

THE EVOLUTION OF PESTICIDES USE IN THE CONTEXT OF SUSTAINABILITY OF AGRI-FOOD SYSTEMS

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Abstract

Future agriculture strategies and policies need to be developed to reduce the use and risks of pesticides, support agricultural production and food security, and encourage the development and adoption of sustainable practices. In the world, in 2021, more than 3.5 million tons of pesticides were used, i.e. 1.4 million tons more than in 2000. The amount of herbicides used in 2021 was higher by about 8.5 million tons compared to 2000, and fungicides and insecticides by 2-3 million t. For the European Union and Romania, there was a decrease in the quantities of all categories of plant protection products. This reflects the permanent concern of today's society, decision-makers, and citizens to improve the quality of life and the environment, biodiversity, and safe agri-food products through the sustainable use of pesticides and to promote the wider use of alternative ways of crops protecting against pests, weeds, and diseases.

Key words: agri-food system, health, pesticides, sustainability.

INTRODUCTION

Agriculture in the last period of time has been constantly progressing. Particularly productive biological forms were created, rich in useful substances (proteins, lipids, essential amino acids etc.), with high adaptability, resistant to pests and diseases, and cultivation methods were established for all agricultural plants, on the most different soils and ecological zones, with specific fertilization methods and techniques, methods of weed, disease and pest control, and agricultural machinery systems were greatly improved (Alengebawey et al., 2021). As a result, agricultural production has increased significantly. Despite all these advances made, contemporary agriculture is threatened by great dangers. Pollution, which leads not only to the modification of ecosystems, but also to the denaturation and degradation of agricultural products, to the loss of biodiversity, the emergence of resistance of harmful organisms, to the application of various plant protection products, but also to the reduction of the quality of life in general (European Environment Agency, 2022).

Current agricultural technologies must contribute to the permanent improvement of the environment, landscapes, human health, plants and animals (Mușat et al., 2021). The sources of pollution are numerous and among them an important role is played by the pollution generated by the irrational use of pesticides and fertilizers with negative effects on the water used to irrigate crops, as well as the effects of greenhouse gases diffused into the atmosphere. The problems facing agriculture are generated precisely by the need to continuously increase the production of food and raw materials for industry for a population that is becoming more and more numerous, over 9 billion people by 2030 (UN, 2022). The nature of these problems is very diverse and we can mention, among others, the climate changes manifested in recent years through the increase in multiannual average temperatures, the occurrence of extreme weather phenomena, socio-economic problems, migration, the various conflicts in some parts of the world. Taking all these aspects into account, the crops damage caused by diseases and pests and weeds is substantial. It is difficult to advance a synthetic figure regarding the value of

these damages, because the situation is very different in various regions of the globe, but sometimes losses of 100% can be reached. The problems regarding the use of pesticides for crop protection are becoming very topical. Different organizations, international institutions have defined the notion of pesticides. For example, FAO defines it as pesticides "any substance or mixture of substances of chemical or biological ingredients intended for repelling, destroying or controlling any harmful organism or for regulating plant growth" (FAO, 2021). The EU's Common Agricultural Policies define pesticides as "something that prevents, destroys, or controls harmful organisms, or protects plants or plant products during production, storage and transport" (EU, Green Deal, 2019). Also, The World Health Organization (WHO) defines pesticides as "substances used in public health to kill vectors of disease, such as mosquitoes, and in agriculture to kill harmful organisms that damage crops" (WHO, 2020).

Over 1000 different pesticides are used around the world (WHO, 2020). Due to the danger that these substances have on the environment, the legislation of recent years in all world, including EU countries, has imposed some actions to achieve a sustainable use of pesticides (EU, Green Deal, 2019). Thus, the Directive 2009/128/EC of the European Parliament and of The Council of 21 October 2009 establishing a framework for Community action to achieve the sustainable use of pesticides. In 2019, the European Commission has adopted a proposal for a new Regulation on the Sustainable Use of Plant Protection Products, including EU wide targets to reduce by 50% the use and risk of chemical pesticides by 2030, in line with the EU's Farm to Fork and Biodiversity strategies (Commission Directive (EU) 782, 2019). Integrated Pest Management (IPM) focuses on pest prevention and prioritises alternative pest control methods, with chemical pesticides only used as a last resort.

Currently, in the world there is a great demand for new, innovative and safe crop protection products that increase the ability to control weeds, diseases and pests in crops (Barbas et al., 2023), in response to current legislative requirements.

Under these conditions, the current paper presents the evolution of crops pesticide use in

Romania by comparison with the European Union and world in context of sustainability of agri-food system.

MATERIALS AND METHODS

The results presented in this paper are based on the study of specialized literature, as well as the statistical databases of FAO and Eurostat, which present centralized data at the global, European and Romanian level regarding the total quantities of pesticides used, the categories of pesticides used, as well as use per area of cropland and use per value AP (Agricultural Production).

FAO methodology highlights pesticides (total) as the sum of active ingredients in the following categories of pesticides: Fungicides & Bactericides, Herbicides, Insecticides, Plant Growth Regulators, Seed Treatment Fungicides, Seed Treatment Insecticides, Mineral Oils, Rodenticides, and Disinfectants and Other pesticides, nes (not elsewhere specified) (FAO, 2024).

The reporting period is 1990-2021. The year 1990 was chosen as the reference year when the Romanian Revolution took place in December 1989 and the transition to the market economy and with the turning point in 2007, as the year in which Romania became a member of the European Union and had to respect and align the legislation and the rules regarding the use of pesticides in agriculture.

RESULTS AND DISCUSSIONS

The worldwide quantity of pesticides applied to agricultural land has experienced a permanent increase since 1990, reaching in 2021 a value of more than 3.5 million tons, respectively with more than 1.70 million tons more than in 1990 (Figure 1). Also, on the continents, the increasing quantities were recorded for America with over 1.16 million tons in 2021 (1,772,194.51 tons), by comparison with 1990 (608,728,21 tons) and at the opposite end is the European Union, which in recent years recorded decreases from 373,053.18 tons to 354,082.32 in 2021.

For Romania, the total amount of pesticides used for agricultural land decreased continuously, reaching 5,590 tons in 2021 (Figure 2).

From the point of view of the quantities used per unit of cultivated area, it can be seen that the greatest increase was observed on the American continent, where the amount used in 1990 was 1.62 kg/ha, and in 2021 the amount was

4.7 kg/ha, a trend that was also maintained for the other continents (Figure 3).

For Romania, the amount used per ha has decreased constantly in the last 30 years, reaching 0.62 kg/ha in 2021 (Figure 4).

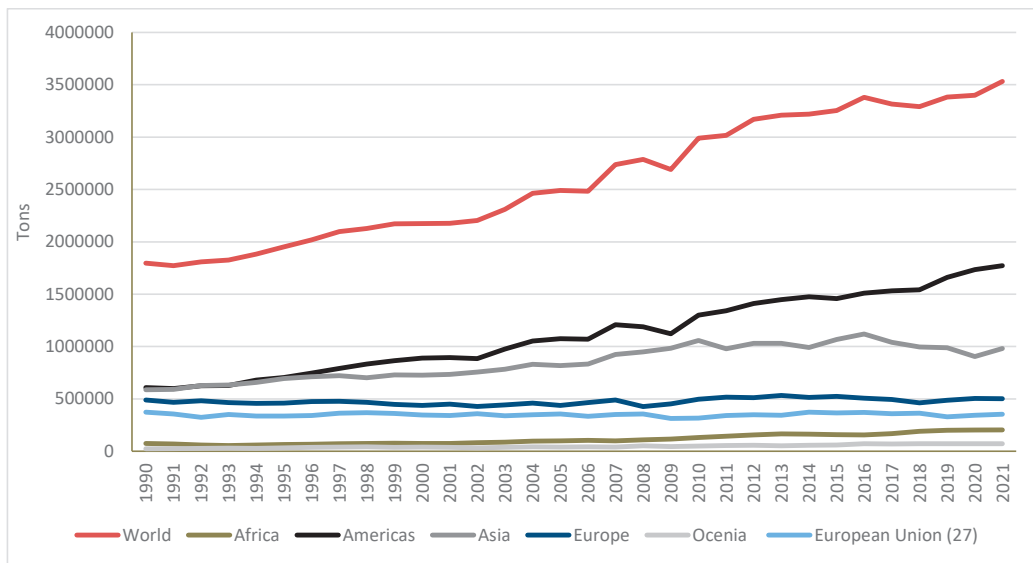


Figure 1. Total pesticides for agricultural use in the world, continents and European Union (FAO, 2024)

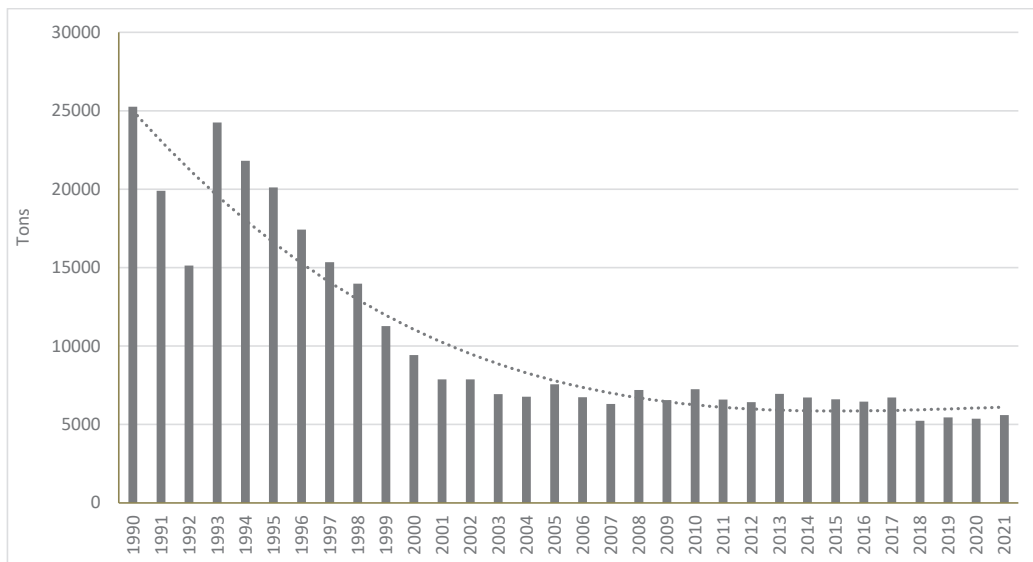


Figure 2. Total pesticides for agricultural use in Romania (FAO, 2024)

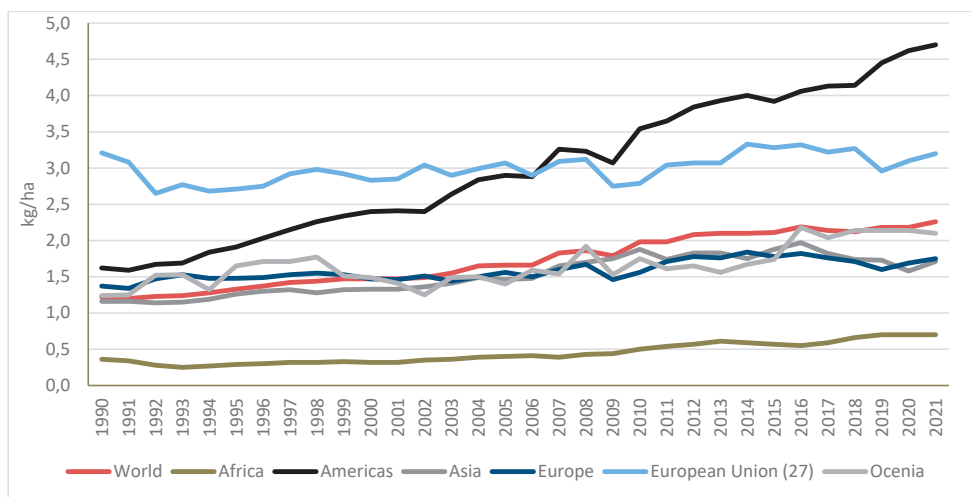


Figure 3. Pesticides used per area of cropland in the world, continents and European Union (FAO, 2024)

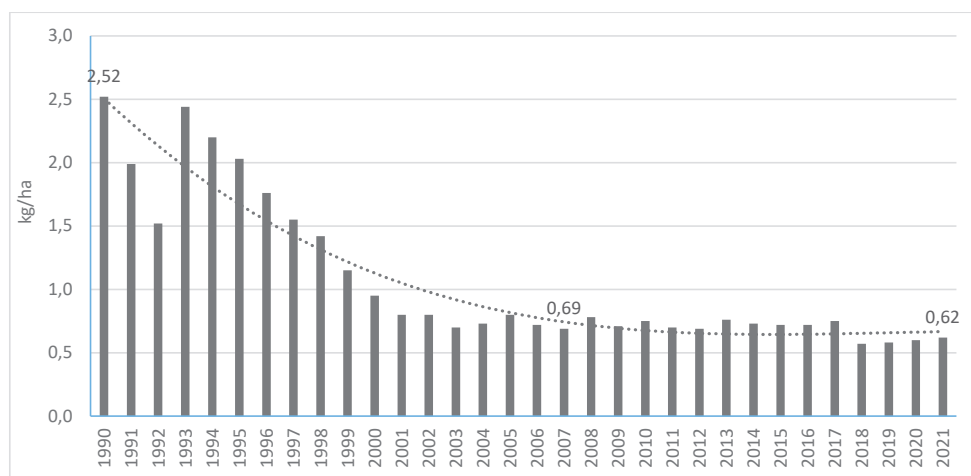


Figure 4. Pesticides used per area of cropland in Romania (FAO, 2024)

From the point of view of the categories of pesticides used, according to the data presented in next figures, it can be observed that the largest quantities used were herbicides. At the global level, the positive evolution of the herbicides use is exemplified by 699602.28 tons in 1990, to 1730303.03 tons in 2021. Also, on the continents, increases of 10-15% were observed throughout the analysed period. In the European Union, the values remained relatively constant, respectively, 10-11 million tons on agricultural land (Figure 5).

There is also a significant increase in the use of insecticides worldwide, from 699,602.28 tons in

1990 to 1,730,303.03 in 2021, or about 2.5 times more (Figure 6).

For fungicides and bactericides, the situation is similar, the quantities increasing in 2021 by about 1.8 times compared to 1990. But, the European Union recorded a decrease in the quantities used, by about 10-12% (Figure 7).

In Romania, the quantity of herbicides has been continuously reduced, reaching 2,969 tons in 2021, compared to 7,567 tons in 1990. Also, for insecticides, there is a decrease in quantities from 5,797 in 1990 to 822 in 2021. This decrease is also valid for fungicides (Figure 8).

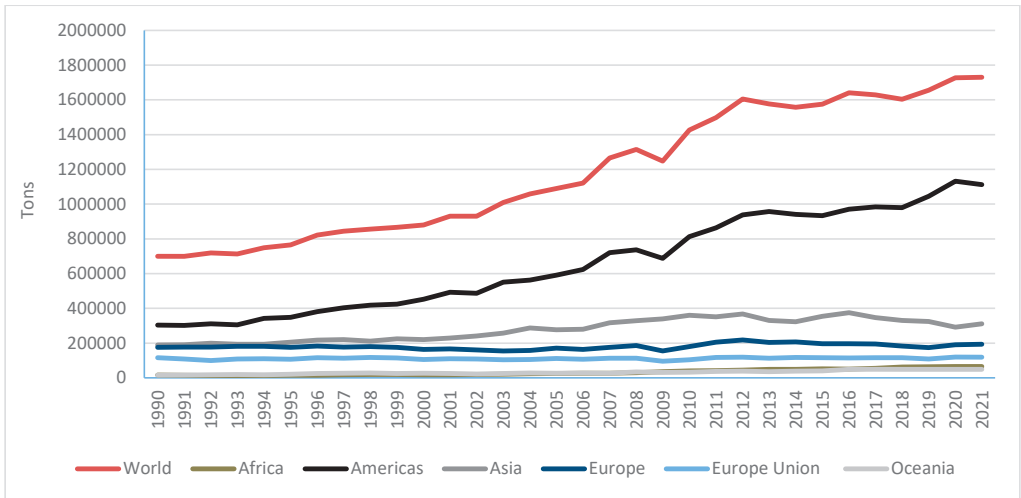


Figure 5. Herbicides for agriculture use (FAO, 2024)

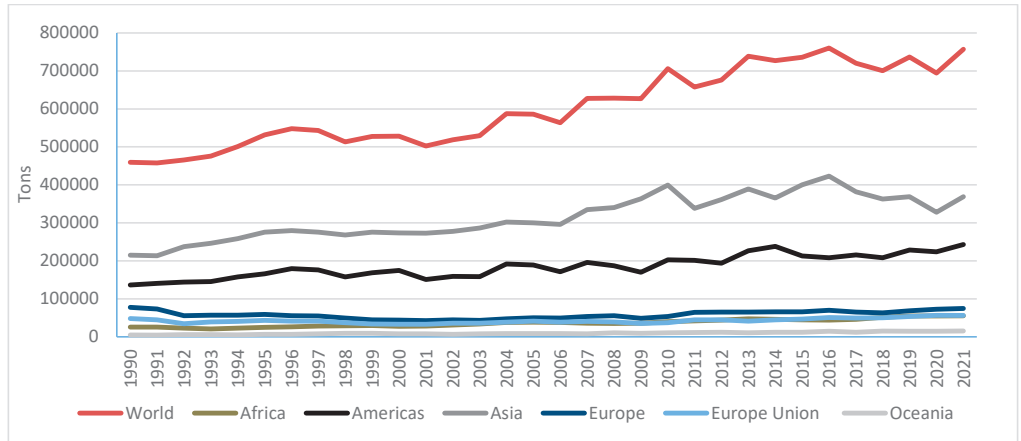


Figure 6. Insecticides for agriculture use (FAO, 2024)

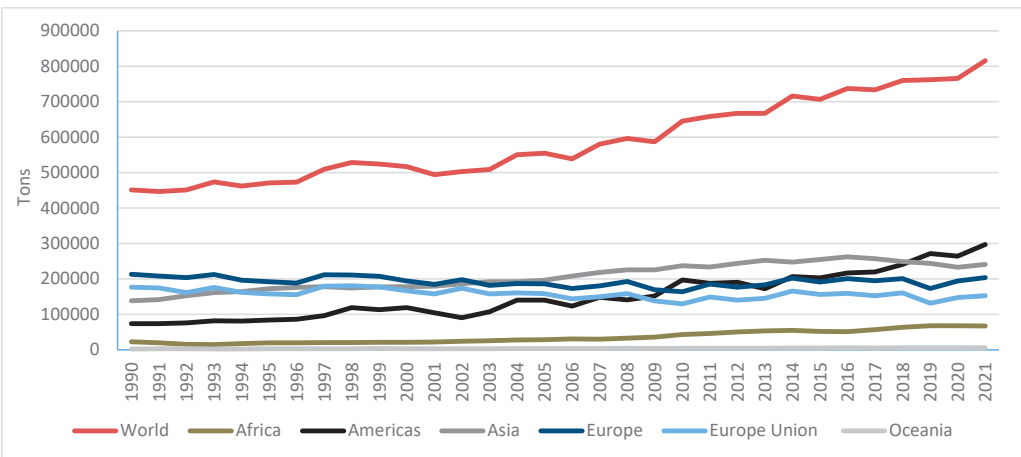


Figure 7. Fungicides and bactericides for agriculture use (FAO, 2024)

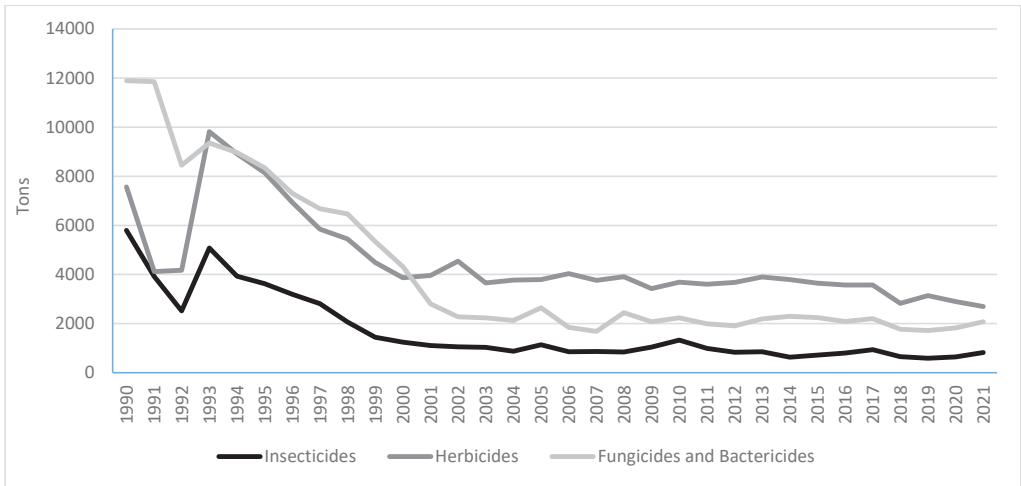


Figure 8. Pesticides categories for agriculture use in Romania (FAO, 2024)

The first countries with the highest consumption of pesticides per agriculture use is present in Figure 9. The largest pesticide user country is Brazil, which started with 51,120 tons in 1990 and reached 719,507 tons in 2021. Also, Argentina started with 26156 in 1990 and reached 241,519,98 in 2021. For the other countries, the values remained relatively constant, with increases of up to 60-70% (Figure 9). Regarding the consumption per area

of cropland, it can be observed that for all countries the consumption has increased. Brazil stands out again, where consumption has increased 10 times in the 30 years, from 0.91 to 10.90 kg/ha. For Argentina, the values increased steadily, reaching 5.58 kg/ha in 2021. For Europe Union, the presence of Spain is noteworthy, both for the consumption used on agricultural land and for crop land (Figure 10).

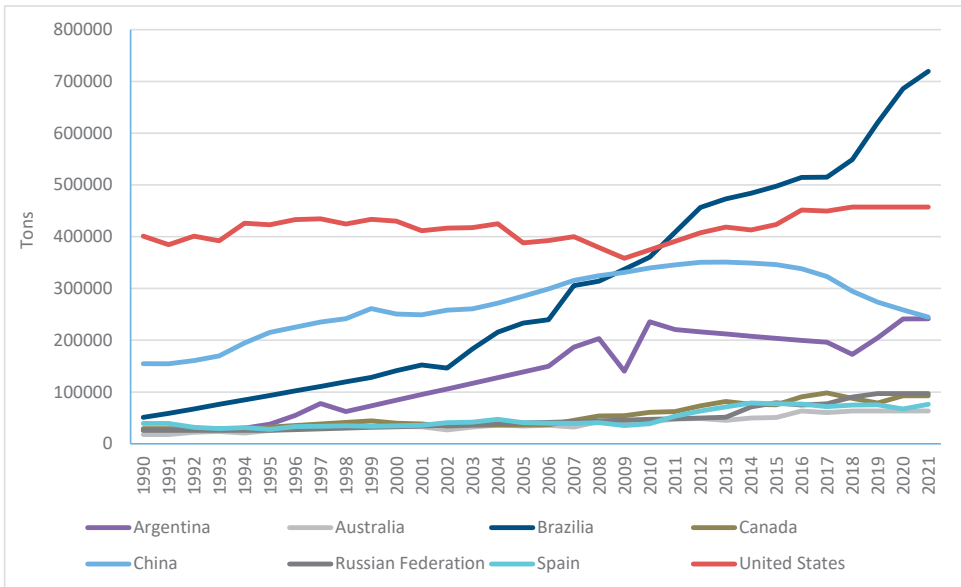


Figure 9. The first countries with the highest consumption of pesticides for agriculture use (FAO, 2024)

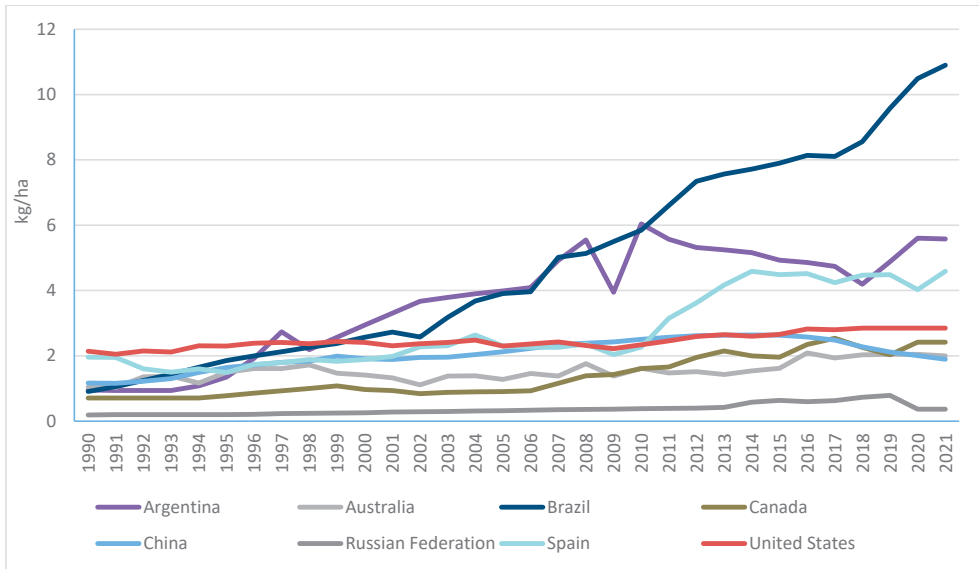


Figure 10. The first countries with the highest consumption of pesticides per area of cropland (FAO, 2024)

The evolution of the amount of pesticides traded in the last 30 years is presented in Figure 11. From the data analysis, it is noted that starting with the year 2020, the quantities traded, both for imports and exports, have decreased by about 0.5 million tons (Figure 11). Regarding the market value, it has continuously increased, but in the last two years the value of the market has decreased by about 3 million dollars (Figure 12) This was primarily due to the lower consumption of pesticides worldwide imposed by the legislation worldwide, but also in the European Union. For Romania, the quantities traded for both import and export increased

continuously until 2020 (Figure 13). In 2021, a decrease in quantities was recorded by 8,179 tons, but the market value of these products increased by more than 41 million dollars (Figure 14). Among the causes reported by the experts in the field are mentioned: interrupted supply chains, very high transport costs, significant logistics problems, skyrocketing energy prices, lack of labour, and missing stocks. Taken together, these issues make sourcing more difficult, drive up prices, and make the supply chain particularly susceptible to the smallest disruptions.

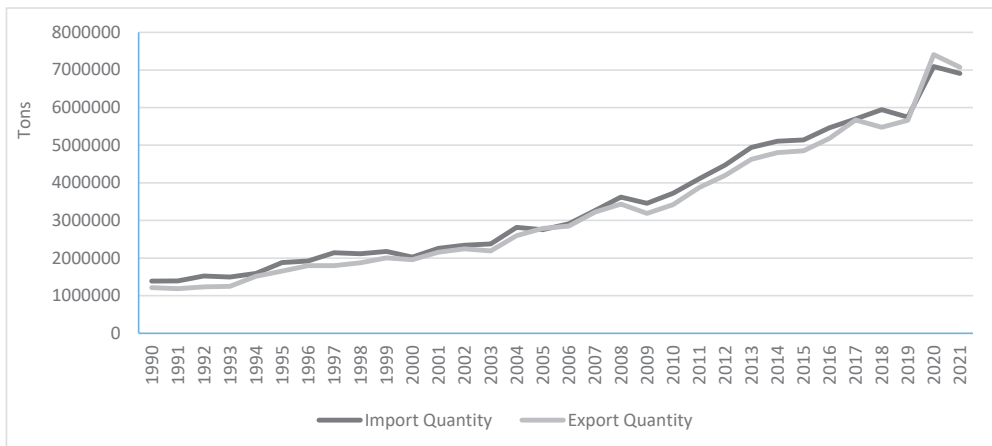


Figure 11. Import and Export quantity in the world (FAO, 2024)

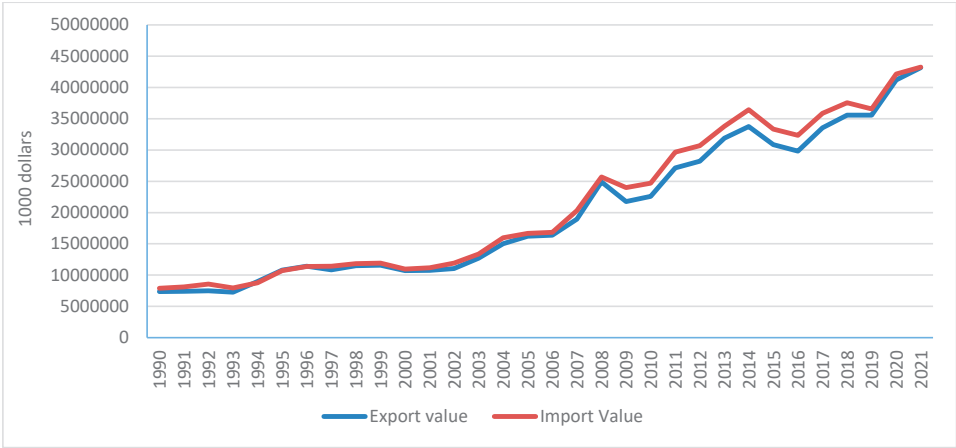


Figure 12. Import and Export values in the world (FAO, 2024)

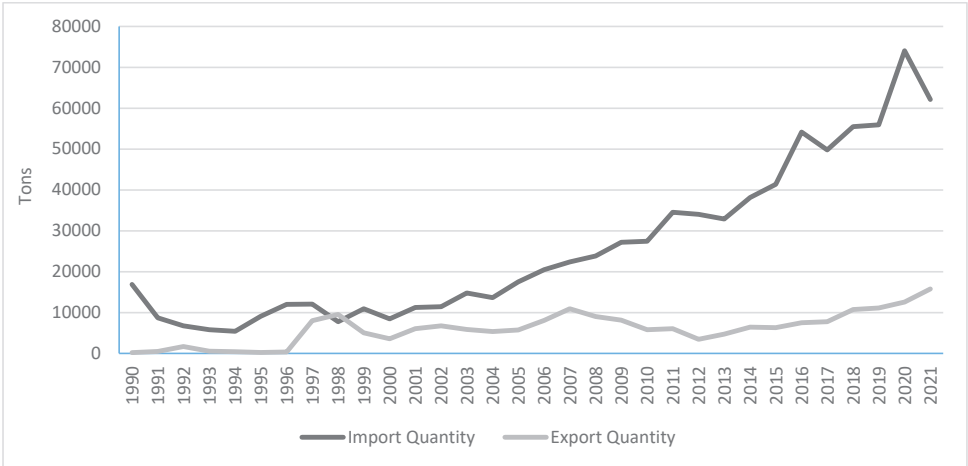


Figure 13. Import and Export quantity in Romania (FAO, 2024)

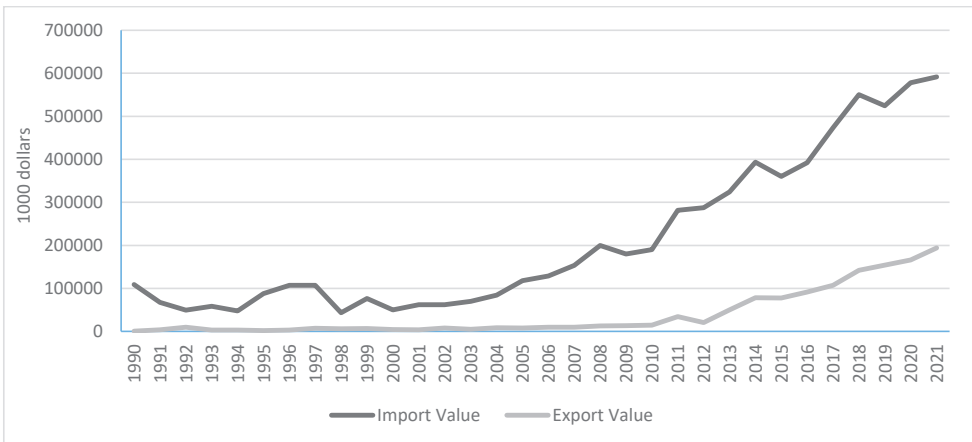


Figure 14. Import and Export values in Romania (FAO, 2024)

As it emerged from the statistical analysis carried out in this study, pesticides are widely used in agricultural production to prevent or combat pests, diseases, weeds and other plant pathogens, in order to reduce or eliminating production losses and maintaining a high quality of products (Zhang et al., 2023). Although pesticides are developed through very strict regulatory procedures to work with a reasonable certainty and with minimal impact on human health and the environment, exists serious concerns about health risks arising from occupational exposure and from food and drinking water residues (Damalas & Eleftherohorinos, 2011).

Also, the integrated pest management (IPM) of the harmful organisms emphasizes the growth of healthy crops and a cleaner environment through methods that affect agrosystems as little as possible and encourage natural pest control mechanisms (EU – Toolbox, 2023).

Pesticide treatments often prove counterproductive because they kill beneficial species, such as natural enemies of pests, and increase the chances of developing resistance pests to pesticides (Damalas & Eleftherohorinos, 2011). Also, the impacts of chemical pesticides on the environment, including biodiversity, water, air and soil, and on human health, have become a major concern for civil society and consumers (Ali, 2023). They are also a major issue for the sustainability of agricultural systems. Recently, the Farm to Fork and Biodiversity European strategies set an ambitious target of reducing the use and risks of chemical pesticides by 50% by 2030 (Mora et al., 2023). For reducing the use of pesticides and indirectly the risks to the health of people, the landscape, animals and plants, prevention and/or eradication of harmful organisms should be achieved or supported by several methods and in particular by: crop rotation; use of appropriate cultivation techniques (eg sowing technique, sowing dates and densities, sub-sowing, conservation tillage, clearing and direct seeding); the use, as appropriate, of resistant/tolerant varieties, as well as seeds and standard/certified planting material; use of balanced fertilization, liming and irrigation/drainage practices; preventing the spread of harmful organisms through hygiene measures (for example by constantly cleaning

machinery and equipment); protecting and spreading important beneficial organisms, for example through appropriate plant protection measures or the use of ecological infrastructures inside and outside production sites; organic agriculture, etc.

Organic agriculture prohibits use synthetic pesticides, it protects the environment, preserves and increases soil fertility, helps to obtain foods of high nutritional value without residues (Nastase & Toader, 2016).

The necessity of having an alternative agriculture method that can be functioned in a friendly Ecosystem while sustaining and increasing productivity. Organic farming is recognized as the best-known alternative (Gamage et al., 2023).

CONCLUSIONS

Pesticides are widely used to protect food production and meet global food demand. Without their use, in some situations, harvest losses can be 100%

However, despite their usefulness, pesticides cause adverse effects on water quality, biodiversity and human health. The use of pesticides is one of the main factors in the negative impact of modern industrial agriculture on the environment. Due to their toxicity, pesticides can harm plants, animals and humans. To limit the impact on the environment, current policies recommend a series of measures to reduce the amount of pesticides. Including the promotion of agricultural systems that use non-polluting technologies for plants, animals and the environment, maintain and improve soil fertility and lead to the sustainability of agri-food systems.

As a result, the prospects of reducing the use of pesticides both in terms of agricultural land and crops or finding alternative solutions for control of harmful organisms can lead to the creation of sustainable practices beneficial both for farmers and for consumers in general.

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