SUSTAINABLE DEVELOPMENT OF TERRITORIES, BRANCHES, AND PRODUCTION COMPLEXES

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THE INFLUENCE OF THE CHEMICAL INDUSTRY AND FERTILIZER PRODUCTION ON THE DEVELOPMENT OF TERRITORIES: TRENDS AND PROSPECTS AT THE MACRO-LEVEL

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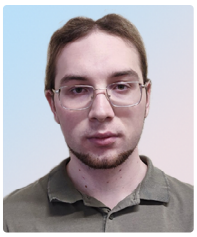

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In the current context of sanction pressures and geopolitical turbulence, mobilizing all available resources is essential for ensuring territorial development. One such resource is the chemical industry, which produces a wide range of products: from low-value-added, large-volume construction materials, mineral fertilizers, and plastics to knowledge-intensive, high-cost pharmaceuticals, cosmetics, electronic components, and household appliances. The study aims to identify the impact of the chemical industry on territorial development at both the global and national levels, as

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well as its future growth prospects in the Russian economy. The analysis shows that the chemical industry's share of global GDP increased from 1.6% in 1994 to 2.7% in 2022, while the nominal value of output grew approximately sevenfold – from USD 400 billion to USD 2.8 trillion. The most intensive development is observed in China, where the industry's share of GDP rose from 2.7% in 1994 to 4.8% in 2023, while the value of export-import operations increased eight- to tenfold. In Russia, the chemical industry is most developed in the mineral fertilizer segment, which serves as a driver of export revenues. However, the positive trade balance generated by fertilizer exports is offset by substantial imports of pharmaceutical products, resulting in a negative balance in this segment. This underscores the need to develop domestic pharmaceutical production to reduce import dependence and contribute to stable foreign trade accounts. The study also reveals the growing role of the chemical industry in generating tax revenues for the regions hosting fertilizer production facilities – from 6–13% in 2009 to 9–33% by 2023. In addition, several other channels through which the chemical industry influences territorial development are identified. The results may be useful for students, researchers, educators, and government officials interested in the development patterns of specific sectors of the national economy.

Chemical industry, territorial development, global corporations, industrial economics, mineral fertilizers.

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Introduction

Currently, the Russian Federation is facing a number of geopolitical challenges that not only exacerbate accumulated socio-economic imbalances, but also exacerbate the issues of finding new and improving existing sources of economic growth. One of these sources is the chemical industry, which serves as a key link in the production chain of related sectors of the economy: pharmaceuticals, agriculture, textile industry, food industry, construction, plastics production and others. At the same time, in recent years, the chemical industry market has become one of the world's leading markets in terms of output[1], continuing to grow due to demand for chemical products. So, today, in everyday life, people have become accustomed to using personal hygiene products or detergents, and in agriculture, they use highly effective mineral fertilizers that can affect the qualitative and quantitative characteristics of the crop *(Tab. 1)*.

[1] According to data for 2023, the oil and gas market is 6.7 trillion U.S. dollars (6,4% of GDP), car market is 3.6 trillion U.S. dollars (3.4% of GDP), household appliances and electronics market – 1.9 trillion U.S. dollars (1.8%), ferrous metals market – 1.2 trillion U.S. dollars (1.2% of GDP), non-ferrous metals market – 1.1 trillion U.S. dollars (1.1% of GDP) (According to: Oil and Gas Market Size, Share, Growth & Industry Analysis. Available at: https://www.kingsresearch.com/oil-and-gas-market-177; Global Automotive Industry Market Size. Available at: https://finance.yahoo.com/news/global-automotive-industry-market-size; Global Consumer Electronics Market Size, Share, Trends, & Growth Forecast Report. Available at: https://www.marketdataforecast.com/market-reports/consumer-electronics-market; Metal and Metal Ore Market Research Report. Available at: https://www.marketresearchfuture.com/reports/metal-and-metal-ore-market-32628; Non-Ferrous Metals Market Report. Available at: https://www.imarcgroup.com/non-ferrous-metals-market; Global GDP for 2023. Available at: https://ru.tradingeconomics.com/world/gdp).

However, despite the wide range of products in the industry, the contribution of chemistry to the development of territories is multifaceted. Large chemical corporations are key taxpayers and employers in their home regions. Due to the instability of the geopolitical situation, it is advisable to update data on the impact of the chemical industry on the development of the Russian economy. Thus, based on the identification of key trends, it is possible to determine the prospects for the development of the chemical industry, which will contribute to strengthening the positive impact on the development of territories in the future.

The aim of the study is to determine the impact of the chemical industry on the development of territories on a global and national scale, as well as its growth prospects. The research objectives are: to characterize the economic content of the chemical industry; to analyze key industry trends at the global and Russian levels; to identify the most significant segments of the industry; to determine the industry's contribution to territorial development; to identify the growth prospects of the chemical industry.

The object of the study is the global and national chemical industry. The subject of the paper is the influence of the chemical industry on the development of territories.

Literature review on the topic under consideration

The Russian economic literature presents many publications devoted to the study of the peculiarities of the development of the chemical industry both at the national and global levels. Many Russian authors note that the chemical industry and the petrochemical industry are the basic industries in the Russian economy. For instance, the level of chemicalization of

Table 1. Examples of applications of chemical industry products

Area of application	Product examples
Agriculture and farming	Mineral fertilizers: nitrogen, phosphorus and potash; plant protection products; greenhouses
Medicine and healthcare	Pharmaceutical products, cotton wool, gauze, bandages, etc.
Construction and renovation	Paints, varnishes, mastics, putties, mixtures, sprayed thermal insulation, polyurethane foam, sealants, plastic building materials, other silicate products: glass, ceramics, etc.
Mechanical engineering and transport	Tires and other rubber products for machinery, corrosion-resistant compounds, lubricants, alkaline and synthetic degassing agents, self-adhesive tinting films, washing fluids and de-icing agents for glass
Defense production	Gunpowder, explosives, elements of atomic weapons, fuel, high-density oxidizing agents, energy-intensive polymers
Perfumery, cosmetology and personal care products	Soaps, creams, extracts and oils, deodorants and other synthetic aromatic compounds, absolutes, gels, shampoos, varnishes, scrubs, masks, etc.
Household chemicals	General-purpose detergents, cleaning products, detergents for washing dishes, cleaning stoves, ovens, grills and removing grease, products for glasses and mirrors, formulations for washing and caring for clothes and shoes, washing powders, gels, capsules and tablets, bleaches and stain removers, conditioners for clothes and shoes, shoe care products
Computer equipment	Monitor care products, thermal pastes, refilling powders and liquids for printer cartridges
Food industry	Preservatives: citric acid, sodium benzoate, potassium sorbate; flavor enhancers: monosodium glutamate, hydrolyzed vegetable protein, yeast extract; artificial sweeteners: aspartame, saccharin; emulsifiers: lecithin, soy lecithin, gum arabic
Sports nutrition	Proteins, amino acids, protein-carbohydrate mixtures, vitamins and minerals; special additives, etc.
Source: own compilation.	

the national economy is a criterion of scientific and technological progress, which contributes to accelerating the pace of its development (Tal'berg, 2016). The importance of developing the chemical industry is also due to the introduction of innovations in areas such as energy, ecology and health. It is worth noting that among the important areas, scientists highlight the creation of environmentally friendly materials, such as bioplastics, which reduce dependence on fossil raw materials (Allanazarova et al., 2024).

In the publications of scientists of Vologda Research Center of RAS, economic research on the chemical industry includes consideration of the financial activities of producers of mineral fertilizers (Kopytova, 2017) and their contribution to the regions of their base (Malyshev, 2021b). Considerable attention is paid to the issues concerning interaction of chemical industry corporations with the state (Malyshev, 2021a), research of factors regarding formation of financial results and peculiarities of distribution policy of chemical corporations (Malyshev, 2024), analysis of export-import operations of the industry (Malyshev, Pechenskaya-Polishchuk, 2024). Thus, we can emphasize that the chemical industry in Russia is based on the production of mineral fertilizers.

The research of foreign authors has not ignored the features of the development of the chemical industry. A team of researchers from China notes that the sustainability of the chemical industry is crucial for achieving global sustainable production. In their opinion, from 2004 to 2014, the indicators of the sustainable development of the global chemical industry as a whole improved, in particular, due to technological processes (Yang et al., 2022). Other authors agree on the trends with the increasing role of science and industry interaction in creating a sustainable, safe and innovative chemical industry of the future (Valencia, 2013).

The monograph of American and Italian scientists proves that the chemical industry was significantly transformed in the 20th century under the influence of the petrochemical revolution. For example, in Germany, by 1960, oil had become a key raw material sent to European countries. In turn, the chemical industry has shifted to the creation of plastics, synthetic fibers, fertilizers, medicines and other mass chemicals (Galambos et al., 2007). Today, the chemical industry is one of the key consumers of oil. According to various estimates, chemical production accounts for up to 14% of the world's oil (Lopez et al., 2023). At the same time, the issue of environmental impact is raised, since processing industries often have a negative impact on the atmosphere and hydrosphere of the territory (Lopez et al., 2023). In this regard, long-term proposals for the development of alternative sources of raw materials for the production of chemical products are being updated (Darkow, Gracht, 2013).

Thus, the chemical industry in modern economic literature is characterized as a fundamental knowledge-intensive industry, the level of development of which serves as a key indicator of scientific and technological progress and technological sovereignty. In particular, the Russian Federation tends to produce mineral fertilizers as its main product.

Research methods

The methodological basis of the study is a systematic approach that allows considering the chemical industry as an integral element of the national and global economy. To achieve this aim and solve the tasks of the work, a set of general scientific and special economic methods has been applied, providing a multidimensional analysis of the industry's impact on the development of territories. The study used economic and statistical methods, in particular dynamic time series analysis, to assess long-term trends in industry development over

the period 1994–2023, including calculating the growth rate of global output and changes in the industry's share in global GDP. The structural analysis was used to determine the contribution of the chemical industry to the gross domestic product of individual countries, as well as to calculate the industry's share in the structure of investments in fixed assets and tax revenues of the home regions, such as the Vologda, Novgorod, and Smolensk regions. It is worth noting that the choice of these regions is justified, first of all, by the availability of accessible and complete financial statements. In addition, PJSC PhosAgro, PAO Acron and PAO Dorogobuzh, based in these regions, are comparable in terms of scale of activity with market leaders such as PJSC Uralkali and JSC EuroChem. The statistical grouping method is implemented when aggregating data over five-year periods to offset cyclical fluctuations and identify stable trends in investment, employment, and tax revenue.

The information base of the study is based on data from international statistics (World Bank, UN Comtrade, FAO, IFA, International Labor Organization), official materials from federal government agencies of the Russian Federation (Rosstat, Federal Tax Service, Ministry of Industry and Trade, Ministry of Agriculture), reports from specialized associations (RAPU) and analytical agencies (Grand View Research, Statista). It is important to note that data on Russia's foreign economic activity (FEA) is limited to 2021, due to the transition to a policy of limiting information related to the protection of FEA participants under sanctions pressure. The regulatory framework was formed by strategic documents for the development of the chemical industry and the agro-industrial complex of the Russian Federation and foreign countries. The theoretical basis of the research was determined by the works of Russian and foreign scientists devoted to the problems of sustainable development of the chemical industry, technological sovereignty and economic security.

Results of the study

Over the previous 30 years, a characteristic feature of the development of the chemical industry has been its progressive growth rate. From 1994 to 2023, the global output of the industry increased 7-fold in value terms, from 0.4 trillion U.S. dollars to 2.8 trillion U.S. dollars, and the industry's share in global gross product increased from 1.6% to 2.7% *(Fig. 1)*.

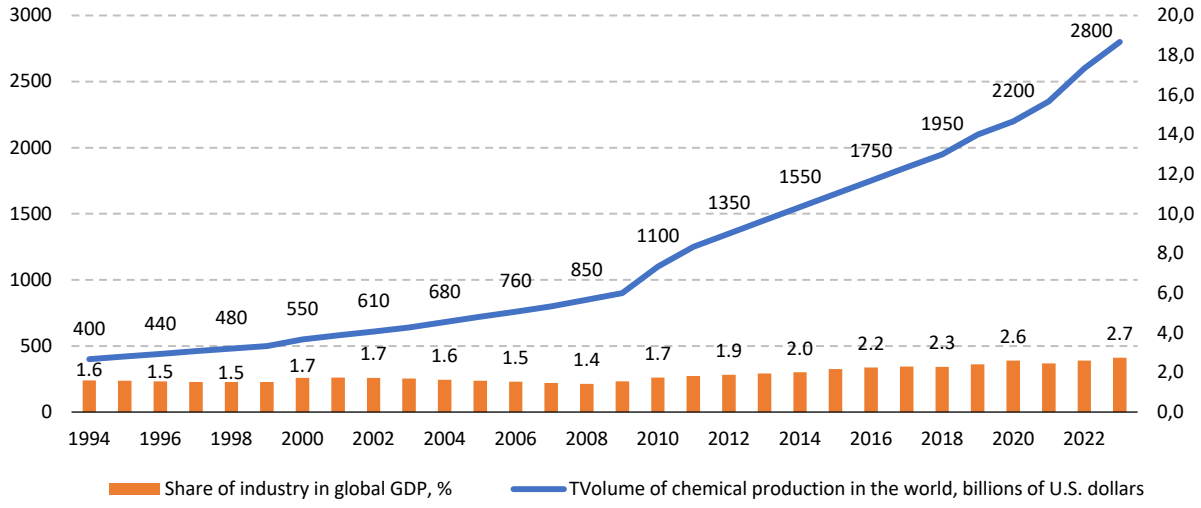

Figure 1. Dynamics of chemical industry output (billion U.S. dollars) and its share in global GDP (%) for 1994–2023

According to: Global chemical products market: current state and prospects. Available at: http://vestkhimprom.ru/posts/mirovoj-rynok-khimicheskoj-produktsii-sostoyanie-i-perspektivy; World GDP History 1960–2023. Available at: https://countrycassette.com/world-gdp-history/

In many countries with developed market economies and high-tech industries, such as China, Japan, and Germany, the average share of the chemical industry in GDP is at the level of 4% or more. Over the previous 30 years, the share of the chemical industry in Russia has increased from 1.6% to 2.8% of GDP, mainly due to the sustainable development of mineral fertilizer production and the creation of polymer facilities. In addition, Russia's undoubted competitive advantage in the development of the industry remains cheap oil and gas raw materials for wholesale consumers, in particular for domestic production *(Fig. 2)*.

However, in the modern economic system of developed and developing countries, the contribution of the chemical industry is regulated not only by macroeconomic indicators. Let us look at the channels through which the industry influences the development of the country.

1. Source of attraction of investment resources.

At its core, the chemical industry, as a manufacturing industry, is an industry that creates products with various added values. For example, the coal and chemical sector is highly dependent on technology, but produces complex products with high performance characteristics (Xu, 2020). The German chemical concern BASF invested in the development of biological fertilizers and plant protection products to increase crop resistance to stressful conditions, which, in turn, led to a 15%[2] increase in revenue in the company's agricultural segment in 2022. Investments of the American chemical company

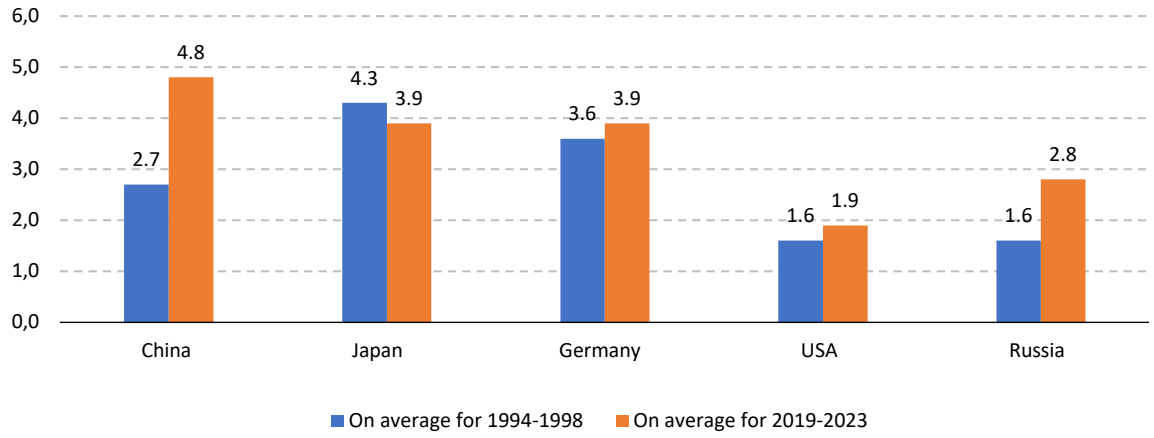

Figure 2. Average annual contribution of the chemical industry to the GDP of different countries in 1994–1998 and 2019–2023, %

According to: World Bank – World Development Indicators (WDI). URL: https://databank.worldbank.org/source/world-development-indicators; China Petroleum and Chemical Industry Association (CPCIA) – Annual Report 2023. URL: https://www.cpcia.org.cn; OECD.Stat – Gross value added by industry (Historical Data for Japan). URL: https://stats.oecd.org; METI – White Paper on Manufacturing Industries (2023). URL: https://www.meti.go.jp/english/statistics/index.html; Destatis – Statistisches Bundesamt Deutschland. URL: https://www.destatis.de/EN/Home/_node.html; Destatis – Volkswirtschaftliche Gesamtrechnungen (VGR), 2023. URL: https://www.destatis.de/DE/Themen/Wirtschaft/Volkswirtschaftliche-Gesamtrechnungen/_node.html; BEA – Industry Eco-nomic Accounts. Value Added by Industry. 325 – Manufacturing: Chemicals. URL: https://www.bea.gov/data/industry/gross-output; American Chemistry Council – Economic Impact Reports (2023). URL: https://www.americanchemistry.com/Economic-Center; Russian Statistical Yearbook (section: "Sectoral structure of GDP"). Available at: https://www.sci.bas.bg/ssc/Statistical_yearbook_of_Russia_1994.pdf; Ministry of Industry and Trade of the Russian Federation – Annual report 2023 on the chemical industry. Available at: https://minpromtorg.gov.ru

[2] BASF continues expanding its global biologics development strategy. Available at: http://www.abercade.ru/research/analysis/15862.html

Dow Inc. in the production of materials with a low carbon footprint allowed to increase revenues from sales of environmentally friendly products for 2019–2023 by 25%, or +5 billion U.S. dollars[3]. Thanks to the development of a new line of biodegradable plastics, the Belgian chemical company Solvay increased revenue from this activity by 10% in 2022, which brought the company an additional 300 million euros[4]. These and other corporate examples from different countries demonstrate active investment in the technological improvement of chemical production.

In Russia, the average annual volume of investments in fixed assets in the chemical industry increased 3.8 times, from 167 billion rubles in 2009–2013 to 638 billion rubles by 2019–2023. At the same time, the industry's share of capital investments among manufacturing industries increased from 11% to 18%, and in the total amount of investments of all types of activities – from 1.5% to 2.5% *(Tab. 2)*.

2. Formation of the trade balance.

For many countries, the chemical industry is an important part of exports, influencing the growth of their economies, foreign exchange earnings, as well as international relations and cooperation. The positive trade balance in the chemical industry is characterized by China (exports exceed imports by 3 times), India and Australia (by 2 times), Japan (by 18%), the countries of North America (by about 14%) and Europe (by an average of 7%)[5].

The situation in the Russian Federation is different: imports of chemical products (about 56 million U.S. dollars) are approximately twice as high as exports (at 27 million U.S. dollars), which creates a trade deficit. The key factor

Table 2. Investments in fixed assets of chemical industries in the Russian Federation as a whole for 2009–2023

Period	Volume of investments in the chemical industry	Total investments in manufacturing	Share*	Investments in fixed assets of all types of activities	Share**
	billion rubles		%	billion rubles	%
Average for 2009–2013	**167**	**1,479**	**11.0**	**10,840**	**1.5**
Average for 2014–2018	**366**	**2,247**	**16.1**	**15,234**	**2.4**
2019	472	2,708	17.4	19,329	2.4
2020	481	2,984	16.1	20,394	2.4
2021	551	3,428	16.1	23,240	2.4
2022	731	3,733	19.6	27,865	2.6
2023	924	4,363	21.2	33,438	2.8
Average for 2019–2023	**638**	**3,443**	**18.1**	**24,853**	**2.5**
2019–2023 to 2014–2018	1.7 times	1.5 times	+2 p. p.	1.6 times	+0.1 p. p.
2019–2023 to 2009–2013	3.8 times	2.3 times	+7.1 p. p.	2.3 times	+1 p. p.

* The share of investments in fixed assets of the chemical industry in manufacturing industries.
** The share of investments in fixed assets of the chemical industry among all types of economic activity.
According to: Investments in Russia. Available at: https://rosstat.gov.ru/folder/210/document/13238

[3] Investing in Decarbonization Across Dow. Available at: https://www.centralcharts.com/en/1115434-dow-inc/news/4380985-investing-in-decarbonization-across-dow

[4] Belgium›s Solvay hikes 2022 profit forecast after first-quarter beat. Available at: https://www.yahoo.com/tech/belgiums-solvay-hikes-2022-profit-050456872.html

[5] UN Comtrade Database. Available at: https://comtradeplus.un.org/

in this is the purchase of high-tech chemical products (mainly pharmaceuticals), while the Russian chemical industry receives its main income from the sale of mainly low-grade products to the world market, in particular mineral fertilizers *(Fig. 3)*.

At the same time, a positive trade balance is typical for Russian regions where large chemical enterprises are based. For example, a significant volume of exports in the Vologda and Novgorod regions, exceeding 2 billion U.S. dollars, is associated precisely with the concentration of large mineral fertilizer production assets in their territories. In the Vologda Region, the excess of chemical exports over imports has increased from 21 times in 2009 to almost 37 times by 2021. In the Novgorod Region, the positive balance of payments increased 4.6 times in the same period, from 421 million U.S. dollars to 1939 million U.S. dollars. Despite the increased demand for imports in the Smolensk Region, in 2021 its value was 3% less than export sales *(Fig. 4)*.

3. Creation of jobs in the regions where chemical industries are based.

The chemical industry plays an important role in the economy in generating employment. The industry employs almost 10 million people worldwide (Abedsoltan, 2023). According to the International Labor Organization, the average

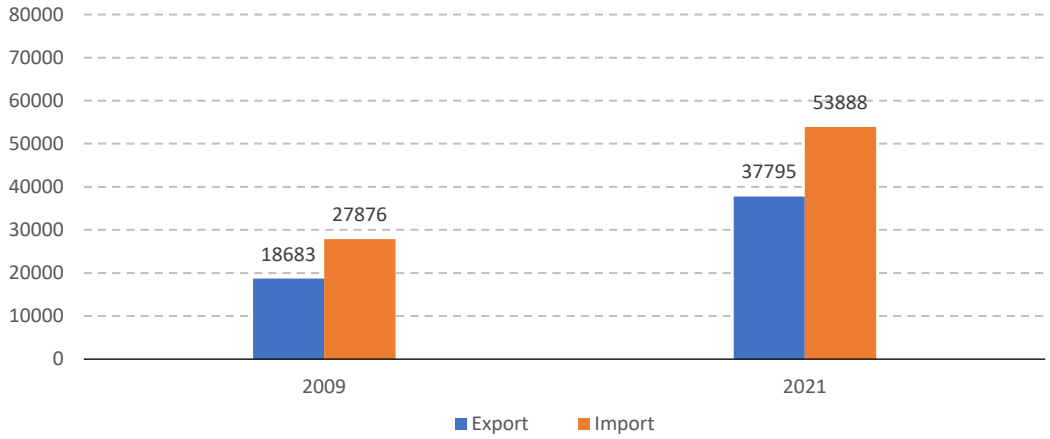

Figure 3. Valuation of exports and imports of chemical products Russia in 2009 and 2021, million U.S. dollars
According to: data from the yearbook "Regions of Russia".

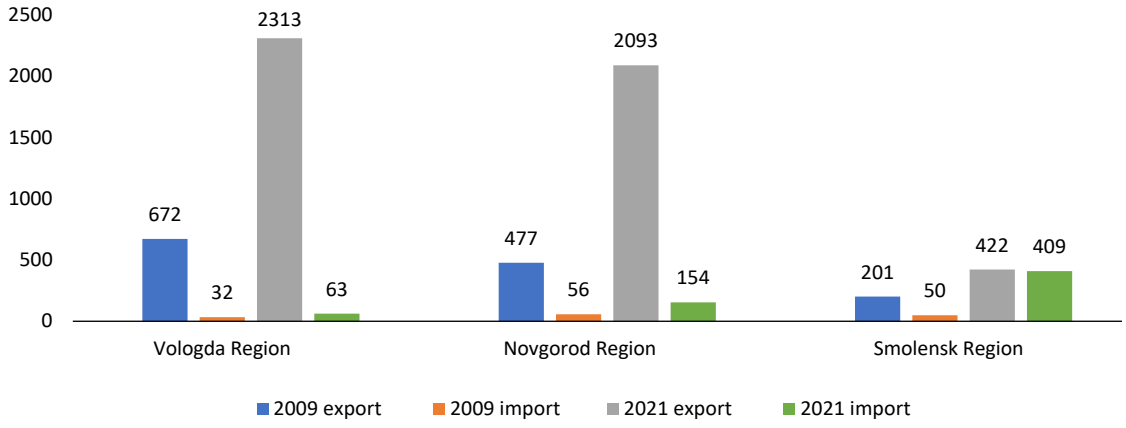

Figure 4. Valuation of exports and imports of chemical products of the Vologda, Novgorod, and Smolensk regions in 2009 and 2021, million U.S. dollars
According to: data from the yearbook "Regions of Russia".

annual number of employees in the chemical industry increased by 21% from 8.1 million to 9.9 million in 1994–2023.

The share of workers in the chemical industry in the Russian Federation as a whole for the period amounted to 5.4% in manufacturing industries. In dynamics (2009–2023), the number of chemical industry workers decreased by 11% – from 415.4 to 370.3 thousand people. To a greater extent, the reduction in personnel was influenced by the educational factor and current employment trends: a shortage of qualified personnel, insufficient compliance of curricula with the technological processes of real industries, as well as growing social and professional mobility[6].

Geographically, the average number of employees has decreased even more. Let's consider this indicator by comparing the dynamics of the national average and in one of the regions where large-scale chemical production is based. *Table 3* shows that the deployment of PJSC Apatit in the Vologda Region contributes to the formation of more than 5.8% of employment among all manufacturing industries. The average Russian value is 5.5%. There is no significant discrepancy between the indicators, but the availability of detailed structured information on the number of employees by type of economic activity in the Vologda Region indicates that the negative trend has affected it more (43% in the region versus 11% in the country). Consequently, even with fourfold gaps in dynamics, the home region is able to generate an outstripping development trend. It is worth noting that the key reasons for the reduction in personnel, on the one hand, include the optimization of production

Table 3. Average annual dynamics of the number of chemical industry workers in Russia and the Vologda Region in 2009–2023

Период	Total in Russia			Vologda Region		
	Number of em-ployees in the chemical indus-try	Share in manufacturing industries	Share among all types of activities	Number of em-ployees in the chemical indus-try	Share in manufacturing industries	Share among all types of activities
	people	%		people	%	
Average for 2009–2013	**415,360**	**5.3**	**4.0**	**7,420**	**7.7**	**1.8**
Average for 2014–2018	**371,225**	**5.3**	**3.7**	**3,875**	**4.9**	**1.0**
2019	365,000	5.4	3.7	3,500	4.7	1.0
2020	365,400	5.5	3.8	4,200	5.6	1.2
2021	372,100	5.6	3.9	4,200	5.8	1.2
2022	378,600	5.7	3.9	4,400	6.2	1.3
2023	no data	no data	no data	4,700	6.8	1.4
Average for 2019–2023	**370,275**	**5.5**	**3.8**	**4,200**	**5.8**	**1.2**
2019–2023 to 2014–2018	1 time	+0.2 p. p.	+0.1 p. p.	1.08 times	+0.9 p. p.	+0.2 p. p.
2019–2023 to 2009–2013	0.89 times	+0.2 p. p.	-0.2 p. p.	0.57 times	-1.9 p. p.	-0.6 p. p.
According to: Industrial production in Russia. Available at: https://rosstat.gov.ru/folder/210/document/13225						

[6] Three points of growth in the shortage of personnel. Available at: https://neftegaz.ru/analisis/companies/656256-tri-tochki-rosta-defitsita-kadrov-/https://neftegaz.ru/analisis/companies/656256-tri-tochki-rosta-defitsita-kadrov-/

and production costs (including the use of automation processes), on the other hand, the shortage of highly qualified personnel[7].

4. Budget system revenue generation.

Due to the export orientation of the Russian chemical industry, its contribution to the formation of federal budget revenues is extremely small (less than 2%), and sometimes negative due to the excess of tax deductions (refunds) over value-added tax charges. However, a different situation is observed in the revenue generation of consolidated budgets of regions where chemical industries are based. Three key taxes (corporate income tax, personal income tax, and property tax) levied on chemical organizations account for up to 41.4% of individual regional budgets (PAO "Acron" in 2022). Thus, the average annual share of these budget revenues from the Vologda Region chemical industry accounted for 5–8% of the revenues of all types of activities in the region, in the Novgorod Region – from 7 to 25%, in the Smolensk Region – about 6%. It is important to note that the end of the pandemic and high fertilizer prices in the face of anti-Russian sanctions significantly expanded the tax base for implementing the fiscal function in 2011–2023 *(Tab. 4)*.

Thus, based on the presented facts and trends, we can conclude that the chemical industry plays an important role at the national and regional levels. It promotes the creation of jobs, including highly qualified ones, increases labor productivity and reduces costs in related

Table 4. Taxes paid by the largest chemical industry manufacturers to the budgets of their home regions* for 2009–2023

Период	Total in Russia		PJSC PhosAgro (Vologda Region)		PAO Acron (Novgorod Region)		PAO Dorogobuzh (Smolensk Region)	
	Taxes to the regions from the chemical industry**	Share***	Taxes to the regions from the chemical industry**	Share***	Taxes to the regions from the chemical industry**	Share***	Taxes to the regions from the chemical industry**	Share***
	million rub.	%	million rub.	%	million rub.	%	million rub.	%
Average for 2009–2013	**66,787**	**1.6**	**2,403**	**7.8**	**1,754**	**11.9**	**1,046**	**5.8**
Average for 2014–2018	**101,703**	**1.7**	**2,049**	**5.0**	**1,344**	**6.8**	**1,702**	**6.4**
2019	119,954	1.5	398	0.6	2,915	12.3	1,344	4.3
2020	95,848	1.2	420	0.7	842	4.1	825	2.6
2021	229,929	2.2	9,398	9.5	10,704	33.3	4,171	11.3
2022	249,403	2.3	14,385	17.2	15,252	41.4	2,219	5.8
2023	292,636	2.0	10,174	8.7	13,677	32.0	2,465	4.4
Average for 2019–2023	**197,554**	**1.8**	**6,955**	**7.4**	**8,678**	**24.6**	**2,205**	**5.7**
2019–2023 to 2014–2018	1.94 times	+0.1 p. p.	3.39 times	+2.3 p. p.	6.46 times	+17.8 p. p.	1.30 times	-0.7 p. p.
2019–2023 to 2009–2013	2.96 times	+0.2 p. p.	2.89 times	-0.5 p. p.	4.95 times	+12.7 p. p.	2.11 times	-0.1 p. p.

* They are indicated in parentheses after the name of the largest chemical industry manufacturer.
** Income tax, personal income tax and property tax.
*** Share of the chemical industry among all types of economic activity.
According to: Federal Tax Service data.

[7] Analysis of the impact of industry on the financial stability of the Vologda Region budget system. Available at: https://web.snauka.ru/issues/2013/12/29748

sectors of the economy, acts as an engine of scientific and technological progress, generates investment flows for the development of new technologies, materials and the introduction of innovative solutions.

Prospects for the development of the chemical industry

The chemical industry is of particular importance for the economy against the background of the actualization of the problem of food security, which is common to all world farms (Chen, Reniers, 2020). Hunger remains one of the main problems of humanity, and the world is moving away from achieving the UN goal of eliminating hunger by 2030, formulated in 2015[8]. Thus, according to estimates by the Food and Agriculture Organization of the United Nations, an average of 733 million people were malnourished in 2023, which is 26% more than in 2019[9]. According to the Eurasian Development Bank, global food security is deteriorating – every ninth inhabitant of the Earth is hungry or malnourished.

The key specialization of the Russian chemical industry, as noted earlier, is the production of mineral fertilizers. According to Roscongress, the country's share in the global market of mineral fertilizers is close to 1/5, which is comparable to providing fertilizers to more than 1.5 billion people[10]. Among the main sub-sectors of the chemical industry *(Fig. 5)*, the production of mineral fertilizers is more related to ensuring food security.

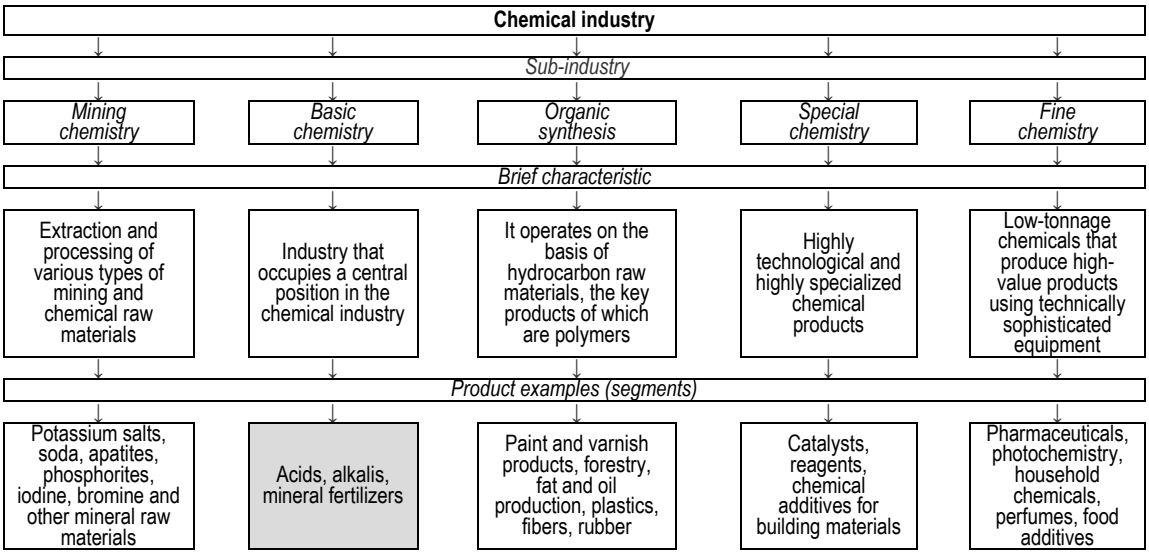

Figure 5. Industrial structure of the chemical industry

According to: Industrial structure of the chemical industry. Available at: https://www.chemistry-expo.ru/ru/articles/otraslevaya-struktura-himicheskoj-promyshlennosti; Chemical industry of Russia. Structure of the chemical industry. Available at: https://spravochnick.ru/geografiya/hozyaystvo_rossii/himicheskaya_promyshlennost_rossii

[8] Food security and unlocking the agro-industrial potential of the Eurasian region. Available at: https://eabr.org/analytics/special-reports/prodovolstvennaya-bezopasnost-i-raskrytie-agropromyshlennogo-potentsiala-evraziyskogo-regiona/

[9] The state of food security and nutrition in the world in 2024. Available at: https://www.fao.org/publications/fao-flagship-publications/the-state-of-food-security-and-nutrition-in-the-world/ru

[10] Expert opinion on the results of the SPIEF-2023 session "Ensuring global food security in modern conditions". Available at: https://roscongress.org/materials/eda-i-my-problema-prodovolstvennoy-bezopasnosti-v-mire/

In this regard, solving the problem of ensuring food security has become an obvious impetus for the development of the mineral fertilizers segment based on three key groups of factors:

– *demographic*: against the background of an increase in population at the global level, the area of land suitable for cultivation has remained virtually unchanged; therefore, ensuring global food security is impossible without increasing soil yields;

– *environmental*: due to climate change, urbanization processes, as well as in the process of growing cultivated plants, land depletion inevitably occurs, and artificial fertilization is a key way to maintain and increase soil fertility;

– *economic*: from the point of view of production costs, it is more profitable for agricultural enterprises to increase soil fertility and harvest high yields in a small area than the opposite.

This is due to a more than threefold increase in the global total consumption of mineral fertilizers per arable area, from 42 to 140 kg per 1 hectare in 1966–2021. Nitrogen consumption increased 5.7 times in the same period, and the use of phosphate and potassium tripled *(Fig. 6)*.

A number of countries that focus on agriculture may exceed the global average consumption of mineral fertilizers per arable area by one and a half times or more. For example, since 2015, Indonesia has been characterized by the use of significant amounts of fertilizers – over 270 kg per hectare of arable land, for India – 193 kg per hectare, for Brazil – 369 kg, for China – 374 kg. We should note that the global average is about 140 kg per hectare *(Tab. 5)*.

Back in 1840, a German scientist, one of the founders of agrochemistry, Ju. von Liebig wrote in his work on the application of chemistry in agriculture: "One day, the time will come when every field, according to the plant that will be grown on it, will be fertilized with a proper fertilizer prepared in chemical plants"[11]. In modern agriculture, the use of fertilizers is an obligatory agrotechnical initiative and is considered as one of the most effective methods of intensive agriculture, due to the close direct relationship between soil replenishment

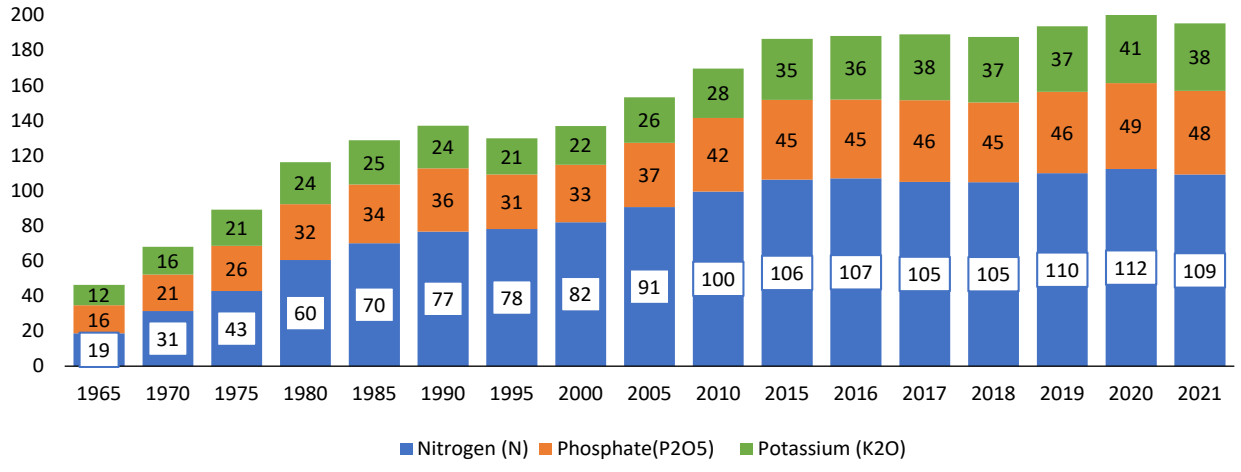

Figure 6. Dynamics of global consumption of mineral fertilizers in 1965–2021, million tons

According to: Global consumption of agricultural fertilizers from 1965 to 2021 by nutrients. Available at: https://www.statista.com/statistics/438967/fertilizer-consumption-globally-by-nutrient/

[11] Liebig von Ju. (1936). Chemistry as applied to agriculture and physiology. Moscow – Leningrad: Gosudarstvennoe izdatel'stvo kolkhoznoi i sovkhoznoi literatury "Sel'khozgiz". 406 p.

Table 5. Use of fertilizers per 1 hectare of arable land in key importing countries, Indonesia and Russia for 1994 and 2021

Country	1994		2021		2021 to 1994	
	Use of fertilizers per 1 ha of arable land, kg	Place in the world	Use of fertilizers per 1 ha of arable land, kg	Place in the world	times	positions
China	238	28	374	13	1.57	+15
Brazil	117	48	369	15	3.15	+33
Indonesia	144	43	279	24	1.94	+19
India	83	62	193	40	2.33	+22
USA	108	52	128	64	1.19	-12
Russia	11	99	25	107	2.27	-8
On average in 182 countries of the world	**91**	**x**	**140**	**x**	**1.54**	**x**

According to: Fertilizer use per 1 hectare of arable land by country. Available at: https://statbase.ru/datasets/agriculture/fertilizer-consumption/; Fertilizer consumption per arable area in the world from 1966 to 2021. Available at: https://www.statista.com/statistics/1287873/global-consumption-of-fertilizer-per-area/

with inorganic compounds and the degree of resistance of crops to climatic conditions, etc.

Grand View Research's forecast estimates indicate that, against the background of a doubling of global GDP, the further growth of the mineral fertilizers market by 2035 will amount to approximately 61% with an average annual growth rate of 4.1% *(Fig. 7)*.

Nitrogen fertilizers, which are in the highest demand, will continue to generate a significant share of the increase[12]. According to the International Fertilizers Association (IFA), the share of nitrogen fertilizers in 2023 reached 60% of total consumption, while the share of demand for phosphorus and potash fertilizers was 25% and 15%, respectively. For comparison, in 1994 nitrogen fertilizers were used less frequently – 55%, and phosphorous fertilizers more often – 30% *(Fig. 8)*.

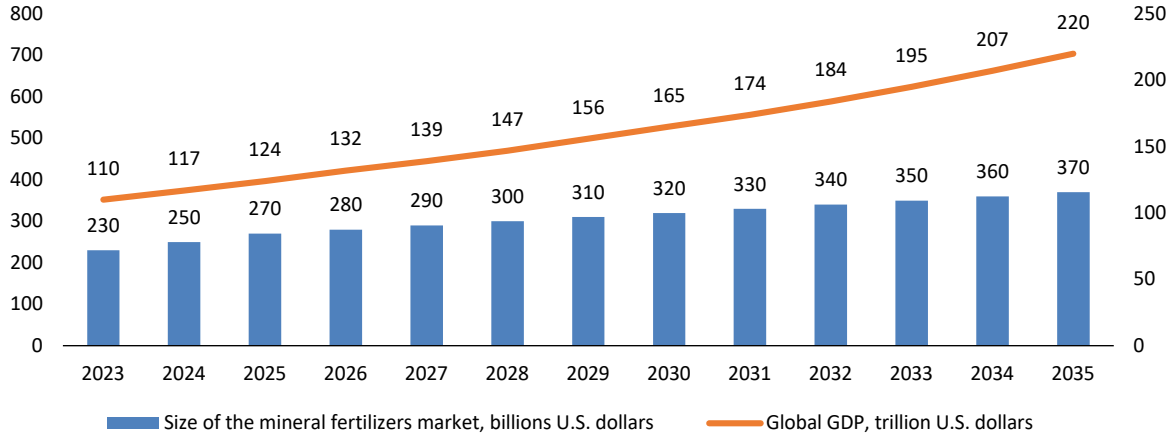

Figure 7. Projected values of the size of the mineral fertilizers market and global GDP until 2035

According to: Grand View Research. Available at: https://www.marketresearch.com/Grand-View-Research-v4060/

[12] The most common nitrogen fertilizers are carbamide, potassium chloride, phosphorous monoammonium phosphate, diammonium phosphate and triple superphosphate.

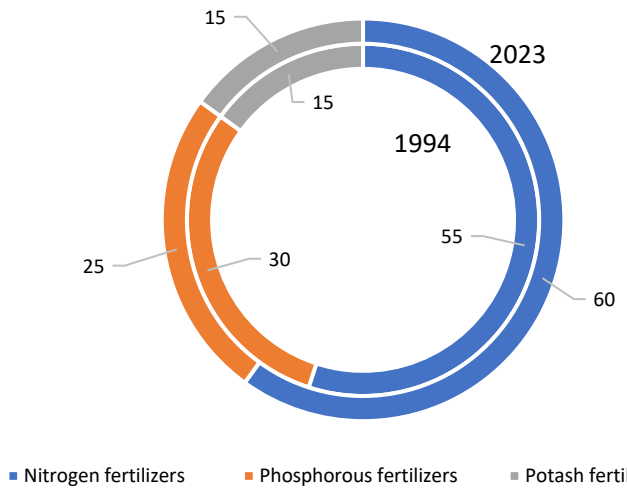

Figure 8. Trends in the global demand for mineral fertilizers in 1994 and 2023, %
According to: International Fertilizer Industry Association. Available at: https://www.fertilizer.org/

The key consumers of agricultural fertilizers in the world in 1994–2023 were the countries of Asia and Africa, where the total use of nitrogen, phosphorus and potassium increased by more than 2–3 times. While Europe, on the contrary, reduced consumption by 28% to 18 million tons.

In its annual reports on food security in recent years, the World Bank cites insufficient availability of fertilizers due to stable price increases as one of the major obstacles to food production[13]. The report of the Eurasian Development Bank also predicts a period of high food prices due to the pricing policy for fertilizers[14], the cost of which increased 2.7–9.5 times[15] depending on the type in 1994–2023. As a result, the 30-year dynamics of rising prices for mineral fertilizers directly affected the cost of key types of agricultural products *(Fig. 9)*: the cost of 1 ton of corn increased 3.4 times, wheat – 2.4 times, rice – by 93%.

When faced with issues of ensuring food security, agricultural countries are developing strategic documents for the development of the agro-industrial complex, in which the production of mineral fertilizers is among the most important areas.

In the Address to the Federal Assembly, Russian President V.V. Putin stressed that "today the agro-industrial complex is a successful industry that feeds the country and conquers international markets"[16]. For its development, the country has adopted a Strategy for the development of the agro-industrial and fisheries complexes of Russia until 2030, in which it is proposed to solve the tasks of strengthening food security by increasing yields and involving at least 13.2 million hectares of land in

[13] For instance: Food Security. 21.01.2025. Available at: https://www.worldbank.org/en/topic/agriculture/brief/food-security-update

[14] Food security and unlocking the agro-industrial potential of the Eurasian region. Available at: https://eabr.org/analytics/special-reports/prodovolstvennaya-bezopasnost-i-raskrytie-agropromyshlennogo-potentsiala-evraziyskogo-regiona/

[15] For example, for carbamide – by 4 times (from 90 U.S. dollars to 358 U.S. dollars per ton), for diammonium phosphate – by 2.7 times (from 203 U.S. dollars to 550 U.S. dollars per ton), for phosphate ore – by 9.5 times (from 34 U.S. dollars to 324 U.S. dollars per ton), for potassium chloride – by 3.4 three times (from 113 U.S. dollars to 383 U.S. dollars per ton), for triple superphosphate – 3.1 times (from 153 U.S. dollars to 480 U.S. dollars per ton) (Commodity Prices. Available at: https://www.indexmundi.com/commodities/).

[16] The President's Address to the Federal Assembly on February 29, 2024. Available at: http://www.kremlin.ru/events/president/transcripts/73585

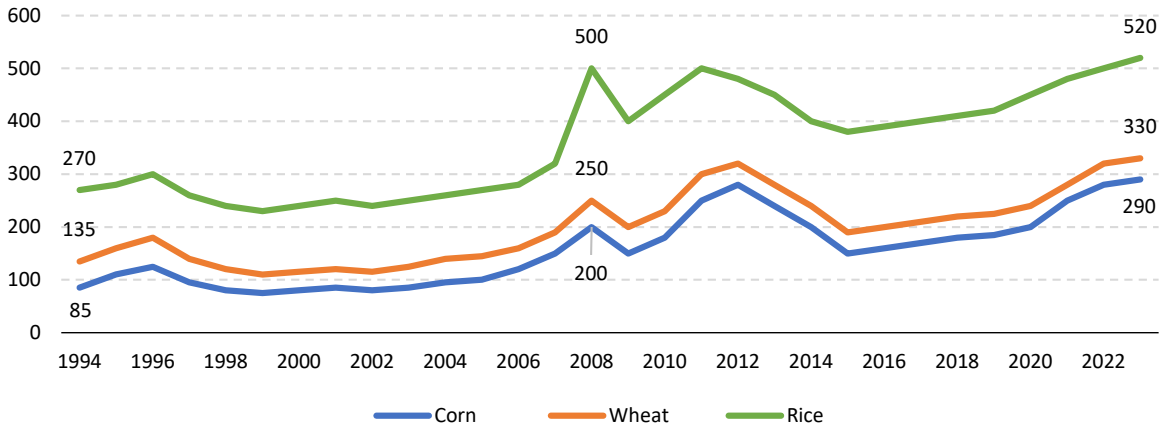

Figure 9. Dynamics of average annual world prices for corn, wheat and rice in 1994–2023, U.S. dollars per ton

According to: Food and Agriculture Organization of the United Nations. Available at: https://www.fao.org/

agricultural turnover by increasing soil fertility[17]. In fulfillment of strategic objectives, in October 2024, the Ministry of Agriculture of the Russian Federation approved a plan to increase purchases of mineral fertilizers by farmers until 2030, according to which the use of mineral fertilizers in the Russian Federation for 2024-2030 should increase by 24% to 6.7 million tons under the baseline scenario, and by 52% to 8.2 million tons under the optimistic scenario. tons[18]. The Russian Association of Fertilizer Producers has predicted a 35% increase in the volume of mineral fertilizer production in the country in 2023–2030 to almost 80 million tons[19].

China, which is actively developing in this area, focuses on the production of mineral fertilizers while minimizing the negative impact on the environment: for nitrogen fertilizers, maintaining a stable production level, but focusing on improving product quality and reducing energy intensity; for phosphorus fertilizers, reducing production by optimizing the use of phosphorus and limiting the extraction of raw materials; for potash fertilizers – an increase of 10–15% by 2030 due to the development of new deposits and technological innovations[20].

In the United States, according to key strategic documents related to the activities of mineral fertilizer producers[21], the main changes by 2040 should be an increase in domestic production, a reduction in the carbon footprint, non-dependence on foreign policy factors and ensuring food security.

[17] The strategy for the development of agro-industrial and fisheries complexes until 2030: Government Decree 2567-R, dated 08.09.2022. Available at: http://static.government.ru/media/files/G3hzRyrGPbmFAfBFgmEhxTrec694MaHp.pdf

[18] Ministry of Agriculture of Russia: A new strategic plan to increase purchases of mineral fertilizers until 2030. Available at: https://graininfo.ru/news/minselkhoz-rossii-novyy-strategicheskiy-plan-po-narashchivaniyu-zakupok-mineralnykh-udobreniy-do-2030/

[19] RAPU: By 2030, Russia will increase the production of fertilizers to almost 80 million tons. Available at: https://ria.ru/20241227/rapu-1991685375.html; Fertilizer production in Russia increased by 10% in 2023: what awaits the industry in 2024. Available at: https://www.forbes.ru/prodovolstvennaya-bezopasnost/505396-proizvodstvo-udobrenij-v-rossii-v-2023-godu-vyroslo-na-10-cto-zdet-otrasl-v-2024-m

[20] The main strategic documents defining the objectives of the production of mineral fertilizers in China: "Strategy for the development of agriculture until 2035", "Sustainable Development Goals until 2030" (Corresponding to the UN SDG).

[21] The main strategic documents defining the goals of the production of mineral fertilizers in the USA: "Bipartisan Infrastructure Law", "Inflation Reduction Act", "National Defense Authorization Act", "U.S. Fertilizer Industry Roadmap to Net Zero Emissions by 2040" and "National Security Strategy of the United States".

The strategy for the development of mineral fertilizers production in Indonesia is aimed at the sustainable development of agriculture and improving food security[22]. According to it, the country aims to reduce dependence on imported fertilizers, increase their efficiency and protect the environment. Through investments in technological development, modernization and expansion of production capacities, the Indonesian government aims to increase production of urea and ammonia by 20–25%, phosphorous fertilizers by 15–20%, and potash fertilizers by 10–15% by 2030.

Summing up the study of the prospects for the development of the chemical industry, it is worth noting that its future is determined by the transition from an extensive raw material model to a high-tech transformation, the key driver will remain the critical role of mineral fertilizers in ensuring global food security. In the Russian context, the strategic vector of development is shifting toward achieving technological sovereignty and eliminating the structural imbalance between export-oriented low-conversion production and the scarce segment of low-tonnage chemicals. At the meso-level, the industry secures the status of a fundamental stabilizer of regional socio-economic systems, ensuring the stability of territories even during periods of acute geopolitical turbulence through ultra-high budgetary efficiency and concentration of investment capital.

Conclusion

We briefly list the main results obtained at the end of the study on the trends in the development of the global and Russian chemical industry and its impact on the development of territories.

1. The Russian chemical complex maintains a pronounced focus on the production of low-grade fertilizers, primarily mineral fertilizers, which generates a significant influx of export revenues. However, at the macro level, there is a trade deficit due to high import dependence in the segments of fine and specialty chemicals, in particular pharmaceuticals.

2. In contrast to the global trend of employment growth in the industry (+21% over 30 years), Russia is experiencing a decrease in the number of employees in it (-11%). Nevertheless, the industry retains a high share in the employment structure of manufacturing industries (5.4% in the Russian Federation), and in some regions remains one of the key employers.

3. The production of mineral fertilizers plays a critical role in ensuring global food security. The increase in global fertilizer consumption (from 42 to 140 kg/ha in 1966–2021) is associated with the need to increase yields against the background of limited land resources and population growth. Russia, controlling about 20% of the global fertilizer market, provides food security to about 1.5 billion people in terms of calories.

4. Despite the sanctions pressure, the industry demonstrates high investment activity: the share of chemicals in the investments of manufacturing industries in the Russian Federation increased from 11 to 18%.

5. Strategic documents from Russia, China, the USA, and Indonesia emphasize the importance of the fertilizer segment. In Russia, it is planned to increase the use of fertilizers by 24–52% by 2030.

6. In the regions where the largest holdings are based (PJSC PhosAgro, PAO Acron, etc.),

[22] The main strategic documents defining the goals of mineral fertilizers production in Indonesia: "Master Plan for the development of the agro-industrial complex (Rencana Induk Pengembangan Pertanian)", "Plan for National Energy and Industry until 2050 (RUEN – Rencana Umum Energi Nasional)", "Strategy for the Development of Sustainable Agriculture (Strategi Pembangunan Pertanian Berkelanjutan)", "Sustainable Development Goals until 2030 (Sustainable Development Goals – SDGs)".

the industry demonstrates extremely high fiscal importance, generating up to 33–41% of regional budget tax revenues during peak periods.

Thus, the scientific novelty of the work lies in a comprehensive study of the influence of the chemical industry on the development of territories through the prism of modern geopolitical challenges and sanctions pressure. The results can be used as a factual basis for subsequent research, as well as to inform authorities about the current state of the industry, and to develop and adjust industry strategic planning documents.

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ВЛИЯНИЕ ХИМИЧЕСКОЙ ПРОМЫШЛЕННОСТИ И ПРОИЗВОДСТВА УДОБРЕНИЙ НА РАЗВИТИЕ ТЕРРИТОРИЙ: ТЕНДЕНЦИИ И ПЕРСПЕКТИВЫ НА МАКРОУРОВНЕ

В современных условиях санкционного противостояния и геополитической турбулентности для обеспечения развития территорий необходима активизация всевозможных имеющихся ресурсов. Одним из них является химическая промышленность, обладающая широким перечнем сфер использования получаемой продукции: от низкопередельных и крупнотоннажных строительных материалов, минеральных удобрений и пластмасс до наукоемкой и дорогостоящей фармацевтики, косметики, элементов электроники и бытовой техники. Цель исследования заключается в определении влияния химической отрасли на развитие территорий в глобальном и национальном масштабе и дальнейших перспектив ее роста в отечественной экономике. Результаты анализа показывают, что вклад химической отрасли в мировой ВВП вырос с 1,6% в 1994 году до 2,7% в 2022 году, при номинальном стоимостном увеличении объема выпуска продукции примерно в 7 раз – с 400 млрд до 2,8 трлн долларов. Наиболее интенсивное развитие отрасли наблюдается в Китае – рост вклада отрасли в ВВП с 2,7% в 1994 году до 4,8% в 2023 году, тогда как стоимостной объем экспортно-импортных операций увеличился в 8–10 раз. В России химическая промышленность наиболее развита в сегменте производства минеральных удобрений, являющихся акселератором формирования экспортных доходов. Определено, что формируемое экспортом минеральных удобрений положительное сальдо платежного баланса нивелируется значительными объемами импорта фармацевтической продукции, тем самым создавая отрицательный платежный баланс. В связи с этим актуализируется вопрос

развития производства отечественной фармацевтики, способной нивелировать импортную зависимость и содействовать формированию устойчивых внешнеэкономических расчетов. Выявлена возрастающая роль химической отрасли в формировании налоговых доходов регионов базирования производств минеральных удобрений – с 6–13% в 2009 году до 9–33% к 2023 году. Помимо этого, определен ряд других каналов влияния химической отрасли на развитие территорий. Результаты исследования могут быть полезны студентам, научным работникам, преподавателям и представителям органов власти, проявляющим интерес к особенностям развития отдельных отраслей отечественного национального хозяйства.

Химическая промышленность, развитие территорий, глобальные корпорации, экономика отраслей, минеральные удобрения.

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