned lands and the increased areas sown with technical crops, requiring additional application of large amounts of mineral fertilizers [8]. In 2021 a drop of 19.73 % was reported. As a whole, we can summarize that various quantities of mineral fertilizers have been used in our country, but there was a desire for them to be

consumed within the certain norms, in order to limit the negative effect upon the environment and natural resources.

Table 2. Used quantities of mineral fertilizers in Bulgaria, in tons and as kg/ha against the utilised farm area (UFA) for the period 2011-2021

Years	Nitrogen (N)		Phosphorous (P_2O_5)		Potassium (K_2O)		Total fertilizers		Relative share %
	t	kg/ha	t	kg/ha	t	kg/ha	t	kg/ha	
2011	371,015	108.8	48,780	14.3	12,723	3.73	432,518	126.83	20.81
2012	245,000	70.48	49,000	14.1	24,000	6.9	318,000	91.48	12.85
2013	292,381	80.9	52,123	14.42	35,188	9.74	379,692	105.06	-0.07
2014	296,591	82.09	54,268	15.02	28,429	7.87	379,288	104.98	**St**
2015	329,546	90.46	65,931	18.1	32,714	8.98	428,191	117.54	11.96
2016	365,913	100.61	82,623	22.72	34,012	9.35	482,548	132.68	26.38
2017	351,120	96.54	67,753	18.63	36,909	10.15	455,782	125.32	19.37
2018	339,329	93.45	76,274	21.01	42,917	11.82	458,520	126.28	20.28
2019	352,486	97.13	76,780	21.16	42,917	11.83	472,183	130.12	23.94
2020	364,335	99.98	78,935	21.66	42,917	11.78	486,187	133.42	27.09
2021	342,890	93.95	72,964	19.99	42,917	11.76	458,771	125.7	19.73

Source: Eurostat [5].

The fertilized areas with Nitrogen and Phosphorous fertilizers in Bulgaria (thousand ha) and as a percentage of the utilised farm area for the period 2011-2021 are presented in the next Figure 5.

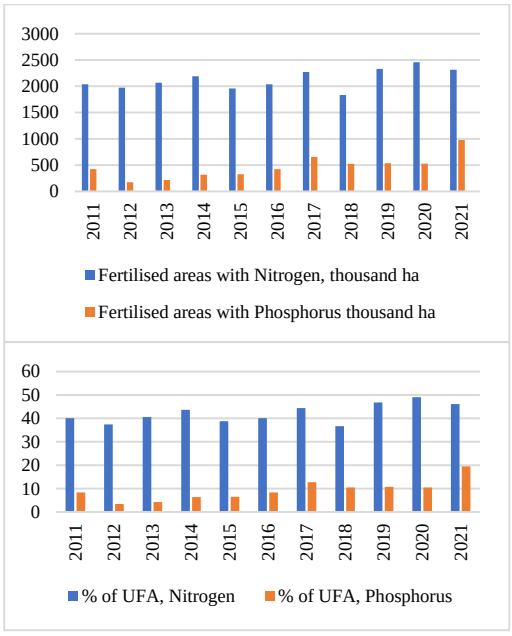

Fig. 5. Fertilized areas with Nitrogen and Phosphorous fertilizers in Bulgaria (thousand ha) and as a percentage of the utilised farm area (UFA) for the period 2011-2021

Source: authors' figure based on data from BABH (Bulgarian Food Safety Agency) [1].

On the basis of the above-specified data regarding the fertilized areas with Nitrogen it is evident that in 2018 minimum quantity of used Nitrogen fertilizers – 1,831.9 thousand hectares was seen, and the maximum quantity used was in 2020 – 2,457.6 thousand hectares. Regarding the areas treated with Phosphorous, data shows that the lowest use was registered in 2012 - 174,5 thousand hectares, and the highest use was reported in 2021 – 979 thousand hectares. If we take into account again 2014 from the last reference period (2014-2020), as a baseline value and compare it with 2021, we will note a slight increase by 5.3 % - from 2,190.5 thousand hectares for 2014 to 2,314 thousand hectares for 2021.

The tendency in the fertilized areas with Phosphorous is similar to the fertilized areas with Nitrogen. In 2021 an increase was seen against 2014 by 67 % - from 318,4 thousand hectares for 2014 to 979 thousand hectares for 2021.

The manure used in agriculture improves on the one hand, the soil fertility, and on the other hand, contributes to the development and feeding of plants. It contains all basic for the plants micro- and macro-nutrients, stimulants and carbohydrates. Organic fertilizers are main element for maintaining the balance of humus in soil and play an important role for the sustainable management of the soil fertility. The quantities of manure used and the areas treated with manure in Bulgaria for the latest 3 years (2019, 2020, 2021) are presented in the next figure (Figure 6). The data presented show that the tendency with the used quantities of input manure in Bulgaria marks a sustainable increase. In 2019, 451,654 tons of manure were used on an area of 30,758 ha.

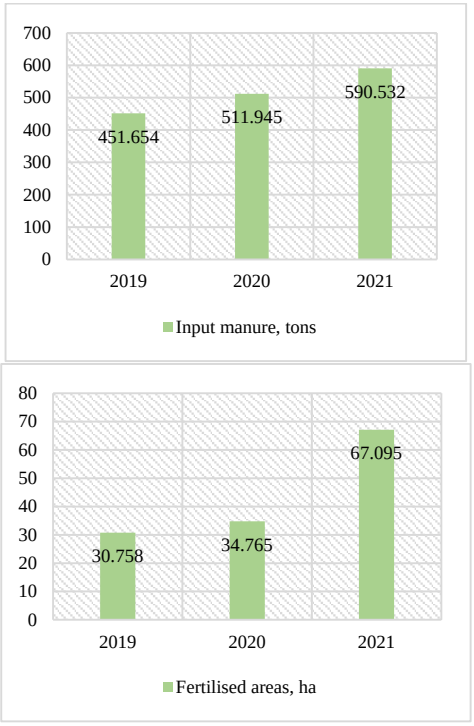

Fig. 6. Used quantities and treated areas with manure in Bulgaria for the period 2019-2021
Source: authors' figure based on data from BABH (Bulgarian Food Safety Agency) [1].

In 2020 there is a positive tendency of increasing, both, of the input manure, and of the fertilized areas – 511,945 tons of manure and 34,765 ha of fertilized areas.
In 2021, the total quantity of the input manure amounted to BGN 590,532 tons, which is an increase of 13.3 % against the preceding year from the studied period.
In 2021, there were almost double as much treated areas in comparison with the preceding 2020 – from 34,765 ha they are increased to 67,095 ha or an increase of 48.18 %. Analysis of data for the last 3 years in Bulgaria prove the established tendency for gradual increase of the areas, fertilized with manure, as well as an increase in the quantity of organic fertilizer used.
On the basis of the statistical data reviewed for the *use of mineral fertilizers in Bulgaria, we can summarize that* the tendency of increasing of the used quantities of Nitrogen fertilizers per unit of area, upon failure to comply with the legally set requirements for management and of the Good agricultural and ecological conditions, creates a risk of pollution of waters with Nitrates. The application rate of Nitrogen fertilizers is not exceeded, but nevertheless, the data about the Nitrogen balance show that there is an ecological risk of pollution of waters with Nitrates. Regarding the use of Phosphorous, we found a deficit in the Phosphorous balance in the soil. The unbalanced ratio of fertilization and the intensive increase of the used mineral fertilizers render negative effects upon the quality of soils, the agricultural produce and the environment.
Next, we will review the total consumption of mineral fertilizers in Bulgaria, the consumption of Nitrogen fertilizers, Phosphorous fertilizers and Potassium fertilizers, individually for the analysed 10-year period (2011-2021), and we will make comparison with the data about the EU, in order to trace the present condition and the place of Bulgaria on a country level and on EU level.
Figure 7 shows data about the consumption of mineral fertilizers for the period 2011-2021.

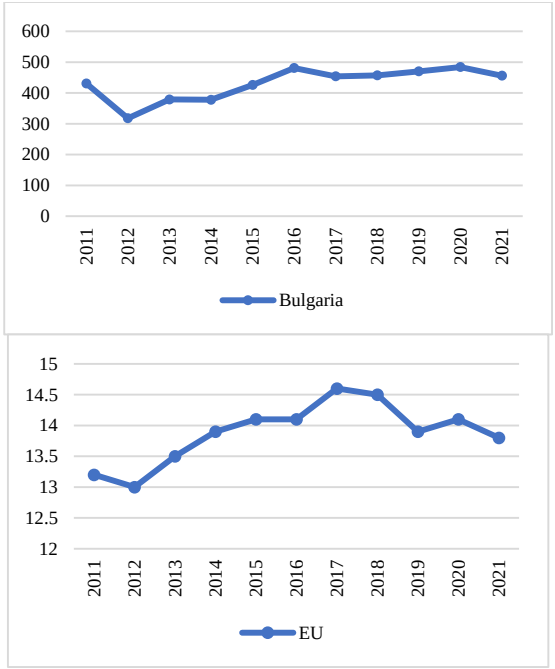

Fig. 7. Consumption of mineral fertilizers in Bulgaria (tons) and EU (million tons) for 2011-2021
Source: Eurostat [5].

Reviewing the data, we can say that the tendency for the used mineral fertilizers in Bulgaria leads to comparatively stable increase (Figure 7). An increase against the

basic 2014 by 17.32 % was seen - from 379,288 tons to 458,771 tons in 2021.

According to the published data on European Union level the consumption of mineral fertilizers in 2021 decreased against 2020. The total quantity of **mineral fertilizers** – Nitrogen, Phosphorous and Potassium used in the agricultural production in the EU amounted to 13.8 million tons in 2021. This represents a drop of 2.17 % in comparison with 2020. In 2017 was registered the highest consumption of 14.6 million tons. For comparison, in 2012 was seen the lowest consumption of 13 million tons.

The data presented in the next figure about the consumption of Nitrogen fertilizers in Bulgaria for the period 2011-2021 shows a tendency of gradual increase and decrease (Figure 8).

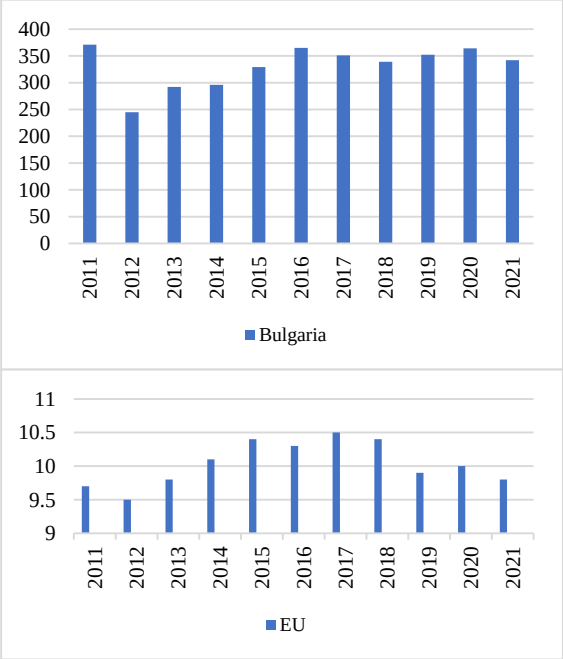

Fig. 8. Consumption of Nitrogen fertilizers in Bulgaria (tons) and EU (million tons) for the period 2011-2021
Source: Eurostat [5].

The highest values were registered in the first analysed year – 2011, and namely 371,015 tons, and the lowest ones were reported in 2012 – 245,000 tons. 2021 saw a tendency of decrease by 6.25 % against 2020. The consumption of **Nitrogen fertilizers** in the agriculture in the EU in 2021 was estimated to amount to 9.8 million tons, a decrease against 2020 by 2 %, which is in conformity with the noted short-term tendency after 2017 onwards. Nevertheless, the lowest value remains in 2012 – 9.5 million tons.

Reviewing the data analysed on the consumption of *Phosphorous fertilizers* in Bulgaria for the period 2011-2021 it can be seen that the maximum quantity used was registered in 2016 – 82,623 tons, and the minimum quantity was reported in 2011 – 48,780 tons. In 2021 a decrease of 8.18 % was seen against the preceding 2020.In 2021 the consumption of **Phosphorous fertilizers** in the agriculture in the EU was 1.1 million tons, i.e. a drop of 9 % was registered against the level in 2020 (Figure 9).

The highest use was found to be in 2019 and 2020 – 1.2 million tons, and in 2011 and 2012 the lowest consumption was registered - 1 million tons.

According to the published data during the four consecutive years (2018-2021) the highest consumption of Potassium fertilizers in Bulgaria – 42,917 tons was registered, a the lowest consumption is 12,723 tons in 2011 (Figure 10). In 2021, an increase against the basic 2014 by 33.75 % was seen - from 28,429 tons to 42,917 tons.

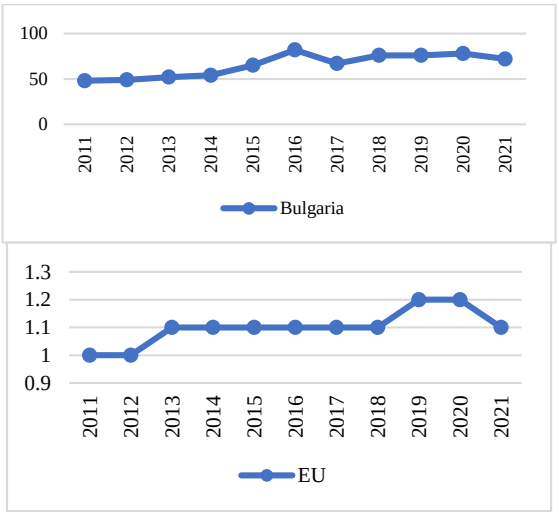

Fig. 9. Consumption of Phosphorous fertilizers in Bulgaria (tons) and EU (million tons) for the period 2011-2021
Source: Eurostat [5].

Data for the consumption of Potassium fertilizers on EU level during the analysed period shows that the maximum quantity used was registered in 2018 and 2019 – 3 million

tons, and the minimum quantity used was seen in 2011 and 2012 – 2.4 million tons.

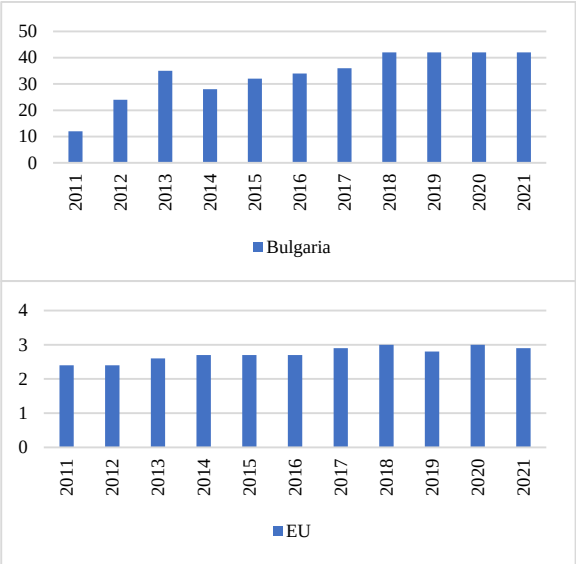

Fig. 10. Consumption of Potassium fertilizers in Bulgaria (tons) and EU (million tons) for the period 2011-2021
Source: Eurostat [5].

Eurostat publishes up-to-date data on the quantities of mineral fertilizers consumed in Bulgaria, on an annual basis. Using its data, we can trace the dynamics of sales of mineral fertilizers on the level of Bulgaria and the EU for the analysed 10-year period. For the period 2011-2014 sales of mineral fertilizers decreased, but from 2015 to 2020 they mark a tendency of increasing (Table 3).

Table 3. Total amount of sales of mineral fertilizers in Bulgaria and EU for the period 2011-2021 (tons)

Years	Country		Country	
	Bulgaria	Change Against 2014	EU-27	Change Against 2014
2011	305 848	+33 748	14 318 890	-951 552
2012	265 421	-6 679	15 161 003	-109 439
2013	237 853	-34 247	14 857 124	-413 318
2014	**272 100**	**St**	**15 270 442**	**St**
2015	338 127	+66 027	15 024 143	-246 299
2016	375 642	+103 542	13 488 226	-1 782 216
2017	377 418	+105 318	15 647 730	+377 288
2018	316 133	+44 033	15 096 746	-173 696
2019	371 226	+99 126	15 157 954	-112 488
2020	295 112	+23 012	15 359 774	+89 332
2021	259 287	-12 813	15 483 882	+213 440

Source: Eurostat [5].

The lowest value was registered in 2013 – 237,853 tons, and the highest was established in 2011 – 305,848 tons. Tracing the last reference period 2014-2020 for development of the rural regions we again assume 2014 as the baseline value or the so-called „standard“, with which we will compare the respective years. The change in reduction of the total amount of sales of mineral fertilizers in Bulgaria in 2021 against 2014 was -12,813. The largest amounts of mineral fertilizers sold at the EU level were registered in 2017 – 15.6 million tons, and the smallest amounts of sales were observed in 2016 – 13.4 million tons. The change in reduction of the total amount of sales of mineral fertilizers in Bulgaria in 2021 against 2014 was -173,696.

CONCLUSIONS

As a result from the analysis done and the assessment of the present state of use of pesticides and fertilizers in agriculture and rural regions of Bulgaria for the period 2011-2021 we can draw some particular summarizations and conclusions:

-Literary analysis of authors' opinions and the results of our study for the last years draws still more the attention towards encouragement of sustainable models and technologies for stimulation of the development of rural territories on a national scale. Sustainable solutions for reduction of chemical fertilizers and pesticides in agriculture, contributing to the recovery of the ecosystems and preservation of the environment on a territorial scale are of crucial importance.

-Bulgaria, being EU Member State, continues the policy for efficient application of the sustainable use of pesticides in the direction of gradual and permanent reduction of the utilised chemical methods and treatment products and their replacement with alternative ones, nature-friendly sustainable agricultural practices for preservation of the population's health and preservation of natural resources. Application of such environment-friendly approaches contribute to the reduction of the risk from the use of chemical pesticides and mineral fertilizers in soil, to ensure stability of the agro-ecosystems and protection of the environment in the long-term

aspect. This way will be guaranteed the sustainability of individual rural territories.

-In Bulgaria the highest consumption of pesticides was registered in 2019 – 6,663 tons of active ingredients, and the lowest use was 1,001 tons of active ingredients in 2014. The most significant quantity of insecticides used in the agriculture in Bulgaria was in 2019 – 730 tons of active ingredients, and the least used quantity was 103.15 tons of active ingredients in 2011. In Bulgaria the maximum quantity of herbicides used was registered in 2019 – 4,340 tons of active ingredients, and the minimum quantity was 636.2 tons of active ingredients in 2015. The levels of pesticide use in our country are below the average, but in the last several years from the analysed 10-year period a tendency of increase was seen.

-In 2021, Nitrogen fertilizers used were 342,890tons, Phosphorous fertilizers – 72,964 tons and Potassium fertilizers – 42,917 tons. The Nitrogen fertilizers used in Bulgaria in 2021 showed a tendency of decrease by 6.25 % against 2020. For the Phosphorous fertilizers, a decrease of 8.18 % was reported against the preceding 2020, and Potassium fertilizers registered the highest consumption in Bulgaria over the four consecutive years (2018-2021) – 42,917 tons, and the lowest consumption was 12,723 tons in 2011. Concerning the use of Phosphorous we found a deficit in the Phosphorous balance in the soil. Data shows an established tendency of gradual and stable increase of the areas, fertilised with manure, as well as an increase of the quantity of organic fertilizers used for the last 3 years in Bulgaria (2019, 2020, 2021).

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