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CHANGES IN THE CONSUMPTION OF MINERAL FERTILIZERS AND PESTICIDES IN POLAND AND UKRAINE – COMPARATIVE ANALYSIS[2]

Key words: trends of changes, mineral fertilizers, pesticides, Poland, Ukraine

ABSTRACT. Ukraine has very good natural conditions for agricultural production and year by year it is becoming an increasingly important producer in Europe and the World. Poland, despite worse natural conditions and more than three times smaller area of utilization agricultural area, is also an important producer in the EU. The current geopolitical situation requires comparative analyzes of numerous aspects of the agricultural potential of Poland and Ukraine. They are necessary for utilitarian reasons and provide a scientific basis for making political decisions of a strategic nature, especially in relation to agricultural policy. Therefore, the purpose of the paper is to compare the trends of changes and the current state in the consumption of mineral fertilizers and pesticides in Polish and Ukrainian agriculture. The material for analysis was statistical data from the FAO. The analysis covers the years 1992-2020. The consumption of mineral NPK fertilizers and pesticides in Poland and Ukraine in the years 1992-2020 varied both in terms of the level, dynamics and directions of changes. The consumption of mineral fertilizers in the analyzed period was higher in Poland than in Ukraine. On the other hand, the use of pesticides in most years was higher in Ukraine than in Poland. However, since 2015, this regularity has changed and therefore the consumption of pesticides in Poland is higher than in Ukraine. Considering the outlined trends in the consumption of mineral fertilizers and plant protection products, it should be pointed out that Ukraine will strengthen its position as the leading food producer in the world. In this case, it will be a big challenge for Poland and the entire EU, which should be the subject of further scientific analyses.

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INTRODUCTION

Ukraine has favourable climatic conditions and quality of land resources, the presence of which indicates the possibility of effective development of agricultural production [Keyzer et al. 2012, Khalatur 2017]. This sector has been developing very dynamically in recent years and year by year Ukraine is becoming an increasingly significant producer in Europe and in the World. This trend was temporarily limited by the war, but it should be assumed that after the situation normalizes, Ukraine will return to the path of intensive agricultural development. Of course, it should be taken into account that the possibility of continuing and developing the production in Ukraine, in addition to the availability of agricultural land, is also influenced by the possibility of purchasing means of production, as well as transport, storage and the possibility of exporting [Matyka 2022]. Soil and climatic conditions in Poland are less favorable for agricultural production. Also, the area of agricultural land is more than three times smaller than in Ukraine. Nevertheless, Poland is also an important food producer in Europe. The main impulse enabling the development of modern agriculture in Poland was the accession to the European Union (EU) in 2004. As a result, Polish agriculture was covered by the support system under the Common Agricultural Policy (CAP). It also involved the implementation of a number of legal regulations and standards, which on the one hand raised quality standards and reduced the impact of agriculture on the environment, but on the other hand imposed many requirements and obligations on farmers [Poczta 2010, Kwasek, Kowalczyk 2022, Harasim et al. 2021, Madej 2022, Mikuła et al. 2022].

However, the main impact on the development of agricultural production, improvement of its efficiency and full use of the soil-climatic and biological potential of plants will continue to be the skilful and environmentally safe use of industrial means of production, mainly mineral fertilizers and pesticides [Sattari et al. 2013, McArthur, McCord 2017, Matyka 2020, Piwowar 2021].

According to Daria Polushvedkina [2023] the analysis of the current state and trends of changes in Polish and Ukrainian agriculture is now very important because the economic dimension of Ukrainian-Polish interstate relations is strategically important for establishing Ukraine's interaction with the European economic space. Polish-Ukrainian cooperation is being built on a new basis of European and Atlantic orientation. The scientific relevance of the topic is due to the fact that in the proposed context it has not yet been developed sufficiently.

The current geopolitical situation requires comparative analyzes of numerous aspects of the agricultural potential of Poland and Ukraine. They are necessary for utilitarian reasons and provide a scientific basis for making political decisions of a strategic nature, especially in relation to agricultural policy. The geopolitical events of the last year show that with regard to the agricultural sector of Ukraine it is necessary to make rational decisions supported by an analysis of the current state and a forecast of their potential effects. This

applies in particular to Poland, which as a member of the EU directly borders Ukraine and is the most sensitive to changes in economic relations in this area. Therefore, the aim of the article is to analyze the trends of changes and the current state of consumption of industrial means of production on the example of mineral fertilizers and pesticides in Polish and Ukrainian agriculture.

MATERIAL AND METHODS

The analysis concerns the comparison of the consumption of the main industrial means of production, i.e. mineral fertilizers and plant protection products, by Polish and Ukrainian agriculture. An assessment of trends in changes in their consumption was also carried out. The material for analysis was statistical data from the Food and Agriculture Organization of the United Nations [FAO 2022]. The assessment was carried out for the years 1992-2020, which conditioned the availability of data

The collected data was processed dynamically by using trend analyses. The criterion for selecting the type of the trend equation was the highest value of the determination index (R^2), which determines the degree of adjustment of the statistical model. On this basis, the polynomial trend equation was used.

All data analyzed were scaled to the utilization agricultural area per hectare (ha UAA) for comparison purposes. The analysis covered mineral fertilizers divided into nitrogen (N), phosphorus (P_2O_5) and potassium (K_2O). The consumption of the active substance and the structure of pesticide consumption divided into insecticides, herbicides, fungicides and bactericides, rodenticides were also assessed.

RESULTS

Mineral fertilization is one of the main factors determining the yield of crops. It also shows the level of production intensity in a given farm or country. In the first year covered by the analysis (1992), the consumption of mineral NPK fertilizers in Poland and Ukraine was at the same level (Figure 1). However, starting from this year, changes in the consumption of mineral fertilizers in the compared countries began to follow completely opposite directions. In Poland, after the crisis caused by the change of the socio-economic system at the turn of the 1980s and 1990s, the process of systematic increase in the consumption of mineral fertilizers began, which lasted until 1998. In the years 1999-2003 there was some stabilization in this area. A strong impulse to increase the intensity of Polish agriculture was the accession to the EU. This resulted in a significant increase in the consumption of NPK mineral fertilizers in 2004-2007. This trend was partially stopped as a result of the 2008 crisis and after that period consumption stabilized relatively. However,

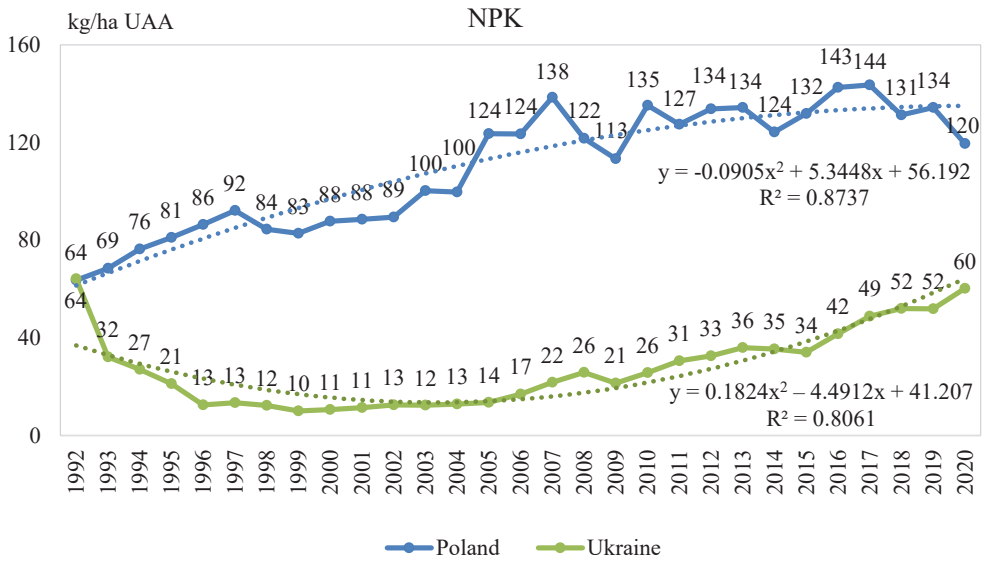

Figure 1. Trends of changes in the consumption of mineral fertilizers (NPK) in Poland and Ukraine in the years 1992-2020

Source: own study based on FAO data

the change in economic relations and external conditions (e.g. COVID-19) resulted in a trend of reducing the consumption of mineral NPK fertilizers starting from 2017.

The situation was completely different in Ukraine, where starting from 1993 there was a rapid and deep regression in the consumption of NPK mineral fertilizers. From 1996 to 2006, their consumption oscillated between 10-14 kg NPK/ha UAA, which accounted for 11-15% of consumption in Poland. This level should be considered very low. Studies by other authors indicate that consumption at such a level did not ensure the correct balance of nutrients and led to soil impoverishment in basic nutrients [Dyck et Puurveen 2020]. As a result, the yields of the main crops in Ukraine were low [Matyka 2022]. Starting from 2007, there was a slow but successive increase in the consumption of mineral fertilizers. This process was significantly accelerated starting from 2017. This may have been influenced by Russia's seizure of Crimea and Donbass in 2014 as a result of the conflict. Therefore, Ukraine, in order to maintain its production potential, intensified production in the remaining area, increasing mineral fertilization with NPK, especially with nitrogen (Figure 1 and 2). In 2020, the consumption of mineral fertilizers in Ukraine amounted to 60 kg NPK/ha UAA, which was 50% of consumption in Poland for that year.

Both in Poland and Ukraine, the trend of nitrogen (N) consumption, which is the main component determining yields, was the same as that of NPK mineral fertilizers (Figure 2). However, the share of nitrogen in the total NPK consumption differed significantly

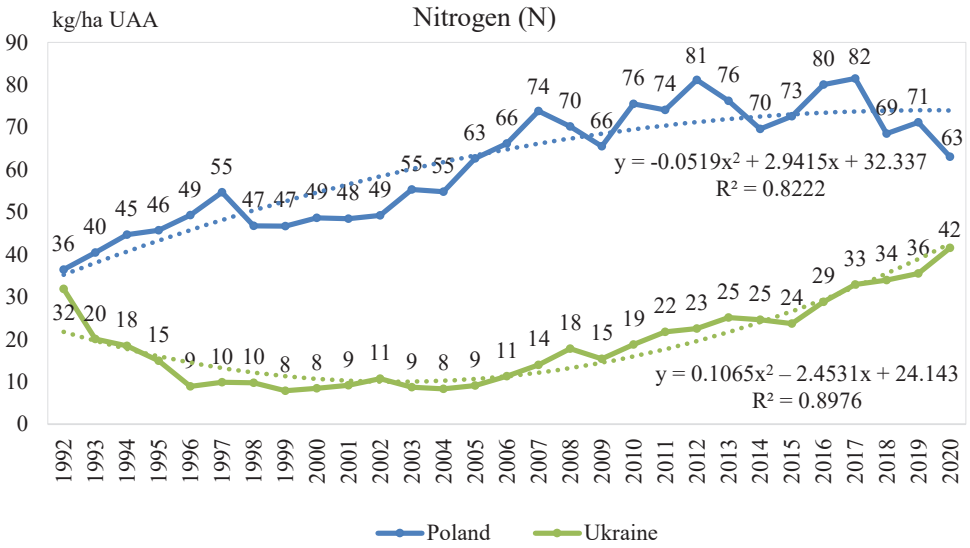

Figure 2. Trend of changes in nitrogen (N) consumption in mineral fertilizers in Poland and Ukraine in 1992-2020

Source: own study based on FAO data

between the compared countries. In the analyzed period, it fluctuated in Poland in the range from 51% to 61%, with an average value of 56%. In Ukraine, this share was higher and ranged from 50% to 85%, with an average value of 70%. The above values indicate that the correct N:P:K ratio in mineral fertilizers was not maintained both in Poland and in Ukraine, but these relationships were more incorrect in Ukraine.

In the case of phosphorus, similarly to nitrogen, consumption in the first year covered by the analysis was at a similar level in the compared countries (Figure 3). On the other hand, potassium consumption was higher (Figure 4). In the following years, there was a sharp decrease in the consumption of both phosphorus and potassium in Ukraine. The dose of phosphorus in the years 1994-2010 ranged from 1 to 4 kg P_2O_5/ha UAA, and potassium from 1 to 5 kg K_2O/ha UAA. It was 4-23% and 3-17% of the dose used in Poland, respectively. Starting from 2011, there was an upward trend in the consumption of phosphorus and potassium in Ukraine. In 2020, which was the last year covered by the analysis, the use of these macronutrients was higher and amounted to 47% for phosphorus and 24% for potassium compared to consumption in Poland. The consumption of potassium and phosphorus in Poland was characterized by varied dynamics (Figures 3 and 4). In the years 1992-2004, the consumption of these macronutrients had an upward trend, which was significantly accelerated from 2005, which was the result of Poland's accession to the EU. However, in 2008 it slowed down, which was related to the disruption of price relations

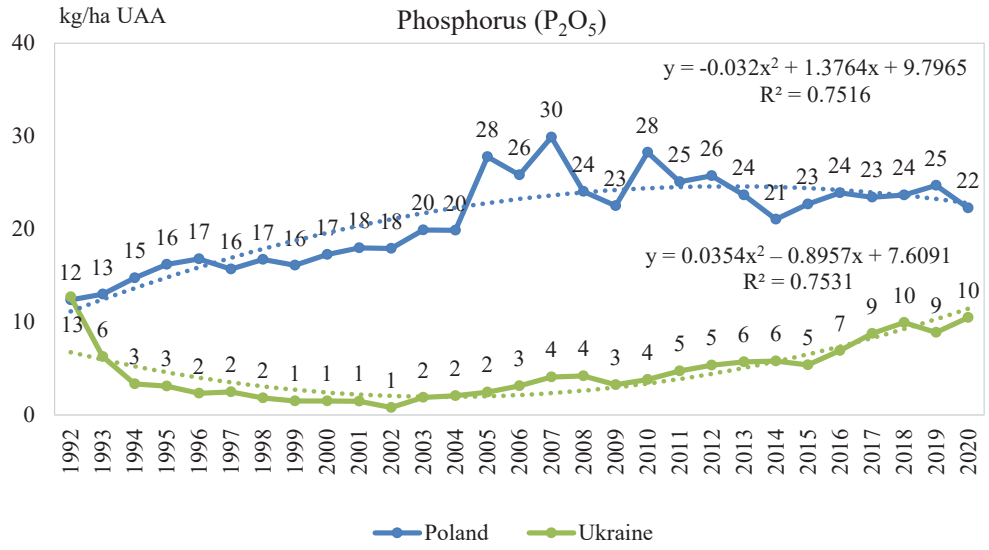

Figure 3. Trend of changes in phosphorus (P_2O_5) consumption in mineral fertilizers in Poland and Ukraine in 1992-2020

Source: own study based on FAO data

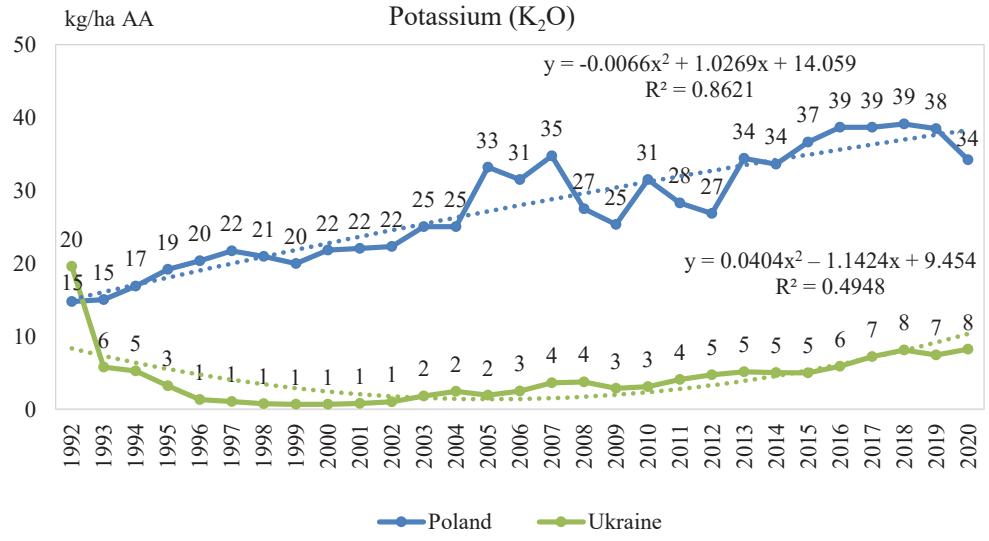

Figure 4. Trend of changes in potassium (K_2O) consumption in mineral fertilizers in Poland and Ukraine in 1992-2020

Source: own study based on FAO data

caused by the global crisis. Starting from 2013, the consumption of phosphorus was at a fairly stable level (21-24 kg P_2O_5/ha UAA). In the case of potassium, the consumption increased from 2013 to 2016, when it reached the level of 39 kg K_2O/ha UAA, and started to decrease from 2019.

Pesticides are an equally important means of production as mineral fertilizers. Despite the fact that their consumption may be associated with a certain burden for the natural environment, at present and in the coming years there are no other alternatives that would enable effective protection of crops against diseases and pests. Plant protection is essential due to the need to maintain an appropriate volume of production of good quality food.

Pesticide consumption expressed in kg of active substance per ha of UAA was characterized by a very different level and dynamics between Poland and Ukraine (Figure 5). In the years 1992-2000, the dose of pesticides per ha of UAA in Ukraine was much higher and ranged from 170% to 405% compared to the consumption in Poland. However, in this period it was characterized by a clear downward trend, while consumption in Poland was growing. As a result, in the years 2001-2004 in both countries, the consumption of the active substance of pesticides was at a similar level of 0.3-0.6 kg/ha UAA. Starting from 2005, the upward trend in Poland strengthened significantly, and in Ukraine the trend changed from downward to upward. In 2010-2014, the growth dynamics of pesticide

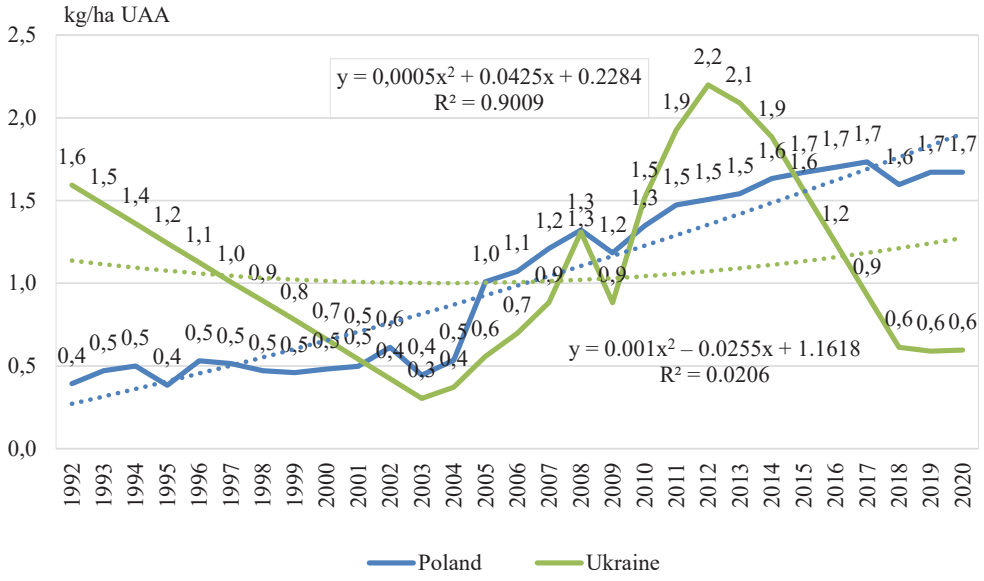

Figure 5. Trend of changes in active substance consumption in pesticides in Poland and Ukraine in 1992-2020

Source: own study based on FAO data

consumption in Ukraine increased significantly and the dose of the active substance per ha of UAA was higher than in Poland by 13-46%. In Poland, in 2011-2014, the consumption of pesticides was at a stable level of 1.5-1.7 kg a.s. per ha UAA. However, in Ukraine, starting from 2012, which was characterized by the highest consumption of the active substance amounting to 2.27 kg/ha UAA, a sharp downward trend was observed to the level of 0.67 kg a.s. per ha UAA. This could have been influenced by the political events of Euromaidan in 2013 and the subsequent conflict with Russia in 2014, which caused a significant weakening of Ukraine's economy. As a result, while the upward trend in the consumption of mineral fertilizers, produced largely in Ukraine, was maintained, it was not possible in the case of pesticides. This is due to the fact that in Ukraine pesticides are mainly supplied by foreign companies, and the economic downturn and the resulting decline in the value of the hryvnia significantly reduced the price availability of this means of production for Ukrainian farmers. In 2018-2020, the consumption of pesticides in Ukraine was close to the level of the 1990s, almost four times lower than in the peak period and lower than in Poland by 62-65%.

The analysis of the structure of pesticide use shows that both in Poland and Ukraine the dominant group was herbicides (Figures 6 and 7). However, their share in Ukraine was higher, because on average for the analyzed period it was 64%, while in Poland it was 59%. The second in terms of share were fungicides and bactericides, whose share was higher in Poland and amounted to 34%, and in Ukraine 19%. The share of insecticides in Poland was 6%, and in Ukraine 17%. Rodentocides were an insignificant group of pesticides in both countries.

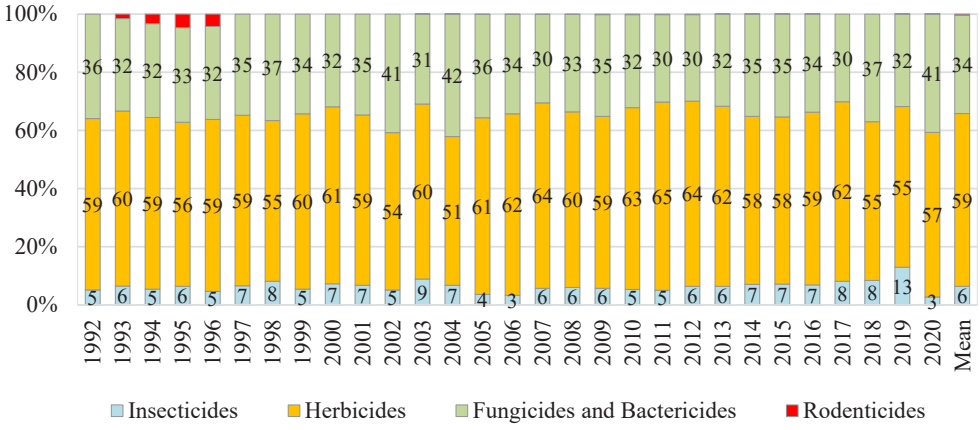

Figure 6. Changes in the structure of pesticide consumption in Poland in 1992-2020
Source: own study based on FAO data

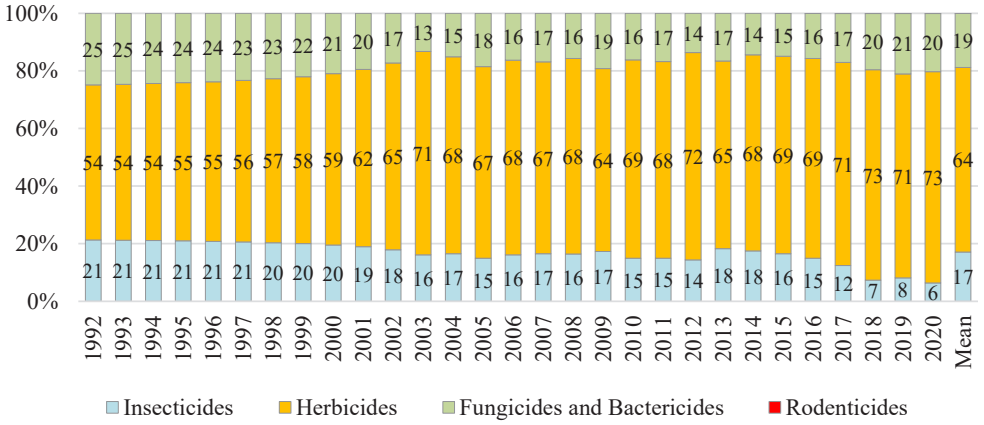

Figure 7. Changes in the structure of pesticide consumption in Ukraine in 1992-2020
Source: own study based on FAO data

CONCLUSIONS

The consumption of mineral NPK fertilizers and pesticides in Poland and Ukraine in the years 1992-2020 varied both in terms of the level, dynamics and directions of changes. This was influenced by the different dynamics of economic development, different geopolitical conditions (e.g. Poland's accession to the EU), diverse soil and climatic conditions as well as the structure and organization of farms. It should be taken into account that in Poland agricultural production is conducted mainly in individual farms. This refers both to animal and plant production. On the other hand, in Ukraine, production takes place in agriculture enterprises and households [Heldak et al. 2018]. It can be concluded that the consumption of mineral fertilizers in the analyzed period was higher in Poland than in Ukraine. On the other hand, the use of pesticides in most years was higher in Ukraine than in Poland. However, since 2015, this regularity has changed and therefore the consumption of pesticides in Poland is higher than in Ukraine. These are very important conclusions in the context of recently raised arguments about the lower quality of agricultural products from Ukraine, which is mainly due to the excessive and uncontrolled use of industrial means of production [Matuszak et al. 2023]. In the light of the presented results, this thesis is quite doubtful, because the results of the analysis clearly indicate that in recent years the consumption of both NPK mineral fertilizers and pesticides has been higher in Poland than in Ukraine. Nevertheless, their consumption in Poland is subject to higher regulatory standards in terms of quantity, time and technique of use. It should be emphasized that many active substances of pesticides that can be used in other countries are not approved for use in the EU, which may also affect the level of their consumption.

Taking into account the soil and climatic conditions of Ukraine in comparison with Poland, it should be pointed out that the growth trend in the consumption of mineral fertilizers in Ukraine in recent years may, after the end of the war, increase the production potential in this country. Also, the consumption of pesticides, which became visible at the beginning of the second decade of the 21st century, may increase rapidly in Ukraine and further strengthen the increase in the volume of food production. As a result, Ukraine will strengthen its position as the leading food producer in the world. In this case, it will be a big challenge for Poland and the EU.

The results of the analysis are an important element for creating a scientific basis for knowledge about the relations between agriculture in Poland and Ukraine. In conjunction with other research, they can be the basis for making rational and effective political decisions that will affect the economic effects in the agricultural sector of Poland and Ukraine and their mutual relations.

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ZMIANY W ZUŻYCIU NAWOZÓW MINERALNYCH I ŚRODKÓW OCHRONY ROŚLIN POLSCE I W UKRAINIE – ANALIZA PORÓWNAWCZA

Słowa kluczowe: trendy zmian, nawozy mineralne, środki ochrony roślin, Polska, Ukraina

ABSTRAKT. Ukraina ma bardzo dobre warunki przyrodnicze do prowadzenia produkcji rolniczej i z roku na rok staje się coraz bardziej liczącym się producentem w Europie i na świecie. Polska pomimo gorszych warunków przyrodniczych i ponad trzykrotnie mniejszej powierzchni użytków rolnych, jest również ważnym producentem w UE. Obecna sytuacja geopolityczna wymaga wykonania analiz porównawczych licznych aspektów potencjału rolnictwa Polski i Ukrainy. Są one konieczne ze względów utylitarnych i dają naukowe podstawy do podejmowania decyzji politycznych o charakterze strategicznym, szczególnie w odniesieniu do polityki rolnej. Dlatego celem pracy jest porównanie tendencji zamian oraz stanu aktualnego w zużyciu nawozów mineralnych i środków ochrony roślin w polskim i ukraińskim rolnictwie. Materiałem do analizy były dane statystyczne FAO. Analiza dotyczyła danych za lata 1992-2020. Zużycie nawozów mineralnych NPK i środków ochrony roślin w Polsce i na Ukrainie w badanym okresie zróżnicowane zarówno pod względem poziomu, dynamiki, jak i kierunków zmian. Zużycie nawozów mineralnych w całym analizowanym okresie było wyższe w Polsce niż w Ukrainie. Natomiast zużycie pestycydów w większości lat było wyższe w Ukrainie niż w Polsce. Jednak od 2015 roku prawidłowość ta uległa zmianie i zużycie pestycydów w Polsce było wyższe niż w Ukrainie. Biorąc pod uwagę zarysowane trendy w zużyciu nawozów mineralnych i środków ochrony roślin, należy wskazać, że Ukraina będzie wzmacniać swoją pozycję jako wiodącego producenta żywności na świecie. W takim przypadku stanowić to będzie duże wyzwanie dla Polski i całej EU, co powinno stanowić przedmiot kolejnych analiz naukowych.

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