

## STUDY ON THE USE AND MARKETING OF PESTICIDES IN ROMANIA IN THE CONTEXT OF APPLYING THE FARM TO FORK STRATEGY

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### Abstract

*The use of pesticides represents a step forward for agriculture, in terms of the fight against the main diseases and pests, in order to ensure some productions destined for the market and implicitly for food safety. The world consumption of pesticides was captured in the main European Union countries highlighted in statistics such as NIS, Faostat, Eurostat and ITC, the position occupied by Romania being highlighted, in terms of quantities used and the surfaces on which they were applied (2010-2019). The comparative analysis of Romania's situation with the other member countries in terms of pesticides is presented in this paperwork in terms of the quantities of pesticides used, the areas with registered pesticides, imports and exports. At Romania's level, the analysis focused on the evolution of the main indicators that characterize pesticides, both at national level and at the level of the development regions, concluding that, at this level, pesticides are applied differently, depending on a series of exogenous and endogenous factors. But, the European agriculture and implicitly the one in Romania, must respond to a new challenge, that of reducing the quantities of pesticides used, according to the requests of the Farm to Fork strategy, component of the Green Deal, which requires that 25% of the agricultural area to be destined for organic agriculture and a 50% reduction in the use of pesticides, an aspect that we will detail in this scientific communication.*

**Key words:** Farm to Fork Strategy, pesticides, consumption, areas with pesticides, import, export, Romania

### INTRODUCTION

According to the specialized literature, pesticides are those substances that are used to remove pests and weeds that negatively impact agricultural crops. Thus, a pesticide can also be represented by an organism such as the bacterium "Bacillus thuringiensis". This bacterium is used in agricultural activity to control a certain number of insects [20].

The composition of pesticides refers to the following types of substances: herbicides; insecticides; insect growth regulator; therticides; nematocides; avicides; molluscicide; pesticide; rodenticides and antibiotic. The most commonly used are herbicides, which account for about 80% of the entire amount of pesticides used [3].

In modern agriculture, the use of fertilizers and pesticides is a necessity, because the world's population grows in geometric

progression, being estimated that by 2050 it will reach 9.1 billion inhabitants. In these conditions, specialists in the field recommend increasing agricultural production by 70% [15, 16, 21].

It is necessary to specify that both the use of fertilizers and the use of pesticides cause, on the one hand, various imbalances to the environment and to the health of the population, and on the other hand, contribute to the increase of the expenses incurred by farmers [9, 10, 11, 16, 21].

According to the researches carried out, it has been revealed that 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 [12, 17].

According to a published study, it was shown that 64% of the areas used for agriculture, respectively for food crops in 168 countries, are prone to the risk of pollution with pesticides. Specialists in the field have pointed out that the use of large quantities of pesticides, on the one hand, will destabilize ecosystems, and on the other hand, will negatively impact the quality of water sources [2].



Photo 1. Culture to which pesticides are applied  
Source: [14].

The total consumption of pesticides worldwide recorded oscillations from one year to another, during the period under analysis. In 2019, the total consumption of pesticides worldwide increased by 3.84%, compared to 2010 (Fig.1).

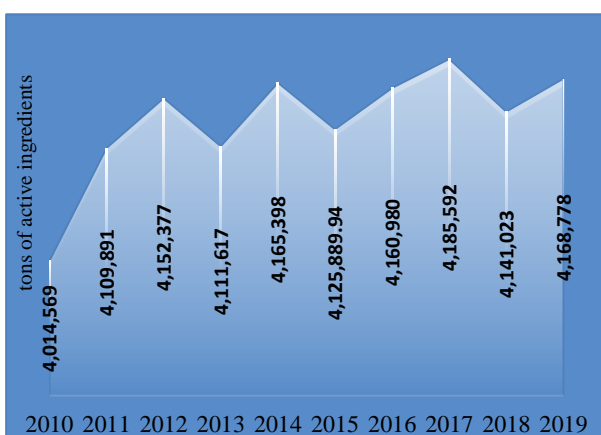


Fig. 1. Total consumption of pesticides worldwide during 2010-2019 (tons of active ingredients)  
Source: [6].

The multiannual average for the period 2010-2019 of pesticides consumption indicates that more than half of all pesticides were used in Asia (52.58%), followed by Americas

(31.84%) and Europe (11.75%) (Figure 2). The lowest pesticide consumptions were recorded in Africa (2.39% of the world total) and Oceania (1.45% of the world total).

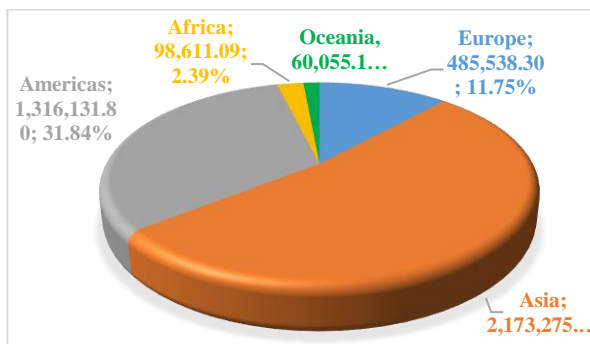


Fig. 2. Multiannual average (2010-2019) of total global pesticide consumption (tons of active ingredients, %)  
Source: [6].

Pesticides are used by most countries that obtain agricultural productions, because they directly contribute to the destruction of pests that compromise crops. At global level, the ranking of the top 10 pesticide-using countries, according to the multiannual average (2010-2019), was the following: China (1,777,486.40 tons of active ingredients); USA (402,834.90 tons of active ingredients); Brazil (365,865.30 tons of active ingredients); Argentina (206,958.20 tons of active ingredients); Canada (79,445.20 tons of active ingredients); France (70,882.50 tons of active ingredients); Ukraine (60,281.00 tons of active ingredients); Italy (60,218.90 tons of active ingredients); Russian (59,122.70 tons of active ingredients) and Spain (56,101.90 tons of active ingredients) (Fig. 3).

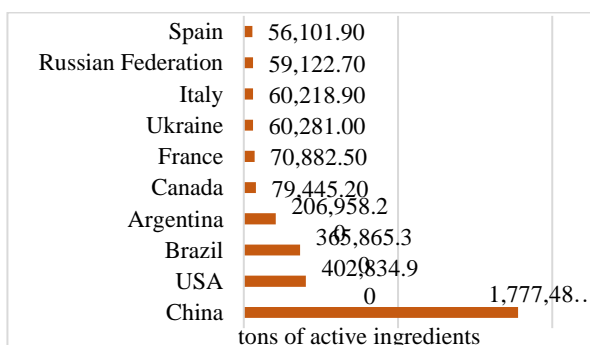


Fig. 3. Ranking of the top 10 pesticide-using countries by multiannual average (2010-2019) (tons of active ingredient)  
Source: [6].

From the data presented in Figure 3, it can be seen that the countries of the European Union

are found in the second half of this ranking, namely: France (6th place); Italy (8th place) and Spain (10th place). During the analyzed period.

According to published statistical data, more than 200,000 tons of pesticides are used in Europe to combat diseases, weeds and pests in agriculture [21].

In this context, the European Commission has published the strategies. From Farm to Consumer (Farm to Fork) and Biodiversity 2030. According to specialists in the field, these strategies will determine, on the one hand, a new way of obtaining food products, and on the other hand, farmers will have to adapt their production mode and the way of relating to the environment. The "Farm to Consumer" strategy aims to improve production, but also, sustainable food consumption through a holistic approach. The implementation of these strategies was determined by the need to mitigate climate change. In this respect, it is necessary to identify the most pertinent solutions that are in accordance with the objectives pursued [1, 4, 19].

Nowadays, reducing the consumption of pesticides is still a challenge for farmers, because, on the one hand, they must consider increasing agricultural production due to the increase in population, and on the other hand, they must not forget about the purpose of the activity of any economic agent, namely, increasing the profitability of agricultural activities [10].

At the level of the European Union, the aim is to obtain a sustainable use of pesticides by reducing, on the one hand, the risks, and on the other hand, the effects on the environment and the health of the population. In this context, the European Union states must consider the previously specified objective and are determined to include in their national plans quantitative targets related to pesticides. In order to measure the progress regarding the reduction of the risks, as well as of the effects of the pesticides, it was found the need for the existence of specific risk indicators. They must be valid at European Union level. Another important aspect to mention is that risk assessment is not a simple operation. This

situation is due to the fact that the risks related to plant protection products are not homogeneous, they are correlated with the modification of specific factors such as:

- active substances that are part of plant protection products;
- their composition;
- the quantity used per hectare and the frequency of application;
- when, where and how farmers use them in their work.

In the European Union, the harmonization of the risk indicators was imposed, on the one hand, due to the need to make comparisons between the Member States, and on the other hand, in order to achieve a realistic evaluation of the EU policy.

In this context, according to the EU directive, member states have the obligation to:

- calculate the risk indicators;
- ascertain the needs for the use of active substances in plant protection products;
- identify those elements that require increased attention.

Currently, in the European Union there are two harmonized risk indicators. The first harmonized risk indicator was established on the basis of the sales of the active substance, and the second indicator was established based on the number of emergency authorizations granted (Fig. 4).

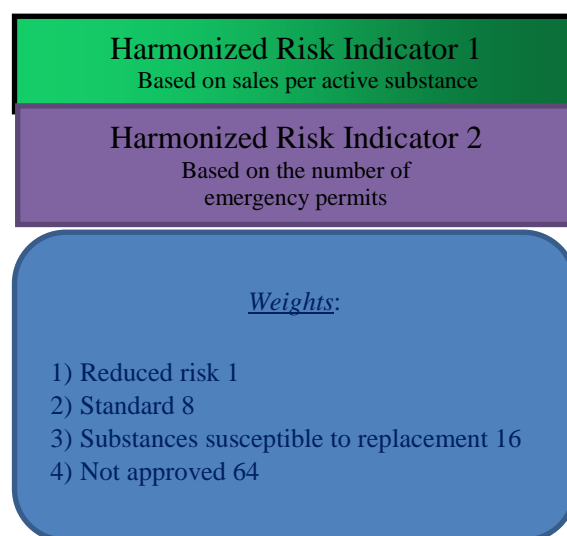


Fig. 4. Harmonized risk indicators  
Source: [7, 18]

It is necessary to specify that the harmonized risk indicators evaluate the progress made regarding the achievement of the objectives aimed at reducing the risks and effects of the use of pesticides on the environment and human health. It also aims to promote the use of integrated pest management, but also alternative approaches to reduce dependence on the use of pesticides [7, 11, 18, 19].

The evolution of the harmonized risk factor in the European Union, between 2011 and 2019, is presented in Figure 5.

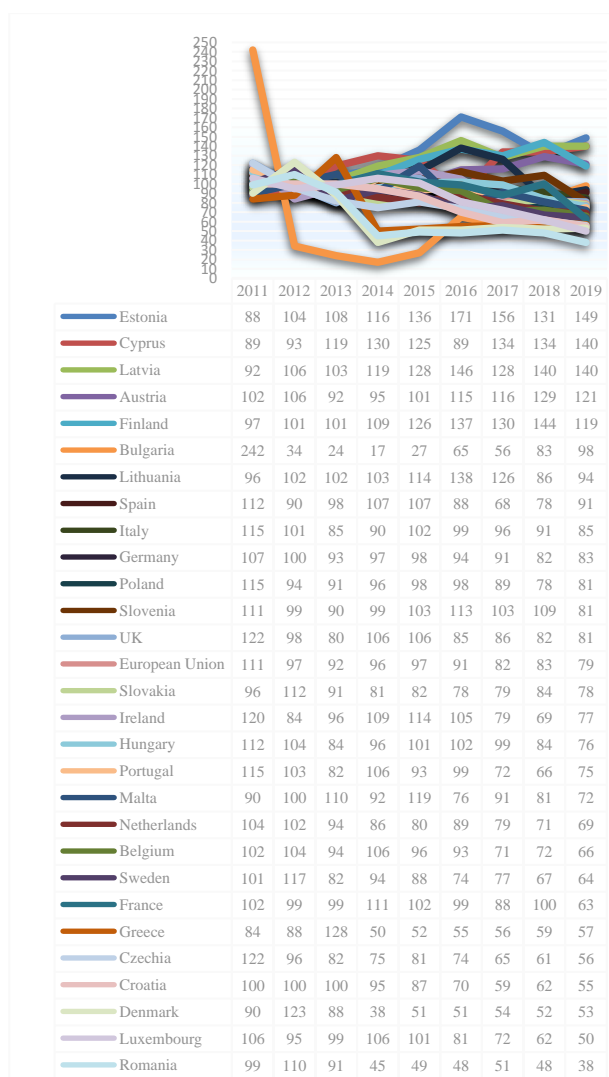


Fig. 5. Evolution of the harmonized risk factor in the European Union, during 2011-2019

Source: [5].

At the level of the European Union, it registered changes from one year to another. The highest risk factor recorded was 111 (2011) and the lowest was 79 (2019). In the countries of the European Union it was

different and varied during the analyzed period. For Romania, the harmonized risk factor recorded values below the European Union average, with one exception, namely, in 2012 (110 -Romania and 97- European Union). From the data presented regarding the harmonized risk factor it can be easily seen that since 2014, it has registered low values. Romania recorded the lowest harmonized risk factor in 2019 (38).

In these conditions, various solutions are sought in order to reduce the negative effects caused by their widespread use. In the short and medium term, it is not possible to eliminate them, but it is possible to reduce the quantities used.

Specialists in the field have highlighted several possibilities of reducing pesticides used in agriculture, considering that innovation is an important segment of the solution. For example, in Romania, NHR Agropartners has identified several directions of action, as presented in Fig. 6.

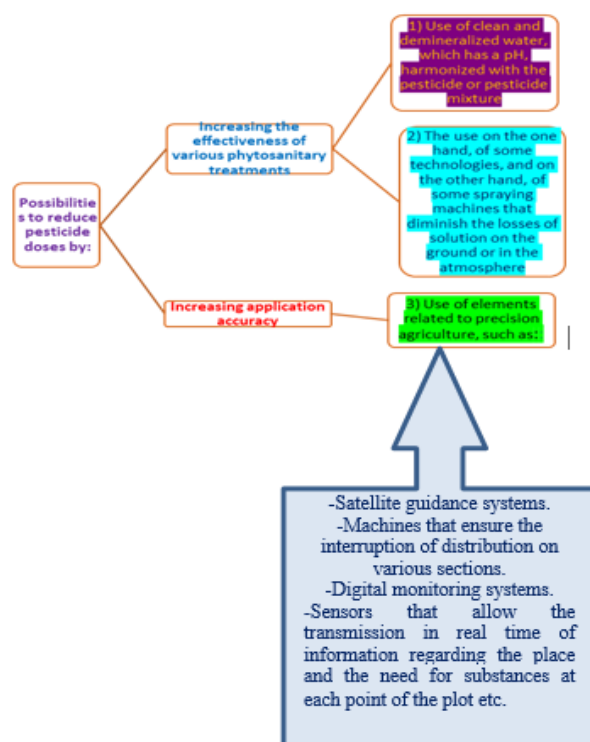


Fig. 6. The main solutions proposed by NHR Agropartners that contribute to reducing the amount of pesticides

Source: [10.]

The solutions proposed by NHR Agropartners lead directly to the decrease of the quantity of pesticides used in agriculture, while

increasing the accuracy of application without negatively impacting the production achieved, the environment and people's health. From the above, it emerged that the widespread adoption of digital agricultural technologies could represent a solution to reduce the consumption of pesticides. It is necessary to specify the need to financially stimulate the farmers who adopt these technologies [10]. In this context, the goal of the paper is the comparative analysis of Romania's situation with the other member countries in terms of pesticides regarding the quantities of pesticides used, the areas with registered pesticides, imports and exports. The analysis is made both at the national and regional level.

## MATERIALS AND METHODS

In the paperwork were analyzed a series of statistical data, starting with 2010. These data focused on the use of pesticides and the main categories of products included in this class (insecticides, herbicides and fungicides) in Romania, as well as in the European Union, in the context of applying the "Farm to fork" strategy. The main analyzed indicators were: consumption of pesticides in the European Union; the surface of the lands on which pesticides have been applied in Romania; the amount of pesticides used in Romania and in the development regions; the world's leading importers of pesticides; Romania's imports of pesticides by sources of origin; the world's leading exporters of pesticides; Romania's exports of pesticides and the main markets. The data collected are expressed in tons of active pesticide ingredients used or sold in the agricultural sector for crops and seeds. This data was taken from the following statistical sites: Faostat, Eurostat, ITC and NIS. It was used the linear regression equation,  $Y = bx + a$ , where Y is the dependent variable and X is the independent variable. In the paper, the results were presented in tables and graphs.

## RESULTS AND DISCUSSIONS

The total consumption of pesticides in the main consuming countries of the European

Union varied from one year to another, during the analyzed period (Fig.7). From the published statistical data on the total consumption of pesticides, it resulted that France is on the first place in the ranking of the European Union countries consuming pesticides, in 2010-2019. The highest pesticide consumption recorded in France was 85,072 tons of active ingredients (2018-2019), and the lowest consumption was 61,352 tons of active ingredients (2011). In 2019, in France, pesticide consumption increased by 37.4 2%, compared to 2010. Romania, in 2019, ranked 13th in the EU in terms of pesticide consumption. Malta recorded the lowest pesticide intakes during the analysis period. Here, the consumption varied between 89 -125 tons of active ingredients.

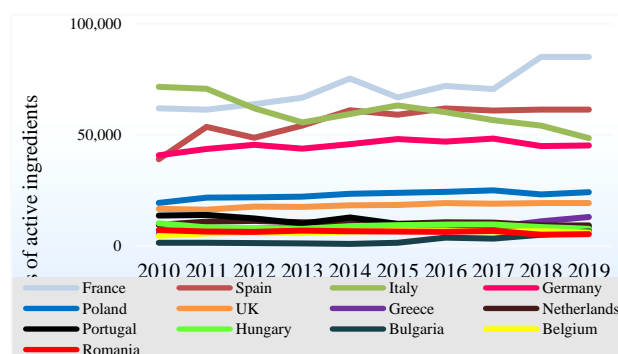


Fig. 7. Pesticides consumption (total) of the main consuming countries in the EU (2010-2019) (tons of active ingredient  
 Source: [6].

The consumption of insecticides in the consuming countries of the European Union has undergone changes during the period under analysis (Fig. 8).

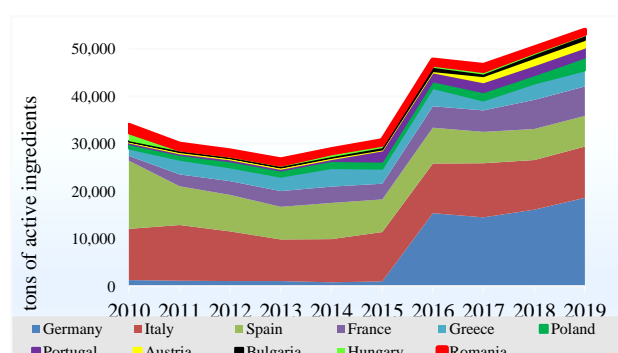


Fig. 8. Consumption of insecticides of the main consuming countries in the EU (2010-2019) (tons of active ingredient)  
 Source: [6].



In the case of insecticides, if we take into account the entire interval under analysis, from the presented statistical data it can be seen that Italy is the leader of the ranking in terms of the consumption of insecticides. The maximum quantity used was recorded in 2011 (11,795 tons of active ingredients), and the minimum amount was 8,713 tons of active ingredients (2013). In 2019, the amount of insecticides used in Italy decreased insignificantly (-0.23%), compared to 2010.

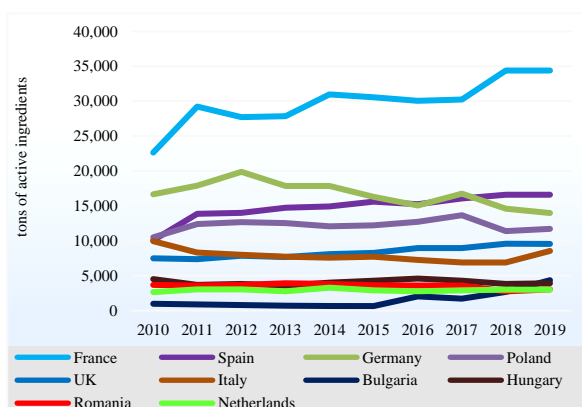


Fig. 9. Consumption of herbicides in the main states, 2010-2019 (tons of active ingredient)

Source: [6].

The consumption of fungicides and bactericides afferent to the main consuming countries in the European Union, recorded changes from one year to another, during the considered period (Fig.10).

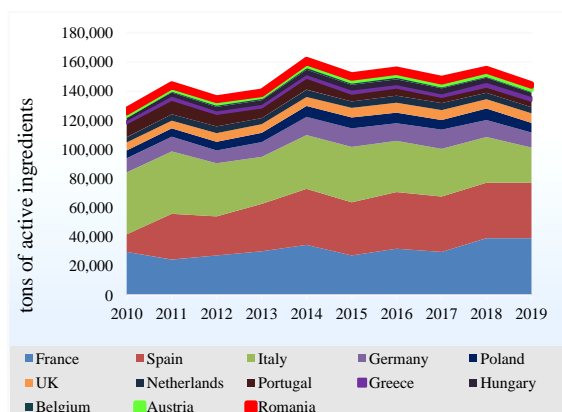


Fig. 10. Consumption of fungicides and bactericides of the main consuming countries in the EU (2010-2019) (tons of active ingredient)

Source: [6].

From the analyzed data regarding the consumption of fungicides and bactericides, it

resulted that France is the largest consumer of fungicides and bactericides in the period 2010-2019. The highest consumption of fungicides and bactericides recorded in France was 39,112 tons of active ingredients (2018-2019), and the lowest consumption was 24,532 tons of active ingredients (2011). In 2019, in France, the consumption of fungicides and bactericides increased by 31.12%, compared to 2010. On the second position in the top of the big consumers of fungicides and bactericides in the European Union is Spain. Here, the highest consumption of fungicides and bactericides was recorded in 2016 (38,919 tons of active ingredients), and the lowest consumption was 11,878 tons of active ingredients (2010). In 2019, in Spain, there was a substantial increase in the consumption of fungicides and bactericides by 220.48%, compared to 2010. The third place in this ranking is occupied by Italy. The highest consumption of fungicides and bactericides in Italy was 42,726 tons of active ingredients (2011). In Italy, in 2019, the consumption of fungicides and bactericides was substantially reduced, by 43.70% compared to 2010. On the following places in the ranking of the largest consumers of fungicides and bactericides are the following countries: Germany (+5.74% in 2019, compared to 2010); Poland (+25.33% in 2019, compared to 2010); UK (+18.13% in 2019, compared to 2010); Netherlands (+18.68% in 2019, compared to 2010); Portugal (-55.86% in 2019, compared to 2010); Greece (+85.86% in 2019, compared to 2010); Hungary (+22.30% in 2019, compared to 2010); Belgium (+35.13% in 2019, compared to 2010); Austria (+22.90% in 2019, compared to 2010).

Romania is on the 13th position in the ranking of countries consuming fungicides and bactericides. The largest amount of fungicides and bactericides consumed by Romania was 2,293 tons of active ingredients (2014), and the smallest amount consumed was 1,711 tons of active ingredients (2019). From the analyzed data, it was found that in Romania, in 2019, the amount of fungicides and bactericides consumed was reduced by 23.38%, compared to 2010. It was noted that

in 2019, Romania consumed only 4.37% of the amount of fungicides and bactericides consumed by France.

In Romania, the surface of the lands on which pesticides (insecticides, fungicides and herbicides) were applied, has changed from one year to another during the period under analysis (Fig. 11).

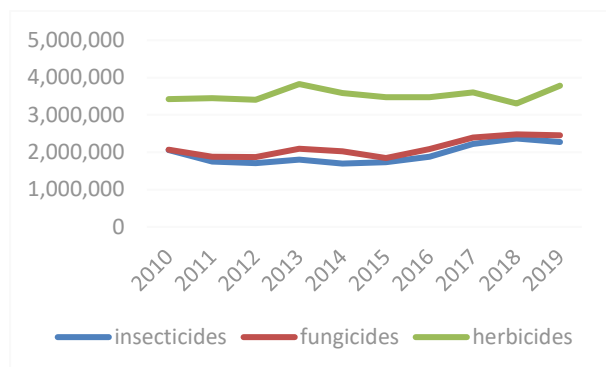


Fig. 11. The area of land on which pesticides were applied during 2010-2019 (ha)  
Source: [13].

The largest area of land on which insecticides were applied was recorded in 2018 (2,367,251 ha). In 2019, the area of land where insecticides were applied increased by 10.13%, compared to 2010. Regarding the surface of the lands where fungicides were applied, in Romania, it varied between 1,872,709 ha-2,478,309 ha. In 2019, the area of land on which fungicides were used increased by 18.77%, compared to 2010. Regarding the surface of the lands on which the herbicides were applied from the data presented in Figure 11 it can be easily seen that it recorded a series of oscillations. The most significant area on which herbicides were applied was recorded in 2013 (3,825,368 ha), and the smallest area was 3,304,749 ha (2018). In 2019, the area on which herbicides were applied increased by 10.55%, compared to 2010.

It should be noted that in Romania, the National Institute of Statistics presents data on only 3 categories of products from the class of pesticides, namely: insecticides, fungicides and herbicides.

In Romania, during 2010-2019, the quantities of insecticides, fungicides and herbicides recorded changes from one year to another

(Fig. 12). The highest amount of insecticides used in Romania was 1,327,660 kg of active ingredients (2019). At the opposite pole, the smallest amount of insecticides used was 590,021 kg of active ingredients (2019). In Romania, in 2019, the amount of insecticides decreased by 55.56% compared to 2010. This was due, on the one hand, to the increase in the prices of insecticides, and on the other hand, to the warnings made to farmers about the negative impact on health, due to the use of insecticides in agriculture [9].

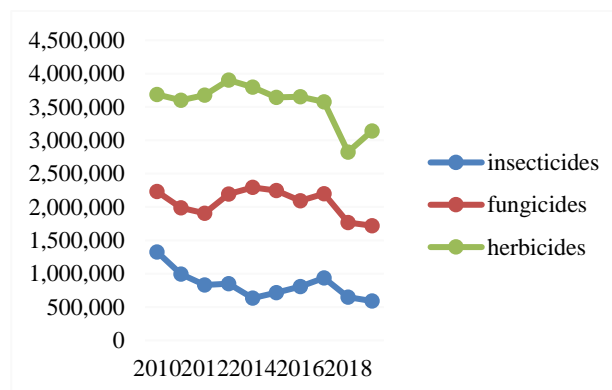


Fig. 12. Pesticide quantities applied in the period 2010-2019 (kg of active ingredients)  
Source: [13].

From the data presented in Figure 12, we can observe oscillations from one year to another regarding the consumption of fungicides recorded in agriculture. The most significant amount of fungicides used in agriculture was in 2014 (2,293,286 kg of active ingredients). The lowest amount of fungicides used was 1,720,401 kg of active ingredients (2019). The amount of fungicides used in Romania in 2019 decreased by 22.94%, compared to 2010. The quantity of herbicides used in the Romanian agriculture recorded changes from one year to another during the period under analysis. The highest herbicide consumption recorded in Romania was 3,903,714 kg of active ingredients (2013), and the lowest consumption was 2,824,733 kg of active ingredients (2018). In 2019, herbicide consumption decreased in Romania by 14.82%, compared to 2010. From the data presented and analyzed, it is found the reduction of the consumption of insecticides, fungicides and herbicides in Romania, in 2019, compared to 2010. It is necessary to

specify that in 2019, compared to 2010, there was an increase in the area of land on which pesticides were applied.

In 2019, according to the published statistical data, the consumption of products from the pesticide class, at the level of the Development Regions in Romania, was as follows:

-*insecticides*- the first three Regions, which used more than half of the entire amount, were: South-West Oltenia (127,696 kg of active ingredients); South-East (90,686 kg of active ingredients) and West (88,044 kg of active ingredients);

-*fungicides*- the first three consuming regions were, in order: South-East (423,945 kg of active ingredients); North-East (354,660 kg of active ingredients) and Centre (291,708 kg of active ingredients), and the quantities used accounted for 62.21%;

-*herbicides*- the main consuming regions, whose used quantities amounted 57.43%, were: North-East (764,364 kg of active ingredients), West (552,575 kg of active ingredients) and South-East (487,569 kg of active ingredients).

In Romania, according to official statistical data, in 2016, the following were sold: 4.5 million kg of bactericides and fungicides; 5 million kg of herbicides and over 700,000 kg of acaricides and insecticides [11].

In the period 2010-2020, the decreasing trend of the amount of insecticides used is observed. Thus, according to the determined linear model, the average annual decrease in the amount of insecticides is 51,908 kg of active ingredients/year (Fig. 13).

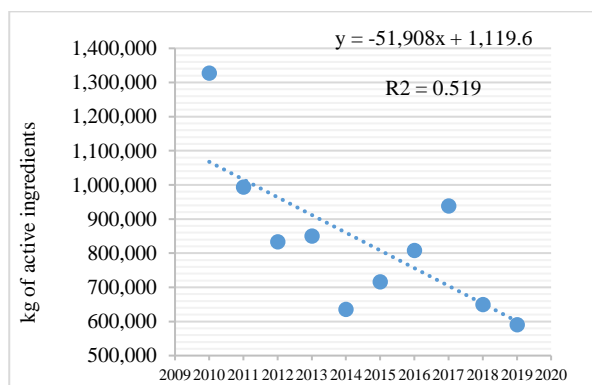


Fig. 13. Dynamics of the amount of insecticides used in Romania (2010-2019) (kg of active ingredients)  
Source: Own processing based on NIS data [13].

In the period 2010-2020, the slightly decreasing trend of the amount of fungicides used is observed. Thus, according to the determined linear model, the average annual decrease in the amount of fungicides is 30,517 kg active ingredients/year (Fig.14).

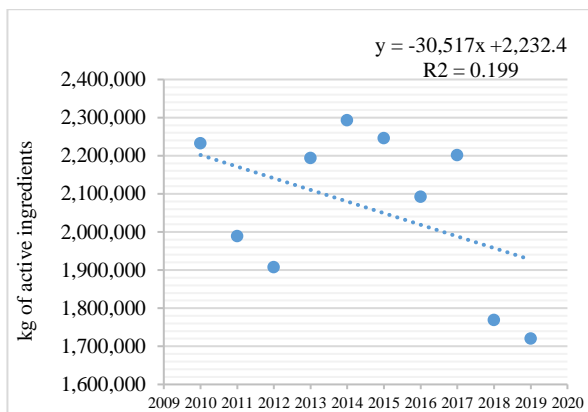


Fig. 14. Dynamics of the amount of fungicides used in Romania (2010-2019) (kg of active ingredients)  
Source: own processing based on NIS data [13].

During 2010-2020, the decreasing trend of the amount of herbicides used is observed. Thus, according to the determined linear model, the average annual decrease in the amount of herbicides is 71,288 kg of active ingredients/year (Fig.15).

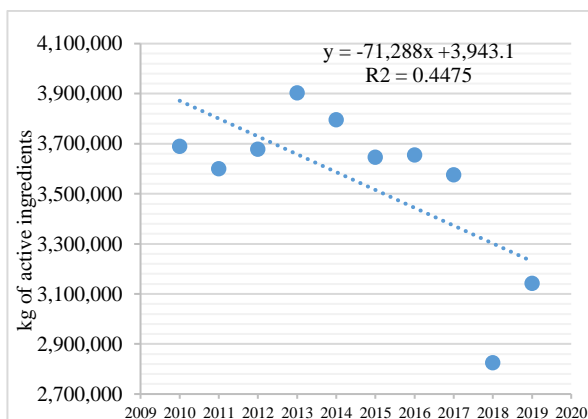


Fig. 15. Dynamics of the quantity of Herbicides used in Romania (2010-2019) (kg of active ingredients)  
Source: own processing based on NIS data [13].

In Table 1, there are highlighted the main importers of pesticides in the period 2017-2019, registered worldwide. From the data presented in Table 1, it is easily found that the first position in the ranking of pesticide importers is occupied by Brazil. Brazil's quantitative imports of pesticides have been



on an upward trend. The largest amount of pesticides imported was in 2019 (397,617 tons). In Brazil, in 2019, quantitative imports increased by 37.44%, compared to 2017. The second position in this ranking is occupied by France. The most significant imports of pesticides made by France were in 2017 (285,521 tons). In 2019, France's quantitative imports of pesticides decreased by 25,432 tons compared to 2017. France in 2019 imported only 65.41% of the quantity of pesticides imported by Brazil in the same year.

Table 1. Main importers\* of pesticides worldwide, 2017-2019 (tons)

Position	Importers	Years		
		2017	2018	2019
1	Brazil	289,288	339,005	397,617
2	France	285,521	269,712	260,089
3	Canada	307,981	247,380	235,071
4	Germany	195,928	195,636	201,466
5	USA	-	-	187,814
6	Belgium	157,482	162,946	153,172
7	Nigeria	No Quantity	147,446	152,651
8	Thailand	222,303	193,221	149,782
9	UK	146,854	160,165	140,942
10	Spain	140,528	136,827	133,516
11-25	....	-	-	-
26	Romania	49,759	55,464	55,941

Source: [8], \*quantity 2019.

On the third place in the top importers of pesticides is ranked Canada. Here, the most significant imports of pesticides were made in 2017 (307,981 tons).

It is noticed that in 2019, the quantitative imports of pesticides made by Canada decreased by 72,910 tons, compared to 2017. Canada, in 2019, imported only 59.11% of the amount of pesticides imported by Brazil. The following places in the top 10 importers of pesticides highlighted worldwide in 2019, are occupied by: Germany (201,466 tons); USA (187,814 tons); Belgium (153,172 tons); Nigeria (152,651 tons); Thailand (149,782 tons); UK (140,942 tons) and Spain (133,516 tons). In the extended top of pesticide importers registered worldwide is Romania. It was positioned in the range under analysis on the 26th position. Imports of pesticides

related to Romania recorded an increasing trend in the period 2017-2019.

From a quantitative point of view, Romania's imports of pesticides recorded a maximum in 2019 (55,941 tons). In 2019, pesticide imports related to Romania increased by 12.42%, compared to 2017. Romania, in 2019, imported only 14.06% of the quantity of pesticides imported by Brazil in the same year.

Table 2 presents the main partners from which Romania imported pesticides, during 2017-2019. The largest quantities of pesticides imported by Romania came from France. This fact was expected, because, on the one hand, France is part of the European Union, and on the other hand, it is on the fourth position in the top of pesticide exporters registered during 2017-2019. The largest quantity of pesticides imported by Romania from France was 11,066 tons (2019). The quantities of pesticides imported by Romania from France increased by 7.75%, in 2019, compared to 2017. Romania imported 2.46% of the total amount of pesticides exported by France in 2019. Germany is Romania's second partner, in terms of quantitative imports of pesticides. From Germany, Romania imported the largest quantity of pesticides in 2018 (7,937 tons). In 2019, the imports of pesticides from Germany decreased compared to 2018, by 5.91%. In 2019, Romania imported 1.57% of the total quantity of pesticides exported by Germany. The most significant amount of pesticides imported by Romania from Belgium was 6,122 tons (2018). In 2019, Romania imported 1.33% of the quantity of pesticides exported by Belgium. In 2019, Romania imported the largest quantity of pesticides from Spain, of 4,059 tons. Imports of pesticides from Spain increased in 2019 by 1,069 tons, compared to 2017. The largest quantity of pesticides imported from Poland by Romania was 4,024 tons (2019). Romania, in 2019, imported over 57.0% of the total quantity of pesticides from: France; Germany; Belgium; Spain and Poland.

Table 2. The main partners\* from which Romania imported pesticides, 2017-2019 (tons)

Specification	2017	2018	2019
France	10,270	10,198	11,066
Germany	6,772	7,937	7,468
Belgium	4,719	6,122	5,336
Spain	2,990	3,380	4,059
Poland	1,903	2,977	4,024

Source: [8], \*quantity 2019.

In Table 3, there are presented the main exporters of pesticides registered worldwide, in the period 2017-2019. From the data presented in the table below, it can be seen that the leader in terms of pesticide exports is China. During the analyzed period, the exports of pesticides made by China have changed from one year to another. China's largest pesticide exports were 1,632,281 tons (2017) and the lowest were 1,468,275 tons (2019). China's quantitative exports of pesticides in 2019 decreased by 164,006 tons compared to 2017.

Table 3. The world's leading exporters\* of pesticides, 2017-2019 (tons)

Position	Exporters	Years		
		2017	2018	2019
1	China	1,632,281	1,490,373	1,468,275
2	Germany	471,734	465,754	475,567
3	India	415,699	442,740	460,959
4	France	415,182	418,326	448,091
5	USA	477,006	435,447	421,937
6	Belgium	436,835	420,700	398,719
7	UK	156,912	170,024	193,620
8	Spain	166,121	178,265	182,102
9	Netherlands	115,549	120,464	118,497
10	Italy	103,965	95,739	89,996
11-39	....	-	-	-
40	Romania	7,758	10,751	11,093

Source: [8], \*quantity 2019.

The second place in the top of pesticide exporters is occupied by Germany, but at a significant distance from China. Germany's exports of pesticides have changed from one year to the next. The largest exports of pesticides were recorded in 2019 (475,567 tons). From the data presented, it can be seen that, in 2019, Germany's quantitative exports of pesticides increased by 0.81%, compared to 2017. Germany exported to the international

market in 2019, only 32.38% of the amount of pesticides exported by China in the same year. On the 3rd place in the top of pesticide exporters registered worldwide is India. During the analyzed period, India's quantitative exports registered an upward trend. The highest quantity of pesticides exported by India was recorded in 2019 (460,959 tons). At the opposite pole, the smallest amount of pesticides exported was 415,699 tons (2017). India, in 2019, increased the quantitative exports of pesticides to the international market by 45,260 tons, compared to 2017. In 2019, India exported only 31.39% of the pesticides exported by China in the same year. The following places in the ranking of the top 10 pesticide exporters registered worldwide in 2019 are occupied by: France 448,091 (tons); USA (421,937 tons); Belgium (398,719 tons); UK (193,620 tons); Spain (182,102 tons); Netherlands (118,497 tons) and Italy (89,996 tons). From the data presented in Table no.3, it is found that Romania ranks 40th in the extended ranking of pesticide exporters registered worldwide. During the analyzed period, Romania's exports of pesticides were on an upward trend. The largest quantitative exports of pesticides were 11,093 tons (2019). Romania's pesticide exports in 2019 increased by 3,335 tons compared to 2017. Romania exported to the international market, in 2019, only 0.75% of the quantity exported by China in the same year. From the data presented and analyzed, it appears that Romania is not an important player on the international market of pesticides.

Table 4 presents the main markets for pesticides exported by Romania during 2017-2019. From the data presented in the table below, it can be seen that the exports of pesticides made by Romania recorded changes during the analyzed period. The largest exports of pesticides were directed to the Bulgarian market. The largest quantity of pesticides exported to Bulgaria was 4,693 tons (2018). In 2019, the quantity of pesticides exported to Bulgaria decreased by 22.74%, compared to 2018. Another market for Romanian pesticides was in the analyzed period, the Republic of Moldova. The amount

of pesticides exported to the Republic of Moldova varied between 1,425 tons and 1,930 tons. In 2019, pesticide exports to the Republic of Moldova market decreased by 8.19%, compared to 2018. In 2019, Romania exported to the Republic of Moldova only 48.86% of the quantity of pesticides exported to Bulgaria in the same period.

Table 4. The main partners\* to which Romania exported pesticides, 2017-2019 (tons)

Specification	2017	2018	2019
Bulgaria	3,336	4,693	3,626
Republic of Moldova	1,425	1,930	1,772
UK	292	580	720
Hungary	534	736	677
Germany	315	376	668

Source: [8], \*quantity 2019.

The quantitative exports of pesticides that were oriented to the UK market registered an upward trend during the analyzed period. The most significant quantity of pesticides exported to the UK was in 2019 (720 tons). In 2019, Romania's pesticide exports oriented to the UK market increased by 146.57%, compared to 2017 and by 24.13%, compared to 2018. Romania exported in 2019 to the UK, only 19.85% of the quantity exported to Bulgaria in the same period. Another partner of Romania, in terms of pesticide exports between 2017 and 2019, was Hungary. Exports of pesticides oriented to the Hungarian market have seen changes from one year to the next. In 2018, a maximum of exports oriented to Hungary was recorded, of 736 tons. In 2019, quantitative exports of pesticides to Hungary decreased by 8.02%, compared to 2018. Germany is on the last place, in terms of Romania's main partners for pesticide exports. During the period under analysis, pesticide exports to Germany recorded an upward trend. The highest amount of pesticides exported was 668 tons (2019). The exports of pesticides made by Romania to Germany increased by 112.06%, in 2019, compared to 2017. Romania, in 2019 exported to the main 5 markets analyzed, 7,463 tons of pesticides. From the data presented in Table 4 it can be easily ascertained that Romania's exports of

pesticides have been oriented to markets in Europe.

## ACKNOWLEDGEMENTS

We thank the referees for all the data provided for this paper. The publication of this article was possible thanks to the Project no. 182/23.11.2021, Impactul socio-economic al aplicării strategiei FARM TO FORK în agricultură și transpunerea în România (The socio-economic impact of the application of the FARM TO FORK strategy in agriculture and transposition in Romania) contracted with "Asociația Producătorilor de Porumb din România" (Romanian Corn Producers Association).

## CONCLUSIONS

Currently, there is a special emphasis on reducing pesticide pollution. This directly contributes to the protection of biodiversity, which on the one hand, maintains a high soil quality, and on the other hand, influences food security. Following the analysis of the main indicators related to the use and marketing of pesticides, the following conclusions were drawn for the period 2010-2019:

- In France the highest consumption of pesticides was 85,072 tons of active ingredients (2018-2019);
- The most significant consumption of insecticides and bactericides was recorded by France between 2018-2019 (39,112 tons of active ingredients);
- In 2018, in Romania, the largest area of land on which insecticides were applied was recorded (2,367,251 ha);
- In Romania, in 2019, there was an increase of 18.77% compared to 2010, of the land areas on which fungicides were applied;
- In 2013, at national level was registered the largest area on which herbicides were applied, of 3,825,368 ha;
- In 2019, in Romania was recorded the highest consumption of insecticides, of 1,327,660 kg of active ingredients;
- In 2014, internally, the highest consumption of fungicides was observed, of 2,293,286 kg of active ingredients;

-The most significant consumption of herbicides highlighted in Romania was in 2013 (3,903,714 kg of active ingredients);

-At the level of the development regions, the quantity of pesticides used during the analyzed period recorded changes

-In Romania, in 2020, the volume of pesticide sales decreased by 20% compared to 2011;

-Brazil is the world's largest importer of pesticides. The most significant quantity imported was 397,617 tons (2019);

-Romania imported the most significant quantities of pesticides from France during the analyzed period;

-China is the world's largest exporter of pesticides. In 2017, China exported 1,632,281 tons of pesticides;

-Romania exported in 2018, the largest quantity of pesticides to Bulgaria (4,693 tons). In our opinion, the double challenge for farmers is obvious: on the one hand, reducing the amount of fertilizers used, and on the other hand, reducing pesticides used in agriculture. These two aspects mentioned previously will contribute to the achievement of sustainable agriculture. Will farmers be able to face the new challenges of sustainability requirements, ensuring food security and business continuity?

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