

Global Trends in Fertilizer Commerce: A Dual Analysis of General and Nitrogen Fertilizer Markets

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Abstract: This paper explores the dynamics of the global fertilizer market, focusing on general and nitrogenous fertilizers. The aim of the paper is to determine the trends and shifts in this market, specifically examining the role of major players like Russia and Brazil and the growing influence of Middle Eastern countries in nitrogenous fertilizer exports. The study employs index analysis of export and import data over the last 20 years, highlighting the evolution and current state of the market. The results indicate growing trade volumes and evolving trade patterns, reflecting the market's response to global economic and political factors. The discussion includes an emphasis on the increasing global demand for nitrogen fertilizers, which is expected to reach 108 million metric tons by 2024, driven by lower prices and the need for higher agricultural yields. It also highlights the significant role of Middle Eastern countries, especially Oman, in the nitrogenous fertilizer market, leveraging their abundant natural gas resources and strategic locations for expanding exports.

Keywords: fertilizers; nitrogenous fertilizers; trade; export

JEL Classification: F14; Q11; Q17

1. Introduction

The global fertilizer market plays a critical role in maintaining agricultural productivity and ensuring food security despite efforts to restrict their use. This market has evolved significantly over the years, with nitrogen fertilizers emerging as a key component. Their importance in modern agriculture cannot be overstated, as they are fundamental to enhancing crop yields, particularly in staple crops like wheat and rice (Kottegoda et al., 2017), which is one of the most produced grains in the world after maize (Statista, 2023). This has been essential in meeting the food demands of nearly half of the world's population (Ceasar, 2018).

Fertilizer markets are also crucial in ensuring the stability and sustainability of food systems, especially in the face of global challenges such as conflicts and supply shocks (Ben Hassen & El Bilali, 2022; Shahini et al., 2022). Ben Hassen and El Bilali (2022) and Shahini et al. (2022) explained that the disruption of fertilizer supplies due to conflicts, as seen in the Russia-Ukraine war, can lead to reduced agricultural productivity and subsequent rises in food prices. Additionally, the excessive and indiscriminate use of chemical fertilizers in

developing countries has been a common practice to intensify crop yield, highlighting the significance of fertilizers in agricultural productivity (Sharma et al., 2022).

Nitrogen fertilizers, in particular, have become increasingly important in global agriculture. Most agricultural production systems are limited by nitrogen availability, hence the widespread and increasing use of nitrogen fertilizers (Irisarri et al., 2021). However, the efficient use of nitrogen fertilizers is crucial for sustainable agriculture, as it can reduce the negative impact of agriculture on the environment (Szulc et al., 2020). Furthermore, nitrogen fertilization can lead to changes in agricultural characteristics and gas emissions, affecting global warming (Park et al., 2023). Therefore, the management and application of nitrogen fertilizers are critical not only for agricultural productivity but also for environmental sustainability. The efficient use of nitrogen in agriculture is a subject of extensive research, focusing on management practices, precision agriculture, and soil tillage strategies (Rütting et al., 2018).

It is important to say that scarcity of fertilizer supplies could lead to significant global repercussions, particularly in developing nations. In these regions, the impact of soaring fertilizer costs could drastically curtail usage, potentially leading to diminished local crop yields during periods of reduced global supply and unprecedentedly high prices. Elevated fertilizer prices contribute to an increase in the cost and a decrease in the abundance of the world's food supply. This occurs as farmers, facing financial constraints, reduce the amount of nutrients provided to their crops, resulting in decreased agricultural yields (RaboResearch, 2022).

Moreover, the global fertilizer market has significant economic implications. The global fertilizer market, particularly the nitrogen fertilizers market, is influenced by various factors such as technological advancements, environmental concerns, and international trade dynamics. Fertilizer production accounts for a substantial portion of ammonia and nitric acid demands, and it has a considerable market size in terms of revenue (Lim et al., 2021). However, the rising international prices of fertilizers, exacerbated by increasing oil and gas prices, pose challenges for governments in subsidizing fertilizers and maintaining food security (Dulanjani & Shantha, 2022; Ward et al., 2020).

One of the key trends in the global fertilizer market is the adoption of knowledge-based nitrogen management practices aimed at increasing staple grain production while minimizing greenhouse gas emissions and reactive nitrogen pollution (Xia et al., 2017). This trend reflects a shift towards sustainable agricultural practices prioritizing productivity and environmental impact.

There are trade-offs between nitrogen fertilizer use and land utilization, emphasizing the need to consider resource efficiency in food production systems (Ibarrola-Rivas & Nonhebel, 2016). This perspective is crucial in understanding the trade dynamics of nitrogen fertilizers, as it reflects the complex relationship between fertilizer use, land availability, and international trade patterns. In the context of international trade, the importance of food supply chain resilience to environmental shocks is emphasized, highlighting the need for diverse sourcing strategies and domestic reserves to mitigate potential disruptions in the global fertilizer market (Davis et al., 2020). Furthermore, the incidence of environmental charges in the nitrogenous fertilizer industry within the context of trade exposure provides insights into the economic and regulatory aspects influencing international trade dynamics (Bushnell & Humber, 2017).

It is compelling to note that the global dependency on nitrogen fertilizers has led to a significant increase in agricultural productivity, contributing to food security. However, recent shifts in trade patterns, coupled with environmental and geopolitical factors, have raised concerns about the stability and sustainability of the global fertilizer market. The interconnectedness of international trade, environmental impacts, and agricultural productivity underscores the need for comprehensive strategies to address the challenges and opportunities within the fertilizer market and nitrogen fertilizer market.

The aim of the paper is to examine trends in the global fertilizer market and to clarify the nuances of the international trade with fertilizers and nitrogenous fertilizers. In particular, the first research question is to identify the main actors in the trade with fertilizers and nitrogen fertilizers. The second research question concerns the investigation of the differences between the general trade with fertilizers and the trade with nitrogenous fertilizers among the largest exporters.

2. Methodology

To identify the global fertilizer market trends, the focus was on the volume of exports and imports expressed in monetary value, specifically in United States Dollars (USD). To compare the tendencies, the index analysis was used as the primary statistical method. The paper uses the growth coefficients, which determine the dynamics of the observed time series. The basis is formed by the simple growth coefficient

$$k_i = \frac{Q_i}{Q_0}, \quad (1)$$

where Q_i represents the value in the current period and Q_0 represents the value in the base period.

Because the simple growth coefficient demonstrates only the change within two periods, the average growth coefficient is also employed. The average growth coefficient, which determines the average growth during the observed period, is calculated as a geometric mean of all simple interannual growth coefficients:

$$\bar{k} = \sqrt[n]{k_1 \cdot k_2 \cdot \dots \cdot k_n}. \quad (2)$$

By replacing the individual coefficients with the expression from Equation 1, the following formula is achieved:

$$\bar{k} = \sqrt[n]{\frac{Q_1}{Q_0} \cdot \frac{Q_2}{Q_1} \cdot \dots \cdot \frac{Q_n}{Q_{n-1}}} = \sqrt[n]{\frac{Q_n}{Q_0}}. \quad (3)$$

The average growth coefficient represents one of the primary indexes used to describe a specific time series (Hindls et al., 2007). In this paper, average growth coefficients for the largest exporters will be compared to determine the tendencies among particular countries.

The data employed in this paper were taken from the Trade Map database, an online platform developed by the International Trade Centre UNCTAD/WTO (ITC). The values from the last 20 years were used (International Trade Centre, 2023). The dual analysis of the trends focuses on comparing the general and nitrogenous market development with fertilizers. In both cases, the attention was paid to the five largest exporters.

3. Results

As the global population expands, a demand for higher agricultural yields arises. Simultaneously, the trade volume associated with fertilizers experiences an adequate increase. This tendency is outlined in Figure 1, where the exports of fertilizers expressed in metric tons are presented. Due to the limitation of the International Trade Centre database, which contains only data on trade values in USD, the FAOSTAT database was used for this particular figure (FAOSTAT, 2024).

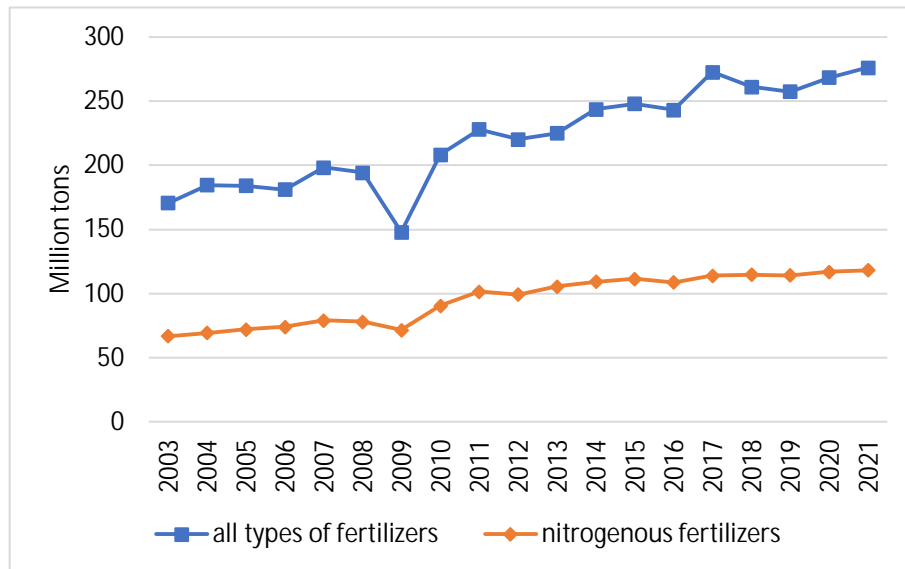


Figure 1. Global exports of fertilizers 2003–2021 in tons (own elaboration based on data from FAOSTAT 2024))

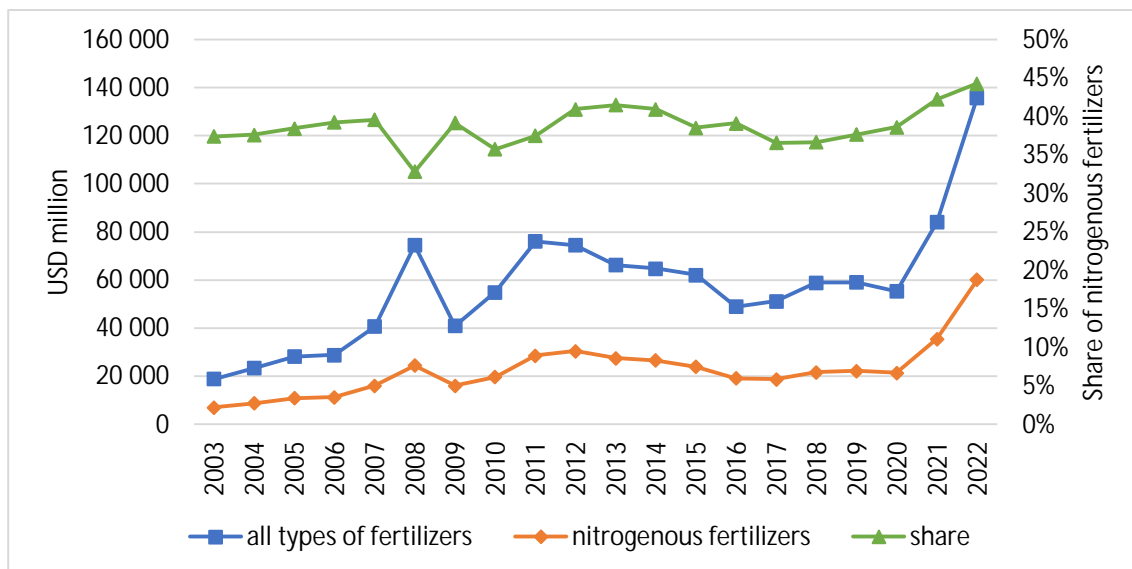


Figure 2. Global exports of fertilizers 2003–2022 (own elaboration based on data from International Trade Centre (2023))

Figure 2 sets up the basic framework for the analysis of the trade with fertilizers. A constant augmentation in the amount of fertilizers exported is intricately linked to the dynamics of changes in the prices of the key commodities needed to produce fertilizers

(Huang et al., 2009). For this reason, it is possible to identify significant volatility in the trade volume expressed in USD.

Before 2008, the prevailing trend in the fertilizer market reported a rise in the value of exports. This tendency resulted from two phenomena: the increasing demand for fertilizers and the escalation in commodity prices. However, the growing prices entailed demand destruction, manifesting as a noticeable reduction in the exported value in 2009 (Huang et al., 2009).

The significance of commodity prices has become evident over the past two years after the outbreak of the Ukraine conflict. Heightened uncertainty and disruptions in the markets of key crops for fertilizers have resulted in a rise in commodity prices. Concurrently, the escalation in fertilizer prices can be attributed to an increase in natural gas prices, as natural gas is necessary for producing fertilizers. The conflict has also shown its influence because of Russia's abundance of natural gas (Kee et al., 2023). While the overarching trend in the general demand for fertilizers has not undergone substantial changes, the monetary value of exports has experienced a considerable increase in the last two years (Quinn, 2020).

Within the dual analysis, it was necessary to delineate the scope of the role of nitrogen fertilizers in the entirety of the fertilizer trade. Based on the examined time series, it is evident that nitrogenous fertilizers establish the predominant constituent within the long-term perspective of fertilizer trade. In recent years, nitrogenous fertilizers have almost attained a half share in the monetary value of the global fertilizer trade. Specifically, the share of individual types of fertilizers in total exports is shown in Figure 3.

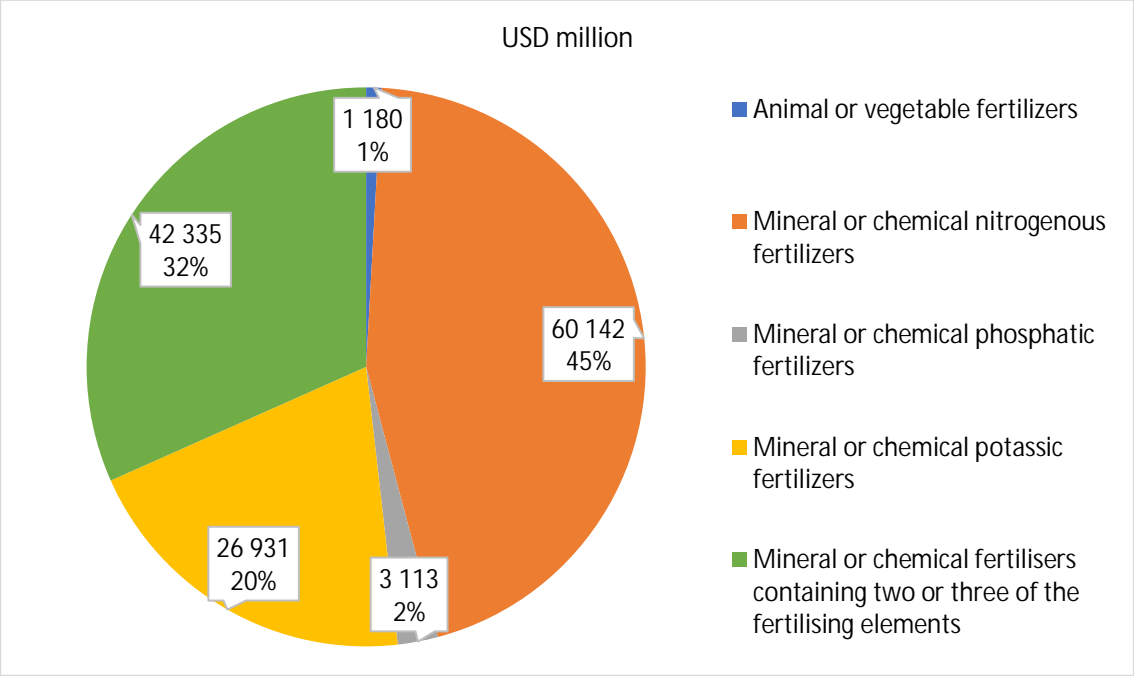


Figure 3. Structure of the global export of fertilizers in 2022 (own elaboration based on data from International Trade Centre (2023))

For the analysis of global trends itself, it was first necessary to identify the main global actors. The following table demonstrates the five largest exporters on the general market with fertilizers and on the market with nitrogenous fertilizers in 2022.

Table 1. Five largest exporters of all types of fertilizers and nitrogenous fertilizers in 2022 (own elaboration based on data from International Trade Centre (2023))

All types of fertilizers			Nitrogenous fertilizers		
Country	Value exported in 2022 (USD million)	Share in world export	Country	Value exported in 2022 (USD million)	Share in world export
Russia	20,969	15.44%	Russia	7,222	12.01%
Canada	13,729	10.11%	Oman	4,976	8.27%
China	11,380	8.38%	China	4,923	8.19%
USA	8,472	6.24%	Qatar	3,577	5.95%
Morocco	7,715	5.68%	Saudi Arabia	3,221	5.36%

In the case of exports, Russia stands as the largest exporter in both categories. Beyond Russia, China also emerges as one of the five major exporters. Nevertheless, it is necessary to highlight that, in contrast to the trade involving all types of fertilizers, the preeminent positions in nitrogenous fertilizer exports are predominantly occupied by Middle Eastern countries.

The same table was created to outline the situation among the main importers. In this case, there is no significant difference between the situation in the import of all types of fertilizers and the import of nitrogenous fertilizers.

Table 2. Five largest importers of all types of fertilizers and nitrogenous fertilizers in 2022 (own elaboration based on data from International Trade Centre (2023))

All types of fertilizers			Nitrogenous fertilizers		
Country	Value imported in 2022 (USD million)	Share in world export	Country	Value imported in 2022 (USD million)	Share in world export
Brazil	24,785	16.17%	India	7,489	11.59%
India	17,260	11.26%	Brazil	6,683	10.34%
USA	13,248	8.64%	USA	4,885	7.56%
China	4,954	3.23%	France	3,581	5.54%
France	4,786	3.12%	Australia	2,323	3.60%

The relationships between the largest exporters and importers were examined as a next step. Among the top five global exporters of all types of fertilizers, Brazil is consistently ranked as the largest or second-largest trading partner. However, within the subset of the top five exporters of nitrogenous fertilizers, Brazil is the primary trading partner solely for China. Meanwhile, Brazil does not belong among the largest trading partners for Qatar and Saudi Arabia.

The last step of the analysis was the usage of growth coefficients. The procedure described in the methodology was applied to the five largest exporters of all fertilizers and, simultaneously, to the five largest exporters of nitrogenous fertilizers. To discern the principal patterns, simple growth coefficients were calculated to determine the changes in the last 20 years, the last 10 years, and the interannual change. Moreover, the average growth coefficient was calculated for the whole period.

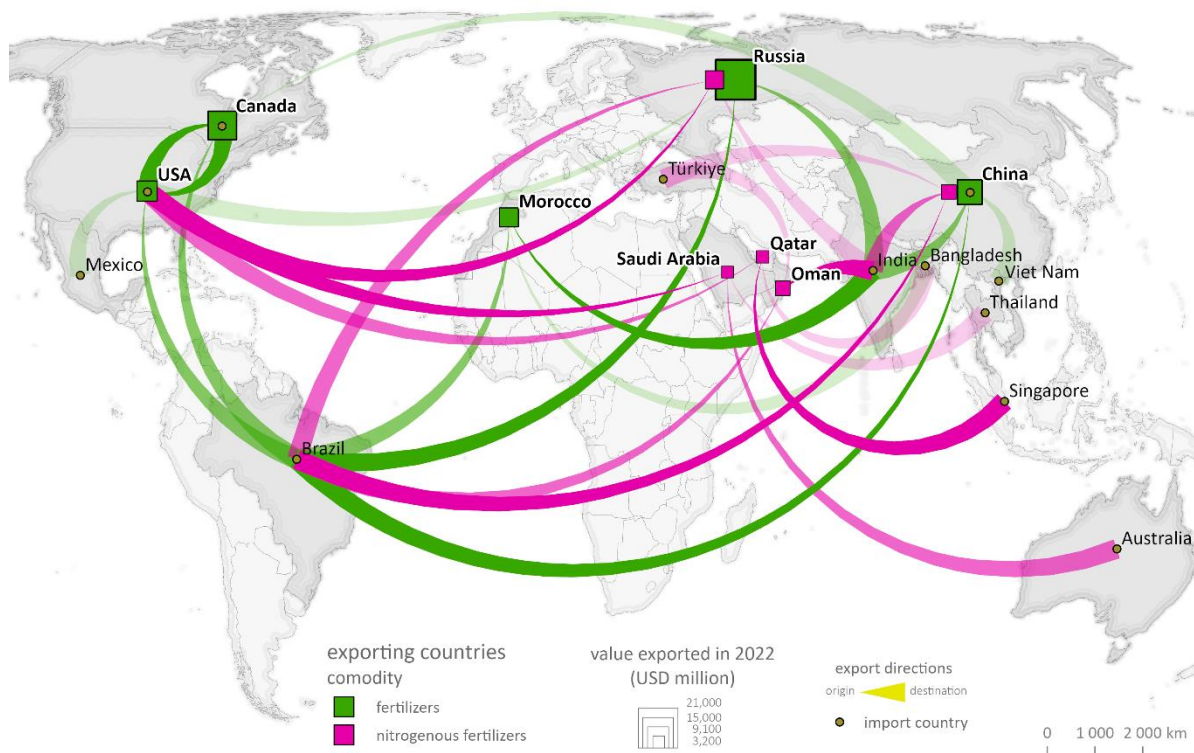


Figure 4. Relations between the largest exporters and importers of all fertilizers and nitrogenous fertilizers (own elaboration based on data from International Trade Centre (2023))

Table 3. Analysis of export development of all types of fertilizers (own elaboration based on data from International Trade Centre (2023))

Country	Value of all types of fertilizers exported (USD million)				k_{03-22}	k_{13-22}	k_{21-22}	\bar{k}_{03-22}
	2003	2013	2021	2022				
World	18,843	66,198	84,029	135,840	7.21	2.05	1.62	1.11
Russia	1,964	9,121	12,495	20,969	10.67	2.30	1.68	1.13
Canada	1,840	6,605	6,607	13,729	7.46	2.08	2.08	1.11
China	800	6,253	11,472	11,380	14.23	1.82	0.99	1.15
USA	2,549	5,022	4,621	8,472	3.32	1.69	1.83	1.07
Morocco	372	1,925	5,715	7,715	20.76	4.01	1.35	1.17

Table 4. Analysis of export development of nitrogenous fertilizers (own elaboration based on data from International Trade Centre (2023))

Country	Value of nitrogenous fertilizers exported (USD million)				k_{03-22}	k_{13-22}	k_{21-22}	\bar{k}_{03-22}
	2003	2013	2021	2022				
World	7,051	27,482	35,512	60,142	8.53	2.19	1.69	1.12
Russia	660	3,358	4,472	7,222	10.94	2.15	1.61	1.13
Oman	0.054	906	1,498	4,976	92.139	5.49	3.32	1.83
China	434	3,284	4,449	4,923	11.34	1.50	1.11	1.14
Qatar	278	2,187	2,410	3,577	12.86	1.64	1.48	1.14
Saudi Arabia	431	1,028	1,722	3,221	7.48	3.13	1.87	1.11

Regarding the leading exporters of all fertilizers, China is the only country whose export of all fertilizers decreased interannually. Beyond this exception, the majority of countries conform to the prevailing general trend expressed by the average growth coefficient of the world's export of fertilizers. Russia demonstrates its predominance in this field by being the leader for the last decades.

Russia also stands as the leader in the export of nitrogenous fertilizers. As this is a long-term trend, the focus was on the countries that experienced notable changes in recent years. Among the primary exporters of nitrogenous fertilizers, Oman exhibits a notably higher growth of the value exported than the other countries. In 2003, Oman occupied the 91st position with a trade balance of -3.374 million USD. However, it has since ascended to the second position with a trade balance of 1,460 million USD.

The comprehensive findings indicate that the overarching trend on a global scale does not exhibit substantial differences between the development of the trade with all types of fertilizers and the trade with nitrogenous fertilizers. The average growth coefficients present similar values, with the exception of Oman.

4. Discussion

Global consumption of nitrogen fertilizers is expected to reach 108 million metric tons in 2024, reflecting a global trend of increasing demand. This increase results from lower fertilizer prices, leading to increased purchasing by farmers. Furthermore, global consumption is expected to increase until 2030, albeit at a more moderate annual growth rate (Quinn, 2023). However, the International Fertilizer Association (2022) claims that the global commodity market will remain disrupted in contrast to pre-2020 levels (International Fertilizer Association, 2022).

Regarding the results being found within the analysis, the first finding was that Brazil stands as the preeminent importer. It imports more than 80% of its total fertilizer needs. This trend is partly due to limited domestic resources and capacity for fertilizer production, forcing the country to rely on imports to meet the needs of its large agricultural sector (United States Department of Agriculture, 2022). In 2022, fertilizer imports to Brazil reached record volumes, driven by concerns about potential fertilizer shortages due to international conflicts and trade sanctions (Samora and Mano, 2022). Geopolitical events such as the Russia-Ukraine conflict have significantly impacted global fertilizer supply chains. Brazil, dependent on imports, especially from Russia, faced the risk of supply disruptions. In response, the Brazilian government took international diplomatic action and concluded agreements with several countries, including Iran and Russia, to ensure the continuity of fertilizer supply (United States Department of Agriculture, 2022).

Another specific feature is the production of nitrogenous fertilizers in the Middle East. According to Mosier et al. (2004), the decision to produce nitrogenous fertilizers is primarily determined by the availability of raw materials, notably natural gas and crude oil. The rapid increase in the export of nitrogenous fertilizers by Middle Eastern countries can be attributed to the abundance of those resources (Mosier et al., 2004).

Among the Middle Eastern countries, Oman experienced the most enormous export growth. It is a result of the fact that it has abundant natural gas reserves, a key raw material for fertilizer production. Natural gas serves as the primary input for the production of ammonia and urea, which are essential components of nitrogen fertilizers. The country is also strategically located on the Arabian Sea, which facilitates the export of fertilizers to major Asian markets such as India, Bangladesh, or Pakistan (Mendoza, 2023). Due to the region's low natural gas cost, fertilizer production costs in Oman are low. This makes the construction of export-oriented, integrated urea plants very attractive (Wainwright, 2018).

In the context of the global fertilizer market, countries such as Saudi Arabia, Iran and Qatar have emerged as major producers of ammonia and urea in the region. While global fertilizer demand and supply are changing, Oman and other Middle Eastern countries seek opportunities in export markets, particularly in Asia (Wainwright, 2018).

Regarding the European Union's trade with fertilizers, the main trading partners for the individual states are also members of the EU. For example, the two largest EU exporters, Belgium and Netherlands, traded in 2022 mainly with each other or with France and Germany (International Trade Centre, 2023). However, trade with countries outside the EU contains numerous uncertainties. One of the contemporary concerns is the preeminence of Russia as the primary importer to the EU. The Ukraine conflict's inception emphasizes the sensitivity of this matter for the following years. According to the European Commission, the European Union's reliance on imports and susceptibility to market volatility increases. Therefore, prudent measures have to be implemented to face current challenges to ensure the availability and affordability of fertilisers and, in a broader context, the whole food security. Besides the direct support for farmers and fertilizer producers, the European Commission emphasizes trade diversification to ensure the availability of fertiliser production sources and mitigate risks associated with possible supply disruption (European Commission, 2024).

5. Conclusions

A comprehensive understanding of the global trends in fertilizer markets necessitates a holistic perspective that integrates economic, environmental, and technological dimensions. This evolving landscape underscores the necessity for stakeholders to adapt their strategies to maintain competitive advantages. Particularly in nitrogenous fertilizers, the increasing participation of Middle Eastern countries, notably Oman, represents a significant shift in the market dynamics. This transition not only reflects changing geopolitical influences but also highlights the critical role of technological advancements and environmental considerations in shaping future trade patterns. As the global demand for agricultural yields intensifies, these factors collectively point towards a more interconnected and dynamic global fertilizer market.

Addressing the first research question, the analysis elucidated Russia's prevailing influence in the area of fertilizer exports and Brazil's predominant role in imports. However, it is necessary to note that the trade dynamics, particularly concerning nitrogenous fertilizers, are experiencing a rising tendency in states within the Middle East. The overall direction has manifested a growing movement towards an increase in trade volume; however, strongly affected by the inscrutability of the key commodity prices.

The dual analysis of the general fertilizer market and nitrogenous fertilizer market presented the growing importance of nitrogenous fertilizers as the share of total fertilizer export is increasing. The market with nitrogenous fertilizers has also shown the differences among the main actors, as the market with nitrogenous fertilizers involves Middle Eastern countries as the main actors.

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