AGRICULTURAL CHEMISTRATION IN THE CONTEXT OF SUSTAINABLE DEVELOPMENT OF ROMANIAN AGRICULTURE

M.C., CUCU[1], Ioana, PANAIT[1]
[1]The Bucharest University of Economic Studies
Corresponding author: cmc.catalin02@gmail.com

Abstract. *In Romania, approximately 98% of the agricultural area is cultivated in a conventional system, which indicates the fact that it is an important consumer of chemicals used in agriculture. The use of chemicals as well as the increase in the degree of technical endowment have led to improved yields per hectare and in some cases even doubled production, however, although food security is becoming an easier goal to achieve, food security is becoming a vulnerable target. chemicals. The purpose of the study is to determine the trend of the use of chemicals in Romanian agriculture and to highlight their impact on the sustainable development of the agricultural sector. The article presents a quantitative analysis of the statistical data collected and processed to determine as accurately as possible the situation of Romania in terms of agricultural chemicalization. The importance of the study stems from the fact that sustainable development is a concept that has gained more and more ground recently and reducing the amount of chemicals in agriculture is an important goal. The European Union's strategy for 2030 is to reduce fertilizer consumption by 20% and reduce the use of hazardous pesticides by 50%. The research results reflect the evolution of the quantities of chemicals used in Romanian agriculture, analyze the trend of the main agricultural regions, and determine the relationship between the degree of chemicalization and the yield of agriculture.*

Keywords*: sustainable use, food safety, rationalization*

INTRODUCTION

In order to improve crop yields, the intensive use of pesticides have been used, which help the plants to offer an increased and quality production. Pesticides have the role of reducing disease and fighting pests to protect the plant to ensure high yields, but excessive use of pesticides harms the environment, these are chemicals that used also emit greenhouse gases.

According European Commission (EC), pesticides are the products that prevents or eliminates the diseases or pests and contain active substances which supports the plant to grow harmoniously. Below in table 1 is a list of the main products that fall into the category of pesticides.

Table 1

Types of pesticides

Fungicides	Acaricides	Molluscicides	Nematicides	Rodenticides
Herbicides	Insecticides	Biocides	Growth Regulators	Repellents

Source: European Commision, 2020

If until 1989 the agricultural chemicalization was carried out under the careful monitoring and recommendation of the state, then, through the re-ownership process, the chemicalization process (substances, quantities and application) passed to the private sector or small farmers, the state being forced to develop, with an emphasis on the concept of

sustainable development, methods and regulations for monitoring chemicals and quantities used in agriculture. (Anghelache, 2018)

The chimization in agriculture has been and is a solution of food security, but this emphasizes the quantity-quality ratio, therefore the aim is to use as much natural fertilizers, ecologically certified pesticides and varieties and hybrids as resistant. (Sincari,

Pests have begun to be resistant to chemicals used to control them and even to migrate to other plants, so ongoing research is needed to update information and find new solutions to protect plants and research and innovation are important, but they must be adapted to the conditions and requirements of Romanian agriculture. More and more pesticides have been developed, and phytosanitary are a well-developed market in all Member States, which are products needed for plant cultivation, including organic production that allows the use of organic substances.

Small farmers do not have the necessary knowledge regarding the rational use of pesticides, they apply high amounts of substances that end up harming production, but also the environment. Excessive use of pesticides and non-compliance with the residual period leads to the identification of traces of residues in agri-food products, especially in the case of fresh fruits and vegetables. At European level, maximum limits have been set for the amount of pesticides that can be present in food, named as maximum residue level however for the exact control and evaluation of the level of pesticides used, plant health and environmental protection by reducing greenhouse gases and pollution due to chemical contaminants are points of interest that must be considered when it comes to developing agricultural activity, and farmers should implement a very strict internal control and a correct register of the treatments used as well Integrated Pest Management (IPM).

At EU level, measures have been taken on chemicals used in agriculture aimed at the sustainable development of the environment such as: promoting accountability and encouraging cooperation efforts related to the import / export of agricultural chemicals and Ministry of Agriculture and Rural Development (MARD) from Romania is monitoring and checking the quantities of residues and chemicals used in agriculture at any stage according the Regulation (EU) 2017/625. Internationally, there are over 800 active substances in pesticides that are registered for use in agriculture. (Shokrzad et al., 2011)

According Ralph, an innovation that helps the development of the agricultural sector is precision agriculture which based on technologies can provide a clear picture of the situation facing production and can adjust in real time its course according to all influential factors, contributing to sustainable development. An alternative to chemical agriculture (intensive agriculture) may be representative of organic farming, although it can solve only part of the problems and should not be a return to the classical agricultural model. (Borza, 2008)

Food safety pays close attention to food safety, but also animal welfare and plant protection, so agricultural practices must always consider the best options for an agricultural crop to ensure food security in sufficient quantities but also the safety of food consumed, thus chemicalization in order to obtain agri-food products, it must be made rational and with minimal negative impact so that in the end the food is safe for human consumption and the environment does not suffer.

Intensive use of pesticides also has negative effects, and the authors (Aktar et all, 2009) listed several hazards, as: impact on environment, water contamination, Soil contamination, Contamination of air, but also negative impact on public health.

MATERIAL AND METHODS

The applicative part of the study focused on statistical analysis and on the identification of the evolution of pesticide use and sales in Romania, but also on determining the impact of pesticides in increasing Romanian agricultural production. The database contains statistical data collected from National Institute of Statistics from Romania and Eurostat.

RESULTS AND DISCUSSIONS

The climatic peculiarities of each year have influenced and continue to influence the amount of active substance from the application of pesticides, rain being the main influencing factor. The tendency to apply pesticides on a constant and occasionally growing surface indicates the fact that Romania is a country that practices conventional agriculture in a significant proportion. It is gratifying that the constant maintenance of the total amount of active substance from pesticides in the context of increasing the applied area or the decrease of the total amount of active substance from pesticides in the context of maintaining the applied area indicates the increase of profitability of applied substances.

As a result of the development of the agricultural sector, but also of the increase of the food demand, the Romanian agri-food production had to adapt and offer the requested quantity, thus it resorted to pesticides as support in plant protection in order to obtain high yields. Analysing the sale of pesticides at European level in the period 2011-2018, Romania maintained its sales at over 10,000 tons annually, the highest level being in 2017, respectively 11,548 tons. Table 2 shows the evolution of pesticide sales in Europe.

Table 2

The evolution of pesticides sales

Location	2011	2012	2013	2014	2015	2016	2017	2018
Romania	11,426	11,523	10,586	10,021	11,484	10,813	11,548	11,108
Europa	386,404	370,689	371,038	394,836	391,063	439,369	432,237	433,630

Source: Eurostat, 2020

Romania ranks 8th in Europe in terms of pesticide sales volume and 6th in the European Union. While the French leader increased its sales by 39% in 2018 compared to 2011, Romania decreased them by approximately 3%. Examining the best-selling categories of pesticides in Romania, it is found that Herbicides, haulm destructors and moss killers and Fungicides and bactericides represented in 2018 approximately 87.5% of the total pesticides sold.

Table 3 includes an analysis of the evolution of pesticides used in Romania, both in active substance and reported per hectare. Following an analysis of the quantities of active substance from pesticides applied in agriculture, in the period 2007-2019 it can be said that there is a slightly downward trend compared to the applied area.

Table 3

The evolution of pesticides uses by type in Romania

Year	Indicators	Categories of pesticides		
		Insecticides	Fungicides	Herbicides
2007	Kilograms of active substance	863,108	1,683,848	3,767,126
	Hectares	1,649,500	1,574,310	2,963,526
	Kilograms of active substance / ha	***0.52***	***1.07***	***1.27***
2008	Kilograms of active substance	847,580	2,440,697	3,905,442
	Hectares	1,597,382	1,607,114	3,166,854
	Kilograms of active substance / ha	***0.53***	***1.52***	***1.23***
2009	Kilograms of active substance	1,046,317	2,076,329	3,426,087

	Hectares	1,830,777	2,228,263	3,142,770
	Kilograms of active substance / ha	***0.57***	***0.93***	***1.09***
2010	**Kilograms of active substance**	1,327,660	2,232,598	3,688,948
	Hectares	2,061,336	2,066,323	3,418,235
	Kilograms of active substance / ha	***0.64***	***1.08***	***1.08***
2011	**Kilograms of active substance**	993,324	1,989,229	3,600,382
	Hectares	1,750,803	1,875,748	3,444,013
	Kilograms of active substance / ha	***0.57***	***1.06***	***1.05***
2012	**Kilograms of active substance**	832,646	1,907,540	3,678,610
	Hectares	1,706,104	1,872,709	3,407,054
	Kilograms of active substance / ha	***0.49***	***1.02***	***1.08***
2013	**Kilograms of active substance**	850,103	2,194,060	3,903,714
	Hectares	1,799,582	2,093,070	3,825,368
	Kilograms of active substance / ha	***0.47***	***1.05***	***1.02***
2014	**Kilograms of active substance**	635,076	2,293,286	3,795,431
	Hectares	1,695,816	2,028,434	3,583,839
	Kilograms of active substance / ha	***0.37***	***1.13***	***1.06***
2015	**Kilograms of active substance**	716,308	2,246,188	3,645,541
	Hectares	1,731,526	1,844,664	3,476,103
	Kilograms of active substance / ha	***0.41***	***1.22***	***1.05***
2016	**Kilograms of active substance**	803,275	2,085,007	3,574,876
	Hectares	1,881,948	2,082,232	3,474,815
	Kilograms of active substance / ha	***0.43***	***1.00***	***1.03***
2017	**Kilograms of active substance**	1,001,430	2,282,330	3,575,547
	Hectares	2,217,777	2,395,123	3,605,714
	Kilograms of active substance / ha	***0.45***	***0.95***	***0.99***
2018	**Kilograms of active substance**	641,421	1,759,968	2,739,818
	Hectares	2,367,251	2,478,309	3,304,749
	Kilograms of active substance / ha	***0.27***	***0.71***	***0.83***
2019	**Kilograms of active substance**	582,794	1,711,491	3,052,255
	Hectares	2,270,113	2,454,160	3,778,820
	Kilograms of active substance / ha	***0.26***	***0.70***	***0.81***

Source: National Institute of Statistic of Romania, 2020

The amount of active substance from fungicide treatments also fluctuated, in 2019 the quantitative value being below the values recorded in the period 2008-2018, except for 2007, when the amount of active substance was lower by 2 percentage points. The area on which fungicide treatments were used registered in 2019 values higher than the analyzed period, except for 2018, year in which a value was registered with 2% higher compared to 2019.

Regarding insecticides, analysing the amount of active substance in 2019 compared to 2007 we notice a decrease of 32 percentage points, while 2019 compared to 2014 recorded a decrease of only 8 percentage points, and 2019 compared to the year 2018 registered a gap of 9 percentage points. All this happened in the context in which the area applied with insecticides increased in 2019 by 38% compared to 2007, by 34% compared to 2014 and decreased by 4% compared to 2018.

Herbicides have the highest quantitative intake of active substance in the category of pesticides, registering values clearly superior to insecticides and fungicides. The quantity of active substance oscillated during the analyzed period, during all this time the value registered in 2019 being below those of the previous years, except for 2018, year in which compared to 2019 it registered a quantity of active substance used with 11 lower percentage points. Although for the most part 2019 recorded values of the amount used of the active substance from herbicides lower than previous years, the applied area recorded higher values than previous years, except for 2013 where the gap was about 1%.

Following the above, we can confirm the small downward trend of the quantities of active substance from the application of the 3 categories of pesticides per hectare by the simple

fact that the trend of the amount used by the active substance was positioned below the increasing trend of the area it was applied.

Table 4 presents the evolution of fertilizer use in Romanian agriculture in the period 2007-2019, being analyzed 5 main categories of fertilizers. Analyzing the active substance from fertilizers applied in agriculture, we find that during the analyzed period, the largest amount comes from natural fertilizers, in 2019 95% came from natural fertilizers and only 5% from chemical ones.

Table 4

The evolution of fertilizer uses by type in Romania

Year	U.M.	Fertilizer categories				
		Chemicals	**Nitrous**	**Phosphatic**	**Potassic**	**Naturals**
2007	**Tonnes 100% active substance**	387,216	265,487	103,324	18,405	13,497,929
	Hectares	6,422,910	3,908,581	2,081,372	432,957	536,929
	Tone 100% active substance / ha	***0.06***	***0.07***	***0.05***	***0.04***	***25.14***
2008	**Tonnes 100% active substance**	397,965	279,886	102,418	15,661	11,748,140
	Hectares	6,766,070	4,144,134	2,210,472	411,464	495,852
	Tone 100% active substance / ha	***0.06***	***0.07***	***0.05***	***0.04***	***23.69***
2009	**Tonnes 100% active substance**	426,207	296,055	100,546	29,606	13,748,307
	Hectares	5,889,264	3,939,996	1,883,207	494,566	569,531
	Tone 100% active substance / ha	***0.07***	***0.08***	***0.05***	***0.06***	***24.14***
2010	**Tonnes 100% active substance**	480,586	305,757	123,331	51,500	15,231,715
	Hectares	7,092,256	4,303,634	2,119,888	934,264	600,052
	Tone 100% active substance / ha	***0.07***	***0.07***	***0.06***	***0.06***	***25.38***
2011	**Tonnes 100% active substance**	486,944	313,333	126,249	47,362	14,510,194
	Hectares	6,893,863	4,402,007	2,233,875	831,030	630,293
	Tone 100% active substance / ha	***0.07***	***0.07***	***0.06***	***0.06***	***23.02***
2012	**Tonnes 100% active substance**	437,972	289,963	113,035	34,974	13,292,617
	Hectares	6,340,780	4,459,085	2,408,445	954,135	605,694
	Tone 100% active substance / ha	***0.07***	***0.07***	***0.05***	***0.04***	***21.95***
2013	**Tonnes 100% active substance**	491,831	344,468	113,823	33,540	13,580,267
	Hectares	6,194,603	4,513,838	2,322,860	963,723	623,246
	Tone 100% active substance / ha	***0.08***	***0.08***	***0.05***	***0.03***	***21.79***
2014	**Tonnes 100% active substance**	452,239	303,562	118,574	30,103	16,261,702
	Hectares	6,676,089	4,708,281	2,626,536	1,024,445	795,031
	Tone 100% active substance / ha	***0.07***	***0.06***	***0.05***	***0.03***	***20.45***
2015	**Tonnes 100% active substance**	532,702	357,352	132,657	42,693	15,212,325
	Hectares	6,574,741	4,659,502	2,611,995	1,056,564	864,218
	Tone 100% active substance / ha	***0.08***	***0.08***	***0.05***	***0.04***	***17.60***
2016	**Tonnes 100% active substance**	514,126	344,311	126,189	43,626	14,927,199
	Hectares	6,491,498	4,837,494	2,684,452	1,180,322	862,330
	Tone 100% active substance / ha	***0.08***	***0.07***	***0.05***	***0.04***	***17.31***
2017	**Tonnes 100% active substance**	581,470	381,342	144,869	55,259	12,625,073
	Hectares	7,272,565	5,218,331	2,765,381	1,278,542	708,364
	Tone 100% active substance / ha	***0.08***	***0.07***	***0.05***	***0.04***	***17.82***
2018	**Tonnes 100% active substance**	722,308	468,639	188,411	65,635	14,713,549
	Hectares	6,927,578	5,490,518	3,128,386	1,420,873	777,964
	Tone 100% active substance / ha	***0.10***	***0.09***	***0.06***	***0.05***	***18.91***
2019	**Tonnes 100% active substance**	749,551	455,964	201,329	92,258	15,323,344
	Hectares	7,373,689	6,104,220	3,726,745	1,915,470	816,713
	Tone 100% active substance / ha	***0.10***	***0.07***	***0.05***	***0.05***	***18.76***

Source: National Institute of Statistic of Romania, 2020

Analyzing the active substance from fertilizers applied in agriculture, we find that during the analyzed period, the largest amount comes from natural fertilizers, in 2019 95% came from natural fertilizers and only 5% from chemical ones. Regarding the amount of active substance coming from chemical fertilizers, although it registers small oscillations, it is on an

ascending trend from 2007 to 2019, throughout the analyzed period, 2019 registering values superior to the other years.

The amount of active substance from nitrogen-based fertilizers is on an upward trend, 2019 saw an increase of 72% compared to 2007 and 50% compared to 2014. The number of hectares on which they were applied Nitrogen-based fertilizers also showed an increasing trend in the period 2007-2019. Following the analysis of phosphorus-based fertilizers, we find an increase in the amount of active substance in 2019 compared to 2007, their value increased by 95%, from 103,324 tons to 201,329 tons. The area on which phosphorus-based fertilizers were applied also increased significantly, if in 2007 it was only 2,081,372 hectares, in 2019 it registered the value of 3,726,745 hectares, an increase of 79 percentage points.

Following the observations made above, there is a growing trend both in the areas used with chemical fertilizers and in the quantities of active substance derived from them.

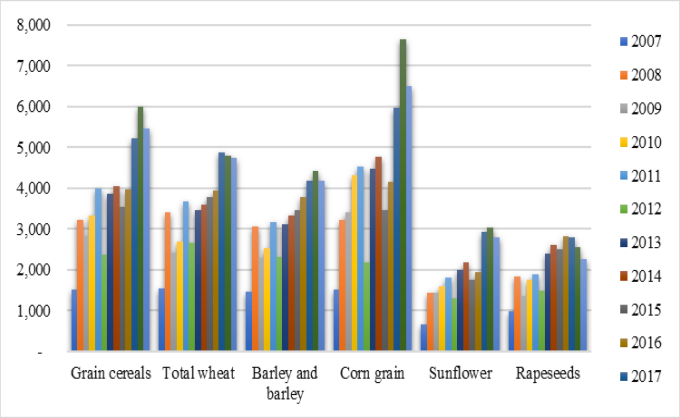

Figure 1 Average production per hectare, for the main agricultural crops in Romania
Source: National Institute of Statistic of Romania, 2020

Analyzing the productions registered by the main field crops in Romania, we notice a significant increase in the period 2017-2019 compared to the beginning of the analyzed period 2007-2009. Reporting the year 2019 to 2007 we find an increase in production per hectare of 258% among cereals for grains, 208% for wheat, 187% for barley and barley, 326% for corn grains, 326% for sunflower and 128% for rapeseed. This growth has as main influencing factor the transfer of knowledge from agriculture, research, development, and innovation bringing agricultural productions in an increasing trend, with small oscillations from year to year due to climate change.

CONCLUSIONS

For a sustainable production to reduce the risks of environmental degradation and enhance the sustainability of agro-ecosystems, rational use of pesticides to minimize the environmental risks and for better plant protection is important in every farm and farmers must use more green pesticides and agricultural practices that are friendly with natural environment.

The climatic particularities of each year have influenced and continue to influence the amount of active substance from the application of pesticides, rain being the main influencing factor. The tendency to apply pesticides on a constant and occasionally growing surface

indicates the fact that Romania is a country that practices conventional agriculture in a significant proportion. It is gratifying that the constant maintenance of the total amount of active substance from pesticides in the context of increasing the applied area or the decrease of the total amount of active substance from pesticides in the context of maintaining the applied area indicates the increase of profitability of applied substances.

BIBLIOGRAPHY

AKTAR, M. W., SENGUPTA, D., CHOWDHURY, A. 2009 - Impact of pesticides use in agriculture: their benefits and hazards. Interdisciplinary toxicology, 2(1), Slovakia, 1–12

ANGHELACHE, C., 2018 - Analiza structurală a agriculturii româneşti, Revista Română de Statistică – Supplement, Romania, 2:3-10

BARZMAN, M., RICCI, P., LABUSSIÈRE, E., 2010 - European Crop Protection in 2030 - a foresight study. Endure Editions INRA, France

BEGUM, A., ALAM, S., UDDIN, M., 2017 - Management of Pesticides: Purposes, Uses, and Concerns. Pesticide Residue in Foods, Springer, 53-86, United States

BLOJ, C., MEGHESAN-BREJA, A.M., 2015- Societatea de protectia plantelor transilvania, Romania

BORZA, M., 2008 – Agricultura ecologica in contextual schimbarilor de mediu. Lucrările Ştiinţifice Universităţii de Ştiinţe Agricole şi Medicină Veterinară, Iasi, Romania, 51:218-221

DARA, S., 2019 - The New Integrated Pest Management Paradigm for the Modern Age, Journal of Integrated Pest Management, Volume 10, Issue 1, (12), United Kingdom

EARLY, R., 2019 - Pesticides in agriculture. Food Science and Technology, United Kingdom, 33: 52-55

EUROPEAN COMMISSION, The European Green Deal, Brussels, 2019

EUROPEAN COMMISSION, Pesticides explained, https://ec.europa.eu/assets/sante/food/plants/pesticides/lop/index.html

EUROPEAN UNION, REGULATION (EU) 2017/625 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 15 March 2017 on official controls and other official activities performed to ensure the application of food and feed law, rules on animal health and welfare, plant health and plant protection products,

EUROSTAT, Pesticide sales, https://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=aei_fm_salpest09&lang=en

GILL, H., GARG, H., 2014 - Pesticides: Environmental impacts and management strategies. InTech. 188-230, Croatia

NATIONAL INSTITUTE OF STATISTIC OF ROMANIA, Indicators of agri- environment – Quantity of chemicals, http://statistici.insse.ro:8077/tempo-online/#/pages/tables/insse-table

NICOLOPOULOU-STAMATI, P., MAIPAS, S., KOTAMPASI, C., STAMATIS, P., HENS, L., 2016 - Chemical Pesticides and Human Health: The Urgent Need for a New Concept in Agriculture. Frontiers in Public Health (4:148), Switzerland

RABONTU, C., 2010 – Food safety and its role in the evolution of food trade. Analele Universitatii "Constantin Brancusi" din Targu Jiu, Seria Economie, Nr. 2/2010, Romania, 161-172

SHOKRZADE, M., SAEEDI, S., SEYED, S., 2011- Pesticides in Agricultural Products: Analysis, Reduction, Prevention. Pesticides - Formulations, Effects, Fate, United Kingdom, 225-242

SINCARI, M., 2013 - Necesitatea perfecţionării managementului dezvoltării agriculturii ecologice, Annales Universitatis Apulensis Series Oeconomica, Alba Iulia, Romania

TAYADE, S., 2013 - Pesticide Contamination in Food: A Review. IOSR Journal of Agriculture and Veterinary Science. 6. 07-11, India

ZIKANKUBA, V. L., MWANYIKA, G., NTWENYA, J. E., JAMES, A., 2019 - Pesticide regulations and their malpractice implications on food and environment safety. Cogent Food & Agriculture (5:1), United Kingdom