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APPLICATION OF THE PRINCIPLES OF THE CIRCULAR ECONOMY IN CONVENTIONAL AGRICULTURE. CASE STUDY - PESTICIDE WASTE RECYCLING

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Abstract

Conventional farming systems have been an alternative given that global population growth has been accompanied by an increase in food needs, and areas for production have not been able to keep pace with growth. But the practice of conventional agriculture is the one that, along with other ways of aggressive exploitation of natural resources, economic development, has contributed to environmental degradation and resource depletion. Under these conditions, alternative solutions were sought both to reduce the pressure on the environment, but also to obtain healthier foods that would thus contribute to improving human health. Organic farming, sustainable agriculture, uses principles that have been applied for a long time, but with the advent of the concept of circular economy, as a way to reduce pollution and improve the health of the planet, have been sought solutions for its application in agriculture conventional. In this paper we aim to analyze the current situation of the use of pesticides in agriculture, as an important source of pollution, as well as the possibilities of implementing the principles of circularity in their use, given their high degree of toxicity. The working methodology involved the collection of existing data in national databases, as well as in international ones on the quantities of pesticides sold, the quantities of packaging resulting from their use, but also the possibilities of collection and recycling, as a way of applying recircularity. Based on the processed, analyzed and interpreted data, conclusions were formulated that could be the basis for establishing measures regarding the implementation of efficient circularity systems in agriculture.

Key words: *circular economy, conventional agriculture, pesticides, recycling, collection*

INTRODUCTION

The circular economy is a concept that can no longer be considered a novelty, but which is beginning to gain more and more visibility in the context of the pressure that climate change issues have on the political and economic environment, but also on the planet's inhabitants who are increasingly concerned about the effects that uncontrolled consumption, unsustainable practices and irresponsibility have on the environment. The concept of circularity has been discussed since 1976, with over a hundred definitions of the circular economy, but it was developed in 2013 by the Ellen MacArthur Foundation, which sought to develop a new consumption model that deviates from linearity0 and which can use sharing, reuse, repair, renovation and recycling so that the life cycle of the products is as long as possible, and the resulting amount of waste is as small as possible [14]. If the linear economy uses the principle "take-produce-use-throw", the circular economy model wants to transform waste into resources through a more efficient use of them, the effects being to reduce the pressure on the environment and increase sustainability. At the same time, the application of the principles of the circular economy could be measured in terms of increasing the economic efficiency of the activity, increasing the competitiveness of companies, developing innovation, creating new jobs, which will ultimately reduce the negative impact on environment [10]. Therefore, the circular economy means more than reducing the amount of waste, it means closing the consumption loop.

At the level of the European Union there were initiatives regarding the application of the circular economy model, initiatives that continued in 2020 in order to increase sustainability through the implementation of the European Green Pact, in which there is an Action Plan for the circular economy seeks solutions to ensure investment and financing instruments that ensure the European Union the possibility, by 2050, to be neutral in terms of its impact on the environment [5].

Given that in 2020 only 12% of the materials and products used are reintegrated into the production process, the measures aim to make sustainable products a rule in the European Union market, providing consultants to European citizens who can make sustainable choices, will aim to produce as little waste as possible and will also introduce measures in resource-consuming industries with a high potential for recirculation that are both highly polluting.

Agriculture is thus one of the most important sources of pollution on the planet, it is among the five sectors producing greenhouse gases, along with transport, electricity production, industry, trade and household consumers [3, 7]. The company with the food industry produced in 2020 greenhouse gases which accounted for 21% of the total and a carbon footprint of 6500 million tons [4].

Agriculture is also one of the important sources of plastic waste production. The growth of these uses has increased over the last 70 years, but studies show that by 2050, as the population grows, so will the amount of plastic used, by about 30% [16].

Therefore it is necessary to find solutions that contribute in addition to reducing the quantities of packaging using and a reuse of them. In the case of pesticides, this imposes certain limits due to their continuation with high toxicity, which does not allow a calcium recycling. But measures could be taken to collect the resulting waste and speed up the degradation process.

The circular economy also has its limits which are related primarily to the fact that it requires high investment, and on the other hand related to the relatively low transfer of knowledge between users [2].

MATERIALS AND METHODS

To measure the potential application of the principles of circularity for conventional agriculture, in this paper we aimed to analyze one of the activities with a high impact on the environment, namely the use of pesticides (fungicides, insecticides and herbicides) and how the resulting waste can be integrated in circularity.

Various indicators have been taken into account that allow comparisons to be made between European Union countries and that can provide a clearer picture of the concept analyzed, namely: pesticide sales for the period 2015-2019, the amount of waste resulting, the amount of waste collected, amount of waste recycled.

In order to follow the evolution of the analyzed indicators, we used fixed-base indices, determined as follows:

$IFB = (x_n / x_1) * 100$, [1]

where:

x = variable under study,

n = 1,2,3 ... n, chronological series of years.

RESULTS AND DISCUSSIONS

The analysis of the data regarding the use of pesticides in the agriculture of the countries belonging to the European Union highlights the fact that despite the discussions regarding the sustainable development, their average quantity did not decrease much in the analyzed period.

We find that for countries such as Bulgaria, Cyprus and Finland, the quantities traded increased during the entire analyzed period, the highest increase being registered in Finland, this increase being 12.6 times higher in 2019 compared to 2015.

Continuous decreases in the quantities of pesticides sold were registered in Croatia (-50% in 2019 compared to 2015), in the Czech

Republic (-22%), Denmark (-13%), Italy (-38%), Lithuania (- 22%) and Sweden (-59%). For the other countries, the quantities of fish sold fluctuated in the period 2015-2019. We find that the total amount of pesticides sold in European Union countries in 2019 was about 400,000 tons. Some of these pesticides are used for non-agricultural purposes but the statistics do not show this, there are no data on these values.

Table 1. Quantity of pesticides sold in E.U. countries in the period 2015-2019 (tons, active substance)

Country	2015	2016	2017	2018	2019
Austria	2,130.73	2,006.54	1,991.63	2,668.65	:
Belgium	2,611.18	2,856.22	2,495.88	2,457.91	2,449.42
Bulgaria	619.02	1,048.88	1,287.45	1,798.03	1,578.54
Cyprus	776.93	365.93	817.95	823.46	867.43
Croatia	1,315.18	932.01	727.13	767.23	656.07
Czech Republic	2,109.34	1,785.21	1,853.69	1,755.14	1,650.88
Denmark	504.01	406.71	483.73	438.35	:
Estonia	109.27	104.39	117.03	106.54	104.92
Finland	224.68	3,212.36	3,227.75	3,814.41	2,831.62
France	27,373.71	31,971.20	29,786.23	39,086.67	24,404.95
Germany	12,817.36	12,140.88	13,266.13	11,681.86	10,217.44
Greece	1,926.97	1,803.57	1,685.87	1,728.71	1,755.82
Hungary	3,867.89	3,835.02	4,170.52	3,535.07	2,796.08
Ireland	687.73	596.57	633.47	601.99	:
Italy	39,186.66	36,851.94	32,686.89	31,538.59	24,285.68
Latvia	269.84	261.97	266.54	212.65	:
Lithuania	736.75	741.17	690.12	676.67	575.04
Luxemburg	:	:	:	:	:
Malta	118.65	83.52	101.94	82.51	69.78
Netherlands	4,413.10	4,870.37	4,724.86	4,288.41	:
Poland	7,737.60	7,534.41	6,927.32	7,991.71	6,867.38
Portugal	5,193.43	5,473.57	4,133.62	4,335.17	:
Romania	4,142.49	4,525.81	4,600.28	4,145.91	4,020.81
Slovakia	639.21	640.14	685.33	676.11	652.51
Slovenia	759.24	859.61	794.73	849.03	751.78
Spain	36,423.29	38,905.11	37,982.03	38,067.06	34,073.75
Sweden	398.17	249.03	264.77	222.58	164.28
United Kingdom	6,032.36	5,330.00	5,484.05	4,492.46	6,056.98

Source: own processing [6].

Pesticide consumption depends on climatic conditions and the characteristics of agricultural systems, so this consumption cannot be reported in the same way for all countries analyzed. Moreover, the quantities traded do not imply their consumption in the agriculture of the respective country, so that a part of the quantities cannot be attributed to them.

In Romania, the country where agriculture is an important branch of agriculture, on the one hand due to the labor force employed in this branch of the economy [8], and on the other hand to its contribution to GDP [9], pesticide consumption is a high one. Thus, Romania is among the first six countries of the European Union in terms of pesticide consumption. The data show that the amount used in 2019 decreased by 3% in 2019 compared to 2015 and by 13% compared to 2017, the year in which the highest consumption of pesticides in the analyzed period was recorded (4,600 tons - active substance).

Ecological agriculture, as a form of agricultural practice and which works on the application of the principles of the circular economy, contributes in turn to the protection of the environment and to the sustainability of the activities carried out. Although Romania has potential for this niche, in 2019 organic farming had only a share of only 5% of total agricultural production [15].

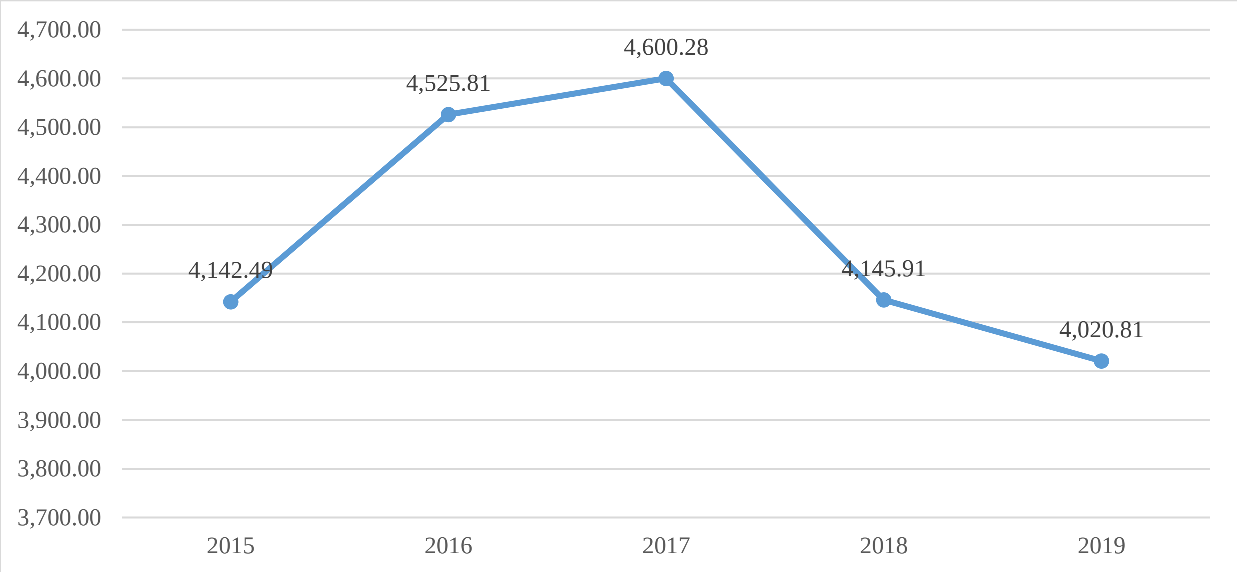

Fig. 1. Quantity of pesticides sold in Romania in the period 2015-2019 (tons, active substance)
Source: own processing [6].

The share of pesticides, by categories, sold in Romania in 2019, in tons shows that 74% of the quantity sold is represented by fungicides, 13% by insecticides, 9% by herbicides and 4% by other categories of plant protection products (Figure 2).

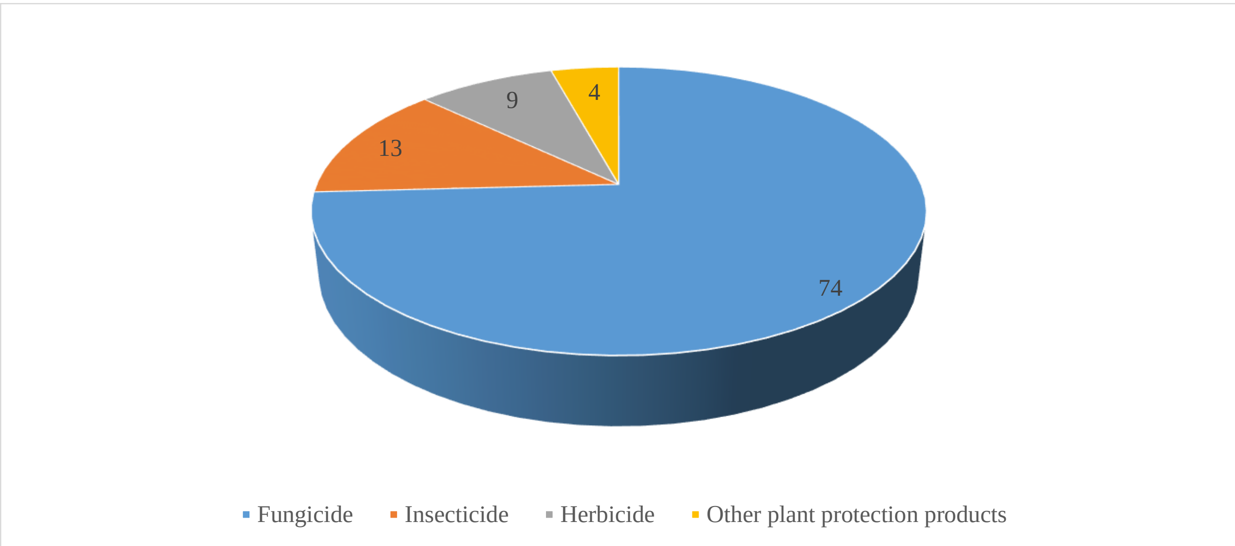

Fig. 2. Distribution of pesticides sold, in tons, in Romania, in 2019 (%)
Source: own processing [11].

The share of liquid pesticides, sold in Romania in 2019, expressed in liters was represented by 58% herbicides, 29% fungicides, 13% insecticides and 3% other phytosanitary protection products. The amount of pesticides, by groups and categories, expressed in active substance, was lower by 18.5% in 2019 compared to 2018.

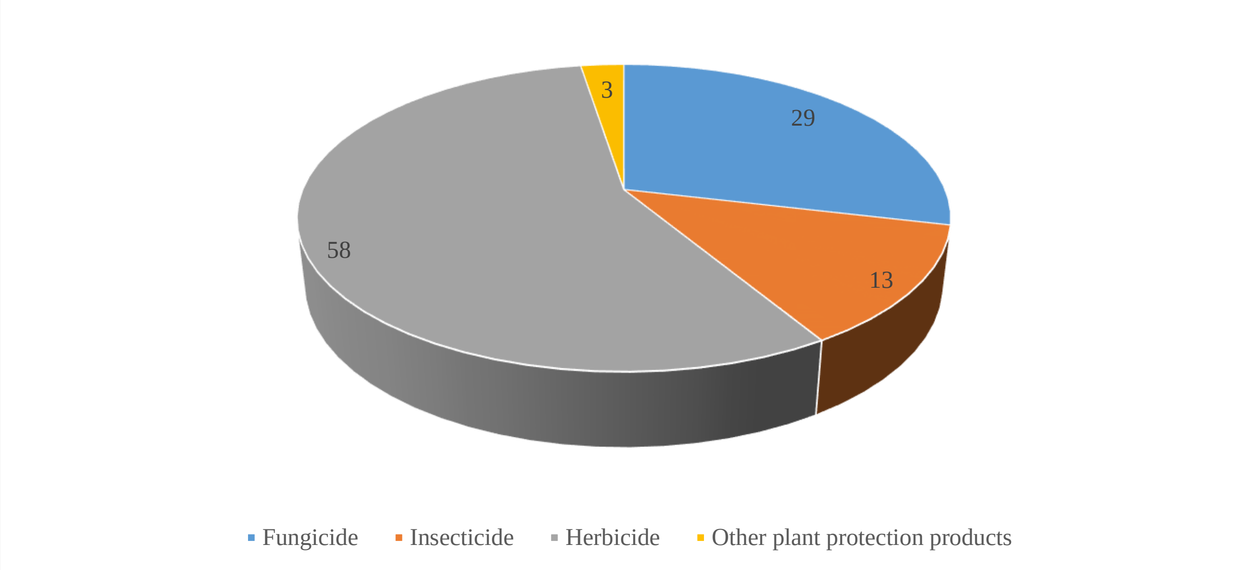

Fig. 3. Distribution of pesticides sold, in liters, in Romania, in 2019 (%)
Source: own processing [11].

Analyzing the structure of pesticides from the point of view of their chemical class, for 2019 the largest share of quantities sold is represented by fungicides based on conazole (9%), organophosphorus herbicides (9%), herbicides based on phenoxy radicals (8 %), dithiocarbamate-based fungicides (8%), chloroacetanilide-based herbicides (6%), inorganic sulfur (4%), copper compounds (4%), phthalamide-based fungicides (4%), fungicides on amide-based (4%), pyridyl-methylamine-based insecticides (3%) and amide-based herbicides (3%).

Given the impact that pesticides have on the environment, the pressure related to their collection and recycling is quite high but it faces many problems. At European level, pesticide producers are the ones who have started procedures for collecting pesticide packaging, but there are many other alternatives related to this waste, such as burying it, burning it, dumping it in landfills, which contributes to a on the other hand to the pollution of the environment, and on the other hand to the increase of the risks related to the human health.

At the international level there are regulations regarding both the recycling of packaging resulting from the use of pesticides and their use. For example, the use of these materials for the manufacture of products used in direct contact with humans is prohibited. The traceability of these products is very important, and the lack of clear procedures contributes even more to the development of the recycling system.

At the level of the European Union, important figures have been advanced regarding the collection and recycling process. Thus, the producers aimed to ensure the collection of a share of 80% of the packaging until 2022 and the recycling of a share of 70% of them.

The quantities collected and recycled of waste resulting from the use of pesticides in the period 2010-2017 show that their amount increased during the analyzed period. Thus in 2010 the amount of waste collected was from 551 tons, and in 2017 the amount was 1050 tons.

The increase in 2017 was 91%, compared to 2010. It is found that starting with 2012, the recycling process of this waste has started, with increases in the quantities processed. In 2013 the increases compared to 2012 were 4.3 times, in 2014 6.5 times, in 2015 6.9 times, in 2016 11.3 times, and in 2017 12.3 times (Figure 4).

The specialized companies ensure the free collection of these packages in case they are decontaminated [12].

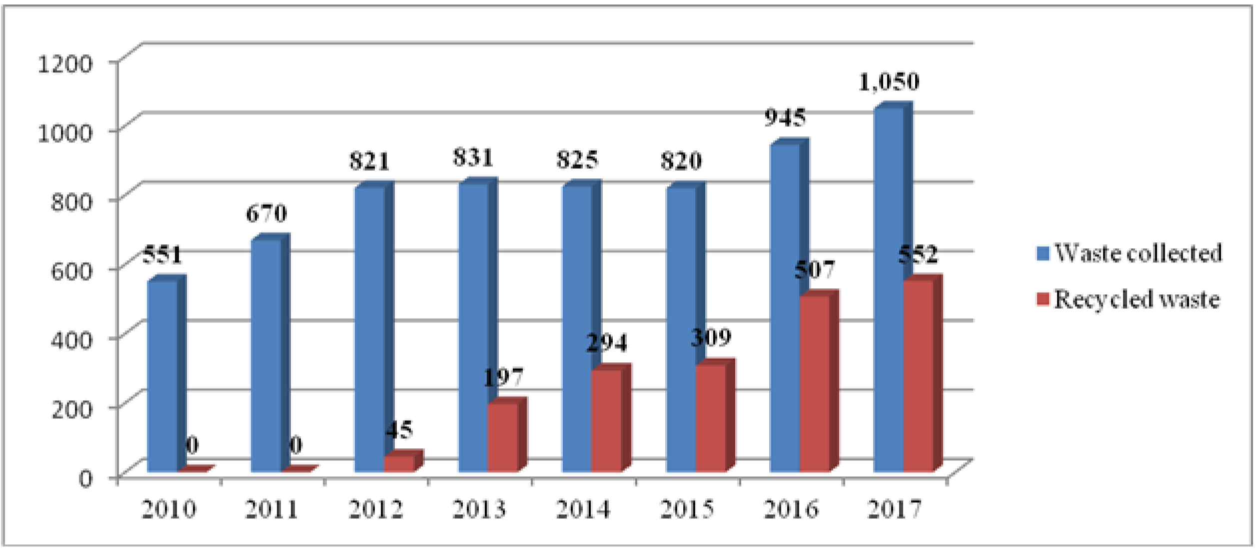

Fig. 4. Evolution of the quantities of pesticide waste collected and recycled (tone)
Source: own processing [13].

Compared to this situation, it is found that there are important uncollected quantities, although their quantity decreased during the analyzed period. Thus, in 2017 compared to 2010, the uncollected quantities decreased by 41%. The smallest quantity left uncollected was registered at the level of 2016, the quantity being 181 tons.

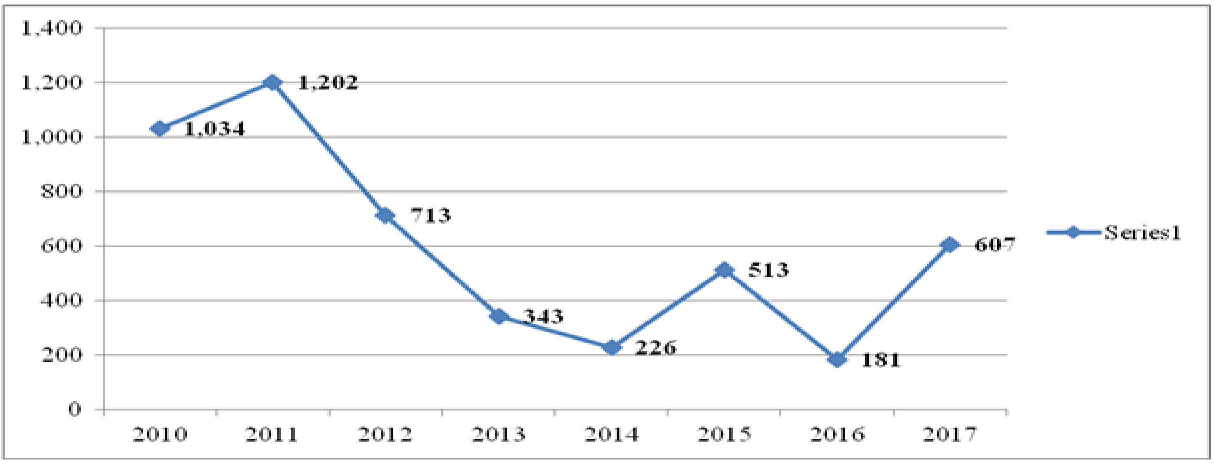

Fig. 5. Evolution of quantities of uncollected pesticide waste in the period 2010-2017 (tons)
Source: own processing [11].

CONCLUSIONS

Recycling is one of the central elements of the circular economy, and its application in agriculture, as well as in the entire consumption circuit could contribute to improving aspects related to environmental protection. In fact, the application of the principles of the circular economy in agriculture is an objective proposed by the policies of the European Union. However, we find that this is not easy to achieve without implementing a traceability of waste resulting from agricultural activities. We have shown in the paper that although the quantities of pesticides can be tracked, the location of their use is more difficult to track due to the fact that they are procured from different sources existing on European territory.

If collection problems could be implemented, there are problems related to the recycling of agricultural waste due to their toxicity. But a well-developed system could have favorable effects not only on environmental sustainability, but also on farm costs, as a result of avoiding some of them.

And yet recycling and reusing waste from pesticide use is not easy. One of the most important issues regarding the recycling of toxic materials, including pesticide waste, is to make the circular loop "toxic" due to the fact that recycled products could be dangerous to human health. The reality showed that such dangerous substances were found in products obtained from recycled materials, the risk being extremely high for health (cancer production, genetic mutations, etc.). This has led to tensions over the use of this category of materials, but when we refer to recycling, this involves not only processing, but also trying to reduce their toxicity, more responsible handling and reuse in complementary areas.

Although the application of the principles of the circular economy has its limits, the proven advantages are economic (such as reducing costs or increasing investment), social (such as increasing household income or increasing employment), but primarily environmental. Therefore, all these support the concept of circular economy, the need to move from the linear model to the circular model being not only useful, but necessary and mandatory if we want future generations to benefit in turn from a clean planet.

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