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The impact of farm direction on the cost and quantity of used fertilizer

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ABSTRACT

Objective: The level of costs and the volume of fertilizers used are largely determined by the situation in world markets and the decisions of state authorities. Moreover, individual farms have different characteristics. Therefore, the objective of the article is to investigate the relationship between the production direction of the European Union farms, the level of fertilizer purchase costs and the amount of P2O5, K2O, and N applied in mineral fertilizers.

Research Design & Methods: The research focused on the purchase cost of fertilizers (€) and the amount of P2O5, K2O, and N applied in mineral fertilizers (q). To illustrate the direction of farm production, I used data relating to the eight agricultural types distinguished in the Farm Accountancy Data Network (FADN) database. I applied one-way ANOVA variance to achieve the research objective. However, as all the assumptions of the ANOVA model were not met, I used the non-parametric Kruskal-Wallis test.

Findings: The most frequent differences in the case of fertilizer costs are found between crop and livestock-oriented farm types. Fewer differences can be observed for farms that are oriented at the same food source. For the amount of compounds used in mineral fertilizers, identical differences are found for P2O5 and K2O. In the case of N, the main differences are linked to farms of the following types: field crops, milk, and granivores.

Implications & Recommendations: The conducted research clearly indicates that the production direction of farms in the European Union countries significantly influences the variation in both the costs incurred for the purchase of fertilizers and the amount of individual chemical compounds used in mineral fertilizers. Individual production specializations are therefore differently exposed to possible adverse political and economic developments. An analysis of the opportunities and threats to the use of mineral fertilizers by individual farm specializations is recommended. At the same time, it is justified to indicate the main determinants causing the existing differentiation.

Contribution & Value Added: The added value of the study is to determine how the production direction of the EU farms influences the costs incurred for the purchase of fertilizers and the quantity of the various types of chemical compounds used in mineral fertilizers.

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INTRODUCTION

One of the most important production factors of farms causing an increase in yields and improving the quality of crops is fertilization. It is the basis for assessing the farming intensity (Igras & Kopiński, 2007). As indicated by Malingreau *et al.* (2012), fertilizers are at the heart of the challenge of sustainable agricultural development, which aims to reconcile increasing demand for food products, respect for the environment, as well as improving farm livelihoods. The lack of fertilizer use would lead to a decrease in agricultural productivity contributing to higher food costs (Oerke, 2005; Brunelle *et al.*, 2015). On the other hand, the use of mineral fertilizers on the farm significantly affects the environment

(Gaviglio *et al.*, 2017; Czyżewski *et al.*, 2019). Indeed, excessive use of fertilizers contributes, among others, to eutrophication and water pollution or air pollution (Zhang *et al.*, 2015).

Basic fertilizers used on farms include nitrogen, potassium, and phosphate fertilizers (Kirilenko & Dronin, 2022). However, the Russian-Ukrainian crisis has caused turbulence in the fertilizer market. Liadze *et al.* (2022) indicate that fertilizer prices have increased by 30% since the beginning of the war in Ukraine. In turn, this contributes to an assessment of the profitability of their use and, consequently, their reduction or the search for alternative farming methods (Alexander *et al.*, 2022; Shahini *et al.*, 2022; Colussi *et al.*, 2022).

Different types of farms are characterized by different levels of incurring costs on means of production, including but not limited to fertilizers (Beckmann & Schimmelpfennig, 2015; Kubala, 2022). Nevertheless, some of them may be characterized by similar approaches to management and technology (Martinho *et al.*, 2022). What is lacking in previous work is an analysis of the relationship that exists between the type of farm production in the EU countries, the level of fertilizer purchase costs and the amount of the different types of chemical compounds used in mineral fertilizers. Therefore, the main aim of the study was to investigate the relationship between the production type of the EU farms and the level of fertilizer purchase costs and the amount of P2O5, K2O, and N applied in mineral fertilizers. Moreover, the results obtained are intended to show, how the production direction of the EU farms influences the costs incurred for the purchase of fertilizers and the amount of particular types of chemical compounds used in mineral fertilizers. The added value is to quantify these differences. The research is distinguished by the use of FADN data, which is a representative data collection system covering various types of European Union farms, as well as the use of ANOVA analysis.

Achieving the adopted goal was based on the formulation of the following research questions:

- Which production lines on farms are characterized by the highest and lowest costs of purchasing mineral fertilizers?
- Which production lines on farms are characterized by the highest and lowest amounts of particular types of chemical compounds in mineral fertilizers?
- Does the direction of production on European Union farms affect the level of the cost of purchasing mineral fertilizers?
- Does the direction of production on European Union farms affect the amount of particular types of chemical compounds used in mineral fertilizers?

The structure of the article comprises several parts. In the first part, I will present a literature search on fertilizer research. The next section will discuss the research methodology, both the research methods and the variables considered. Then, I will present the research results and discussion. The last part of the article will illustrate the final conclusions.

LITERATURE REVIEW AND HYPOTHESES DEVELOPMENT

Fertilization-related research is a relatively frequently undertaken topic and relates to both the supply and demand spheres. Therefore, the topics of research work in this area include the efficiency of fertilizer production, emissions of pollutants, the amount of fertilizer used by farms, or the amount of costs incurred on fertilizer.

Ladha *et al.* (2005) indicate that inorganic soil fertilization yields up to 50% higher compared to unfertilized crops, while De Ponti *et al.* (2012) highlight the greater efficiency of using inorganic fertilizers compared to natural fertilizers by 20-30%.

In contrast, Blanco (2011) and Hernandez and Torero (2013) emphasize the high degree of concentration of mineral fertilizer production, as well as the relatively large share of mineral fertilizer trade in international trade. Although mineral fertilizers are used worldwide, only a fraction of countries produce them. Consequently, other countries depend on imports of individual or all groups of fertilizers.

Van Grinsven *et al.* (2013) reached an interesting conclusion. In their study, they refer to environmental aspects and indicate that the European Union suffers between 35 EUR and up to 350 million EUR in losses per year due to nitrogen in fertilizers leaking into the environment. Zalewski (2008), Zhang *et al.* (2015) and Rudinskaya and Náglová (2021) reached similar conclusions. They all claim that intensive crop production in European countries is largely associated with the supply of nitrogen in mineral form to the soil, which in turn negatively impacts the environment. At the same time, it is associated with a poorer quality of some agricultural products. This poses a major challenge, as there has been a significant increase in the use of nitrogen fertilizers in EU countries in recent years (Matyka, 2013; Ossowska, 2017). Important conclusions are reached by Czyżyk (2011), whose research focused on the analysis of on-farm mineral fertilizer consumption rates. He indicated that on many farms the level of mineral fertilization is too high and exceeds the values recommended for sustainable agriculture. Therefore, it is necessary to know which types of farms use the most mineral fertilizers.

The interesting findings were also presented by, among others, Piwowar (2013) describing selected issues concerning the problem of fertilization and the most important problems related to the implementation of the principles of sustainable fertilization in Poland, or Świtłyk (2022), who assessed the technical efficiency and productivity of mineral fertilization in Poland. In turn, Artyszak (2022) focused on aspects of changes in fertilization between 2006 and 2021. In his work, he indicated that fertilization is dominated by nitrogen, despite the fact that the vast majority of plant species take up more potassium. At the same time, Artyszak (2022) drew attention to the need to revise the main objectives of the Green Deal due to the situation in Europe caused by the war in Ukraine.

Noteworthy, the creation of initiatives to reduce the risks associated with fertilizers should start with an examination of the knowledge, attitudes, and behaviour of farms regarding the use of these production inputs (Koh & Jeyaratnam, 1996; Aldosari *et al.*, 2018). Nowadays, the European Union's internal policies, as well as the pursuit of the United Nations goals, oblige the countries belonging to the EU structures to act to reduce the negative environmental effects of mineral fertilizer use. This means that the decisions made will have a different impact on individual types of farm operations. The biggest changes will affect those farms that use the most mineral fertilizers. Managed policy is one of the decisive factors influencing changes in mineral fertilizer management in the Western European region (FAO, 2016). Others include the strong saturation of the region's food market (Mrówczyński, 2011), the drive to optimize fertilizer use or the increasing pressure to produce healthy food (Zalewski & Piwowar, 2018).

These empirical results allowed me to assume the following research hypotheses:

H1: The distribution of the value of the incurred cost of purchasing fertilizers by the European Union farms in each production direction of these farms is the same (the production direction of the European Union farms does not significantly affect the achieved value of the incurred cost of purchasing fertilizers by these farms).

H2: The distribution of the value of the amount of P2O5, K2O, N applied in mineral fertilizers by the EU farms in each production direction of these farms is the same (the production direction of the EU farms does not significantly affect the amount of P2O5, K2O, N applied in mineral fertilizers by these farms).

This topic is extremely important for several reasons. The costs incurred for the purchase of fertilizers are basic farm expenses, while the amount of chemical compounds used in mineral fertilizers contributes significantly to the environmental impact. The amount of costs and the quantity of fertilizers used are largely determined by the situation on world markets, as well as policy decisions. The increased interest in this topic is therefore extremely necessary at present due to the instability in the Central and Eastern European region, as well as the new European Union regulations on fertilizer products. The war in Ukraine is contributing to high fertilizer prices and restrictions on the use of fertilizers. Indeed, Russia is one of the largest producers of fertilizers in the world and the largest exporter. In turn, in addition to the clear advantages of sustainable agriculture and increased food quality, the Farm to Fork strategy also has disadvantages for the EU countries in terms of a decline in agricultural productivity, which in turn may contribute to higher food prices (Dobrin *et al.*, 2022). It is therefore reasonable to keep a constant eye on both the costs incurred on fertilizers and the amount of chemical compounds used in mineral fertilizers in the various farm production lines. This is all the more so because an accurate knowledge of the level of costs is necessary to actually determine the level of profitability of an organization (Samuelson &

Marks, 2006). The research carried out will make it possible to determine whether or not all production specializations are equally exposed to possible political and economic disadvantages.

RESEARCH METHODOLOGY

The study uses data from the FADN system. This makes it possible to select a representative sample according to the criterion of agricultural type, which determines the production specialization of farms (Goraj *et al.*, 2006). Conducted research based on such samples of farms allows us to formulate conclusions that will apply to the entire population of farms. Irz and Jansik (2015) as well as Kelly *et al.* (2018) emphasize the significant potential of the FADN database to provide answers to many important questions related to the agricultural sphere.

The undertaken studies focus on the purchase cost of fertilizers (€) and the amount of P2O5, K2O, and N applied in mineral fertilizers (q). In the FADN database, these variables are marked by the following symbols: SE295, SE296, SE297, SE298. All countries belonging to the structure of the European Union were taken into account in the research.

To illustrate the production direction of farms, I used data relating to the eight agricultural types distinguished in the FADN database. I distinguished the following farm types:

– Field crops (A);
– Horticulture (B);
– Wine (C);
– Other permanent crops (D);
– Milk (E);
– Other grazing livestock (F);
– Granivores (G);
– Mixed (H).

In the case of the cost of purchasing fertilizers, the study period covered the years 2005-2020. Due to limitations in the availability of statistical data, in the case of the quantities of individual chemical compounds used in mineral fertilizers, the study period covered the years 2014-2020.

One-way ANOVA variance was used to achieve the research objective. ANOVA resolves the existence of differences between averages in several populations (Rutherford, 2011; Aczel & Sounderpandian, 2018). ANOVA tests the hypothesis of equality of means, viz:

H0: $m_1 = m_2 = \ldots = m_k$

H1: $m_1 \neq m_j \; for \; certain \; l \neq j$

The ANOVA method has a number of assumptions (Stanisz, 2007):

1. The independence of the random variables in the populations (groups) under consideration.
2. Measurability of the analysed variables.
3. Normality of the distribution of the variables in each population (group).
4. Homogeneity of variance in all populations (groups).

I tested the assumption regarding the normality of the distribution of the variables in each population (group) using the Shapiro-Wilk test. As indicated by Ahad *et al.* (2011) and Prabhaker *et al.* (2019), this test has greater power to detect non-normality than other tests. To check whether there are grounds to reject the null hypothesis (data distribution follows a normal distribution), I used a p-value. If the p-value is lower than the assumed significance level of 5%, there are no grounds to reject the null hypothesis of normality of the distribution of the analysed characteristic.

I performed the test for homogeneity of variance across all populations (groups) using the Bartlett test. It focuses on comparing the weighted arithmetic mean of the variance with the weighted geometric mean of the variance. It is based on a statistic that has an asymptotic distribution χ^2. If at least one of the assumptions of the ANOVA model is not met, it is reasonable to use the non-parametric Kruskal-Wallis test (van Hecke, 2010). The interpretation of this test is similar to that of a parametric one-way ANOVA, except that this test speaks of equality of mean ranks rather than mean values.

RESULTS AND DISCUSSION

In the first stage of the research, I focused on analysing the basic statistics of the dependent variables (Table 1). In the case of the cost of purchasing fertilizers, the lowest level was characterized by farms of the type: other permanent crops, wine, and other grazing livestock. I observed the highest level of costs incurred in the type: field crops and horticulture, which results from the need for greater use of fertilizers in this type of crops. Smaller values were observed in farms oriented towards grain-eating animals, milk and the mixed type. Growing feed for livestock requires significant use of fertilizers and plant protection products.

Table 1. Basic data of dependent variables in individual groups

Dependent variable: Fertilisers (€)						
Types of agricultural enterprises	**Average**	**Median**	**Min**	**Max**	**Kurtosis**	**Skewness**
A	6964.38	7414.5	5026	7877	-0.86	-0.85
B	5794.62	5606.5	4245	7671	-0.92	0.32
C	1919.75	2009.0	1255	2547	-1.59	-0.06
D	1719.62	1700.5	1067	2401	-1.5	0.04
E	3728.00	3682.5	2469	4917	-0.9	0.06
F	1960.69	1946.5	1609	2323	-0.57	0.31
G	3728.81	4115.5	2232	4978	-1.56	-0.32
H	2777.81	2816.0	1839	3646	-0.79	0.02
Dependent variable: Fertiliser P205 (q)						
Types of agricultural enterprises	**Average**	**Median**	**Min**	**Max**	**Kurtosis**	**Skewness**
A	13.03	15.65	4.46	20.24	-2.13	-0.16
B	4.96	6.33	2.36	7.11	-2.14	-0.22
C	2.88	3.73	1.29	4.08	-2.12	-0.25
D	2.53	3.34	1.06	3.60	-2.18	-0.23
E	4.82	5.51	1.81	7.22	-2.10	-0.15
F	2.73	3.32	0.52	4.43	-2.06	-0.2
G	5.49	6.81	2.84	7.14	-1.91	-0.42
H	4.80	5.17	1.68	7.66	-2.11	-0.08
Dependent variable: Fertiliser K2O (q)						
Types of agricultural enterprises	**Average**	**Median**	**Min**	**Max**	**Kurtosis**	**Skewness**
A	15.24	17.11	5.62	23.12	-2.11	-0.13
B	8.42	10.33	4.07	11.51	-2.06	-0.27
C	3.35	4.44	1.49	4.85	-2.18	-0.22
D	3.27	4.21	1.26	4.83	-2.17	-0.20
E	6.66	7.14	2.61	9.92	-2.09	-0.10
F	3.54	4.18	0.75	5.70	-2.05	-0.20
G	8.00	10.00	3.91	10.96	-1.95	-0.37
H	6.30	6.41	2.38	9.93	-2.11	-0.03
Dependent variable: Fertiliser N (q)						
Types of agricultural enterprises	**Average**	**Median**	**Min**	**Max**	**Kurtosis**	**Skewness**
A	38.74	47.12	13.50	60.46	-2.11	-0.19
B	8.49	9.99	4.40	12.08	-2.10	-0.18
C	4.71	6.62	1.73	6.93	-2.18	-0.24
D	4.53	6.00	1.88	6.73	-2.18	-0.21
E	24.64	27.98	9.46	36.46	-2.09	-0.16
F	10.59	13.29	2.70	17.73	-1.98	-0.23
G	22.64	30.32	8.89	31.88	-2.03	-0.33
H	17.97	20.83	5.78	27.97	-2.10	-0.15

Source: own study.

In the case of the volume of use of individual types of chemical compounds in mineral fertilizers by the EU farms, I observed similar relationships. Both the share of P2O5, K2O, and N in mineral fertilizers is highest on farms of field crops type. Farms targeting granivores, horticulture, and milk follow this sequence for P2O5. For K2O, farms focusing on horticulture, granivores, and milk adhere to this order. In the case of N, farms specializing in milk, granivores, and mixed types follow this pattern. We can observe the smallest magnitudes in farms oriented towards wine, other permanent crops, and other grazing livestock.

Moreover, I created box plots were created (Figure 1).

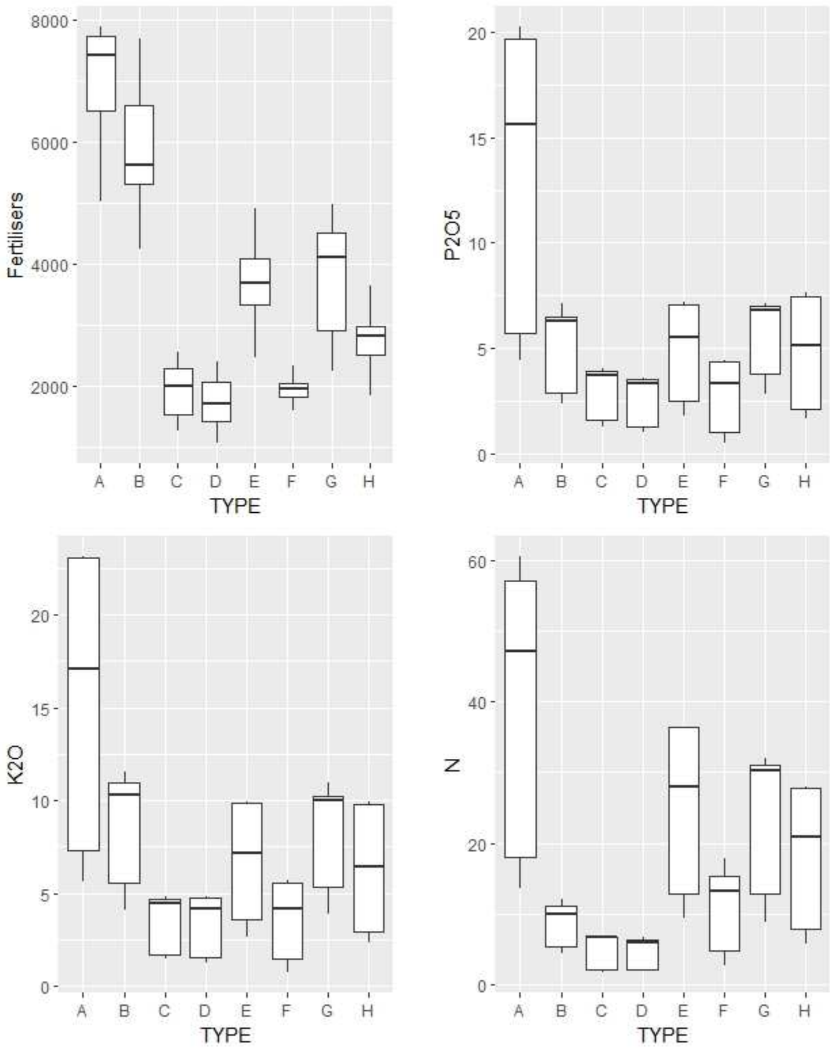

Figure 1. Box plots showing the relationship between the direction of production of the EU farms, the value of the incurred cost of purchasing fertilizers and the amount of each type of chemical compound used in mineral fertilizers by these farms

Source: own elaboration.

In the next step, I checked the normality of the variables' distribution. I included the results of the Shapiro-Wilk test in Table 2. The conducted tests indicate that there is a p-value of less than 5%, which means that there is no normal distribution in each of the groups.

I verified the homogeneity of variance using the Bartlett test. Table 3 presents the results. The test allowed me to conclude that there was no homogeneity of variance in any of the groups considered. This was evidenced by the p-value values as each was less than 5%.

Table 2. Results of the Shapiro-Wilk test

Types of agricultural enterprises	Dependent variable: Fertilisers (€)		Dependent variable: Fertiliser P205 (q)		Dependent variable: Fertiliser K2O (q)		Dependent variable: Fertiliser N (q)	
	W	p-value	W	p-value	W	p-value	W	p-value
A	0.811	0.004	0.796	0.037	0.801	0.042	0.815	0.058
B	0.945	0.416	0.794	0.036	0.816	0.059	0.841	0.101
C	0.926	0.210	0.779	0.025	0.747	0.012	0.729	0.008
D	0.940	0.350	0.743	0.011	0.751	0.013	0.748	0.012
E	0.971	0.852	0.816	0.059	0.822	0.067	0.810	0.052
F	0.965	0.750	0.815	0.057	0.826	0.073	0.864	0.165
G	0.901	0.082	0.771	0.021	0.809	0.050	0.768	0.019
H	0.974	0.900	0.812	0.054	0.810	0.052	0.804	0.045

Source: own study.

Table 3. Bartlett test results

Dependent variable: Fertilisers (€)	
K-squared	p-value
51.835	6.293e-09
Dependent variable: Fertiliser P205 (q)	
K-squared	p-value
33.488	2.147e-05
Dependent variable: Fertiliser K2O (q)	
K-squared	p-value
24.798	0.000824
Dependent variable: Fertiliser N (q)	
K-squared	p-value
42.718	3.781e-07

Source: own study.

The Shapiro-Wilk and Bartlett tests indicated that the assumptions of ANOVA tests were not met for each dependent variable. Therefore, it was reasonable to apply the non-parametric Kruskalla-Wallis test in further considerations (Table 4). Its purpose in the research was to determine the relationship between the direction of production of the European Union farms and the adopted dependent variables.

Table 4. Results of the Kruskal-Wallis rank ANOVA test

Dependent variable: Fertilisers (€)	
Chi-squared	p-value
109.030	< 2.2e-16
Dependent variable: Fertiliser P205 (q)	
Chi-squared	p-value
20.476	0.004629
Dependent variable: Fertiliser K2O (q)	
Chi-squared	p-value
24.661	0.0008714
Dependent variable: Fertiliser N (q)	
Chi-squared	p-value
32.786	2.902e-05

Source: own study.

The obtained values indicated – at the assumed significance level of 5% – that the individual hypotheses, which indicate that the distribution of the value of the incurred cost of purchasing fertilizers/amounts of P2O5, K2O, and N applied in mineral fertilizers by the European Union farms in each production direction of these farms is the same, should be rejected in favour of the alternative hypothesis, according to which at least two production directions differ in terms of the value of the incurred cost of purchasing fertilizers/amounts of P2O5, K2O, and N applied in mineral fertilizers by these farms from the others. This means that the production directions of farms in EU countries significantly differentiate the level of dependent variables adopted for the study.

To determine the reasons for the significant differentiation of the direction of production of farms in the European Union and the values of individual variables, I used a multiple comparison test (Table 5).

Table 5. Dunn test results with Bonferroni correction

Types of agricultural enterprises	Dependent variable: Fertilisers (€)						
	A	B	C	D	E	F	G
B	1.000	-	-	-	-	-	-
C	0.000*	0.000*	-	-	-	-	-
D	0.000*	0.000*	1.000	-	-	-	-
E	0.048	0.459	0.002*	0.000*	-	-	-
F	0.000*	0.000*	1.000	1.000	0.002*	-	-
G	0.033	0.339	0.003*	0.000*	1.000	0.003*	-
H	0.001*	0.004*	0.274	0.062	1.000	0.274	1.000
Types of agricultural enterprises	**Dependent variable: Fertiliser P205 (q)**						
	A	**B**	**C**	**D**	**E**	**F**	**G**
B	0.864	-	-	-	-	-	-
C	0.021*	1.000	-	-	-	-	-
D	0.005*	1.000	1.000	-	-	-	-
E	1.000	1.000	1.000	0.965	-	-	-
F	0.013*	1.000	1.000	1.000	1.000	-	-
G	1.000	1.000	0.833	0.292	1.000	0.602	-
H	1.000	1.000	1.000	0.818	1.000	1.000	1.000
Types of agricultural enterprises	**Dependent variable: Fertiliser K2O (q)**						
	A	**B**	**C**	**D**	**E**	**F**	**G**
B	1.000	-	-	-	-	-	-
C	0.008*	0.089	-	-	-	-	-
D	0.008*	0.085	1.000	-	-	-	-
E	0.730	1.000	1.000	1.000	-	-	-
F	0.016*	0.152	1.000	1.000	1.000	-	-
G	1.000	1.000	0.245	0.234	1.000	0.393	-
H	0.567	1.000	1.000	1.000	1.000	1.000	1.000
Types of agricultural enterprises	**Dependent variable: Fertiliser N (q)**						
	A	**B**	**C**	**D**	**E**	**F**	**G**
B	0.047	-	-	-	-	-	-
C	0.001*	1.000	-	-	-	-	-
D	0.001*	1.000	1.000	-	-	-	-
E	1.000	0.312	0.015*	0.007*	-	-	-
F	0.224	1.000	1.000	1.000	1.000	-	-
G	1.000	0.503	0.029	0.015*	1.000	1.000	-
H	1.000	1.000	0.402	0.240	1.000	1.000	1.000

Note: * - statistically significant differences.
Source: own study.

The obtained results indicated that significant differences in the amount of costs incurred for fertilizers occur for farms oriented towards field crops with farms of the types: wine, other permanent crops, other grazing livestock, mixed, horticulture type with wine, other permanent crops, other grazing livestock, mixed, milk type with wine, other permanent crops and other grazing livestock and granivores type with wine, other permanent crops and other grazing livestock. On the other hand, in the case of the volume of application of individual types of chemical compounds in mineral fertilizers, significant differences are observed in the case of P2O5 and K2O application by farms specializing in field crops with the type wine, other permanent crops and other grazing livestock. In the case of N application, significant differences are observable between the type of field crops and wine, other permanent crops, the type of milk and the type of wine, other permanent crops and between the type of granivores and other permanent crops.

The results obtained are consistent with the studies by Beckmann and Schimmelpfennig (2015), who indicate that a farm type and location have a significant impact on the level of costs incurred, as well as Martinho *et al.* (2022), emphasizing that certain farm types are characterized by similar approaches to management and technology and therefore also by similar levels of incurred costs for fertilizers. Moreover, the obtained results also allowed me to confirm the achievements of Gerrard *et al.* (2012), who found that English horticulture farms incurred the highest cost on fertilizer purchases, and Dabkiene *et al.* (2021) who indicated that the highest level of inorganic fertilizer consumption is found on farms oriented towards field and horticulture, while the lowest level is found on farms specializing in grazing livestock and mixed farms. It is also worth referring to the research of Ribaudo (2011), who presents that certain crop species can consume a higher amount of fertilizers. These should primarily include maize, oilseed rape, and wheat. Similarly, Grzelak and Kryszak (2023) note that fertilizer use is particularly high for field crops.

CONCLUSIONS

The conducted analysis revealed that we may observe the highest level of fertilizer purchase in the case of farms focused on field crops, horticulture, milk and granivores. On the other hand, I observed the highest level of application of P2O5, K2O, N in mineral fertilizers in farms oriented towards field crops.

I verified negatively the hypotheses stating that the distribution of the value of the incurred cost of purchasing fertilizers by the EU farms in each production direction of these farms is the same (H1) and that the distribution of the value of the amount of P2O5, K2O, N applied in mineral fertilizers by the EU farms in each production direction of these farms is the same (H2).

I found the most frequent differences in the case of fertilizer between crop and livestock farm types. Fewer differences can be observed in the case of farms that target the same food source (especially for farms associated with livestock production).

In the case of the amount of chemical compounds used in mineral fertilizers, I observed identical differences for P2O5 and K2O. The main differences were between farms targeting field crops with the type: wine, other permanent crops, and other grazing livestock. In the case of N, the main differences are linked to the farms of the type: field crops, milk and granivores, *i.e.* the types with the highest average consumption of this chemical compound during the period studied.

On the one hand, the observable differences result from the different specifications of crop and livestock production and, on the other hand, from the amount of costs incurred on fertilizers and the degree of consumption of particular types of chemical compounds in mineral fertilizers. It turns out that those farm types characterized by the highest level of costs on fertilizers and the degree of consumption of individual types of chemical compounds in mineral fertilizers have the most significant differences.

The research unequivocally shows that the production direction of farms in the European Union countries significantly influences the differentiation both in the case of incurred costs of purchasing fertilizers and the amount of particular chemical compounds used in mineral fertilizers. The research results show which production specializations are similarly exposed to possible adverse political and economic phenomena. The achieved results are important primarily for state authorities, which, when deciding to limit the use of fertilizers, should also propose other forms of support for individual types of farms. Therefore, I recommend a further analysis of the undertaken topic. In particular, it is advisable to analyse the opportunities and threats to the use of mineral fertilizers by individual farm orientations in the face of significant political and economic changes.

It is important to remember the limitations of the conducted research. A longer time series may indicate other relationships between the studied variables. Moreover, research conducted for individual countries may give different results, which is important due to the agricultural policy pursued at the national level. Therefore, it is recommended that further work should focus on analysing this topic within individual countries. At the same time, it is justified to indicate the main determinants causing the existing differentiation.

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