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TRANSFORMATION OF THE GLOBAL GM CROP MARKET: NEW PRODUCTION CENTERS AND REGIONAL TRENDS

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Tsymbal L. I., Murakhovskyi M. V. Transformation of the Global GM Crop Market: New Production Centers and Regional Trends

The article examines the transformation of the global market for genetically modified (GM) crops in the context of growing food, climate, and technological challenges. The relevance of the study is determined by the need to identify emerging trends in the development of the global GM crop market, changes in the geography of production, and the increasing role of developing countries in the global agrifood system. Despite the considerable body of research devoted to the economic efficiency and regulation of genetically modified products, the processes of spatial market transformation and the emergence of new regional production centers remain insufficiently explored. The aim of the study is to systematize and assess transformation processes in the global GM crop market, identify changes in the territorial structure of production, and determine new development centers under the influence of economic, technological, and institutional factors. The methodological framework of the research is based on statistical, comparative, structural, and dynamic analysis, as well as the synthesis of data from international organizations and industry analytical reports. The results of the study indicate that global areas cultivated with GM crops increased from 179.4 million hectares to 209.8 million hectares during 2014–2024. The market has entered a mature stage of development characterized by a high concentration of production and the dominance of several major crops, particularly soybeans and maize. A gradual shift of production centers from traditional leaders toward the countries of the Global South, including Brazil, Argentina, India, and several countries in Asia and Africa, has been identified. The study demonstrates that Latin American countries account for nearly half of the world's GM crop cultivation area, while the United States maintains its leading position in biotechnology research, patenting, and commercialization. Furthermore, the growing integration of GM technologies with digital solutions, precision agriculture technologies, artificial intelligence, and big data analytics has been revealed. The scientific novelty of the research lies in its comprehensive analysis of the contemporary transformation of the global GM crop market through the lens of changes in the regional production structure and the emergence of new agrobiotechnology development centers. The practical significance of the findings is associated with their potential application in forecasting the development of the global agricultural sector, shaping public biotechnology policies, and assessing the prospects for integrating innovative agricultural technologies into international food systems.

Keywords: *genetically modified crops; GMOs; global market; agricultural biotechnology; food security; international trade; biotechnology; agricultural sector.*
Fig.: *3.* ***Tabl.:*** *4.* ***Bibl.:*** *18.*

Tsymbal Liudmyla I. *– D. Sc. (Economics), Professor, Professor of the Department of International Economics, Kyiv National Economic University named after Vadym Hetman (54/1 Beresteiskyi Ave., Kyiv, 03057, Ukraine)*
E-mail: *l.tsimbal@ukr.net*
ORCID: *https://orcid.org/0000-0002-0873-9227*
Murakhovskyi Maksym V. *– Postgraduate Student of the Department of International Economics,, Kyiv National Economic University named after Vadym Hetman (54/1 Beresteiskyi Ave., Kyiv, 03057, Ukraine)*
ORCID: *https://orcid.org/0009-0005-3229-8627*
E-mail: *maxzerno@ukr.net*

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Цимбал Л. І., Мураховський М. В. Трансформація світового ринку ГМ-культур: нові центри виробництва та регіональні тенденції

У статті досліджено трансформацію глобального ринку генетично модифікованих (ГМ) культур в умовах посилення продовольчих, кліматичних і технологічних викликів сучасності. Актуальність дослідження зумовлена необхідністю виявлення нових тенденцій розвитку світового ринку ГМ-культур, зміною географії їх виробництва та посиленням ролі країн, що розвиваються, у глобальній агропродовольчій системі. Незважаючи на значну кількість досліджень, присвячених економічній ефективності та регулюванню генетично модифікованої продукції, недостатньо вивченими залишаються процеси просторової трансформації ринку та формування нових регіональних центрів виробництва. Метою дослідження є систематизація та оцінка трансформаційних процесів на глобальному ринку ГМ-культур, визначення змін у територіальній структурі виробництва та ідентифікація нових центрів розвитку під впливом економічних, технологічних і інституційних факторів. Методологічною основою дослідження стали методи статистичного, порівняльного, структурного та динамічного аналізу, а також узагальнення даних міжнародних організацій і галузевих аналітичних звітів. У результаті дослідження встановлено, що протягом 2014–2024 рр. світові площі вирощування ГМ-культур збільшилися з 179,4 до 209,8 млн га. Визначено, що ринок перебуває на стадії зрілого розвитку, характеризується високою концентрацією виробництва та домінуванням декількох культур, насамперед сої та кукурудзи. Виявлено зміщення центрів виробництва від традиційних лідерів до країн Глобального Півдня, зокрема Бразилії, Аргентини, Індії та окремих держав Азії й Африки. Доведено, що країни Латинської Америки забезпечують майже половину світових площ посівів ГМ-культур, тоді як США зберігають лідерські позиції у сфері наукових розробок, патентування та комерціалізації біотехнологій. Встановлено посилення інтеграції ГМ-технологій із цифровими рішеннями, технологіями точного землеробства, штучним інтелектом та інструментами аналізу великих даних. Наукова новизна дослідження полягає в комплексному аналізі сучасної трансформації глобального ринку ГМ-культур через призму зміни регіональної структури виробництва та формування нових центрів агробіотехнологічного розвитку. Практичне значення отриманих результатів полягає в можливості їх використання для прогнозування розвитку світового аграрного сектора, формування державної політики у сфері біотехнологій та оцінки перспектив інтеграції інноваційних агротехнологій у міжнародні продовольчі системи.

Ключові слова: *генетично модифіковані культури; ГМО; глобальний ринок; агробіотехнології; продовольча безпека; міжнародна торгівля; біотехнології; аграрний сектор.*
Рис.: *3.* ***Табл.:*** *4.* ***Бібл.:*** *18.*

Цимбал Людмила Іванівна *– доктор економічних наук, професор, професор кафедри міжнародної економіки, Київський національний економічний університет імені Вадима Гетьмана (просп. Берестейський, 54/1, Київ, 03057, Україна)*
E-mail: *l.tsimbal@ukr.net*
ORCID: *https://orcid.org/0000-0002-0873-9227*
Мураховський Максим Вікторович *– аспірант кафедри міжнародної економіки, Київський національний економічний університет імені Вадима Гетьмана (просп. Берестейський, 54/1, Київ, 03057, Україна)*
ORCID: *https://orcid.org/0009-0005-3229-8627*
E-mail: *maxzerno@ukr.net*

Modern realities, marked by growing global demand for food, aggravation of food security issues and the consequences of climate change, bring to the forefront the importance of the development of biotechnology in agriculture. One of the key areas of these innovative developments is the spread of genetically modified crops (GM crops). They are able to provide increased yields, resistance to pests, diseases and adverse natural and climatic conditions. Over the past decades, the global market for GM crops has shown rapid growth, while simultaneously experiencing significant structural changes under the influence of technological advances, geo-economic transformations and changes in the global agro-industrial system.

The development of the global market for genetically modified products is influenced by a complex of interrelated factors, among which the leading place is occupied by the achievements of biotechnology, the economic advantages of using GM crops and the features of State regulation in the field of agricultural production. The spread of genetically modified organisms is accompanied by active scientific and public discussions on their impact on the environment, food security and health of the population. In the context of increasing global challenges, in particular climate change, population growth and the need to increase agricultural productivity, genetically modified products are increasingly considered as one of the tools for ensuring the stability of the agricultural sector. The use of modern biotechnological solutions contributes to increasing yields, crop resistance to adverse natural conditions and optimizing agricultural production processes on a global scale.

The relevance of the study is determined by the growing role of genetically modified products in ensuring the stable functioning of the global agricultural sector and the need to assess current trends in the development of this market in the context of global economic transformations. Of particular importance is the study of the economic consequences of the spread of GM products, their impact on international trade, food security, and the competitiveness of agricultural economies.

Despite the fact that the USA, Brazil, Argentina and Canada remain leaders in the production of genetically modified crops, new centers have recently appeared on the world map of production in the countries of Asia, Africa and Latin America. The expansion of the geography of GM crop cultivation is largely influenced by changes in State policy regarding the use of biotechnology, increased investment by transnational companies, the development of research infrastructure and the need to adapt the agricultural sector to climate change. However, different regional approaches to regulatory policy, public perception and the level of technological development create a certain heterogeneity in the global trends in the functioning of this market. In view of this, it is becoming increasingly important to analyze the transformation of the global GM crop market, identify new production centers and study the regional features of its development. This approach allows us to more effectively assess current trends in international agribusiness, outline promising areas for the development of the biotechnology sector and predict possible consequences for the global food system.

Literature review. The market for genetically modified products is the subject of active scientific research by a significant number of scientists, and particularly intensive development of this direction is observed at the beginning of the modern century. Modern research is characterized by increased interdisciplinarity and integration of approaches of international economics, agrarian and environmental economics. The main attention of scientists is focused on issues of economic efficiency of biotechnology and transformation of global agri-food markets, which is reflected, in particular, in the works of Kuzmenko O. and Chyzhevska M. [1]. Issues of institutional regulation, as well as analysis of consumer preferences and market behavior are highlighted in the studies of J. Brown et al. [2], S. Smith, V. Kerr and P. Phillips [3].

National approaches to regulating the market for genetically modified products are analyzed in detail in the works of Lubieniechi S., Gleim S. and Smyth S. [4] Meta-analytic studies by Matin Qaim and colleagues, as well as recent works by Graham Brookes and Peter Barfoot [5], demonstrate that the introduction of genetically modified crops can contribute to increased yields, reduced costs for plant protection products and increased profits for agricultural producers. However, it is noted that economic results vary significantly depending on the specific country, the characteristics of the agricultural sector and the level of technological development [6]. In the field of behavioral economics, significant emphasis has been placed on research into consumer preferences for genetically modified products. As evidenced by the works of Jayson Lusk and other scientists [7], consumer attitudes towards such products are determined not only by their price, but also by the level of trust in relevant institutions, transparency of information and socio-cultural characteristics. In addition, there is a stable trend towards increasing demand for alternative market segments, such as organic products and GMO-free products. The works of R. L. Paarlberg [8] and his colleagues emphasize the impact of regulatory differences between countries, in particular in the context of differences between the practices of the European Union and the United States. Such differences form significant non-tariff barriers that affect the structure of international trade in agri-food products. Separately, the scientific literature focuses on issues of sustainable development of the agricultural sector. Modern studies, for example, Amanulah M., Nahid M., Hosen S. Z. [9], note that the use of GM technologies can contribute to reducing the use of pesticides and increasing the efficiency of resource use in agricultural production. At the same time, transformation processes in the market of genetically modified products and changes in regional disparities remain insufficiently studied, which determines the basis of this study.

The *aim of the study* is to systematize and assess transformation processes in the global GM crop market, establish changes in the spatial structure of production, and identify new regional development centers taking into account economic, technological, and institutional determinants.

Results. The formation and development of the global market for genetically modified products is influenced by a combination of technological, economic and regulatory factors. An important driver is the development of genetic engineering and biotechnology, which contributes to increasing agricultural productivity, creating crops resistant to climate change and expanding agricultural production opportunities. At the same time, the deterioration of global food security indicators highlights the need to implement innovative agricultural technologies that can meet the growing food needs of the world's population [10]. During the period from 1996 to 2020, the economic benefits for farms from the use of GM crops were significant, and farm income from the use of these technologies increased by USD 261.3 billion [11]. However, it is worth noting that the market for genetically modified products is under pressure from regulatory instruments, within which international organizations, in particular the Organisation for Economic Co-operation and Development, form safety standards, risk assessments and regulation of international trade in genetically modified products [12].

The global market for genetically modified products is developing at a high pace and is characterized by a steady trend towards expansion both in terms of production volumes and geography of distribution. Since the commercial introduction of GM crops in the mid-1990s, the world's areas of their cultivation have grown almost every year, which indicates a gradual strengthening of the role of biotechnology in modern agricultural production. The dynamics of market development is due to the growing demand for highly productive and resistant to adverse natural and climatic conditions crops, as well as the need to increase the efficiency of land, water and labor resources (*Tbl. 1*).

Table 1

Dynamics of changes in the areas of cultivation of GM crops in the world

Year	Sown area under GM crops	Change
2013	170.1	4.2
2014	179.4	5.3
2015	176.8	–1.4
2016	180.2	1.9
2017	186.9	3.7
2018	186.9	0.0
2019	186.4	–0.2
2020	189.1	1.4
2021	196.2	3.8
2022	202.9	3.4
2023	205.8	1.4
2024	209.8	1.9

Source: [13;14].

Over the period 2014–2024, the global planted area under genetically modified crops increased from

179.4 million hectares to 209.8 million hectares, corresponding to a cumulative increase of about 16.9% and an average annual increase of about 1.7%. The dynamics is characterized by a wave-like development: in 2014–2019 there was stagnation and periods of slight contraction (in particular in 2015 and 2019), which reflects market saturation in the leading producing countries and regulatory restrictions, while after 2020 there was a recovery of growth with peak rates in 2021–2022 (3.8% and 3.4%, respectively), which was caused by the strengthening of global food demand, price shocks and the expansion of production in the countries of the Global South, primarily in Brazil and Argentina, which collectively increased more than 10% of the cultivated area. In 2023–2024, the growth rate stabilized at 1.4–1.9%, which indicates the transition of the market to the phase of a mature, moderately growing agro-biotechnological sector with a high concentration of production and limited space for expansion in traditional regions. In 2024, the world saw a moderate expansion of the area of cultivation of genetically modified crops – the increase was almost 2%. The main factor behind this was the increase in soybean, cotton and canola crops, while the area under GM corn decreased. The most dynamic growth among individual countries was demonstrated by Vietnam, Uruguay, Spain and Myanmar. At the same time, the largest absolute increase was recorded in Argentina, where the cultivated area increased by 1.8 million hectares. The United States retained its position as the largest producer of GM crops in the world, demonstrating an increase in acreage due to the expansion of soybean, cotton and rape cultivation [15].

The number of countries growing genetically modified crops is increasing every year and is approaching 30 (*Fig. 1*).

The GM crop market is characterized by a high level of territorial concentration, with production largely concentrated in a limited number of countries. The leading producers are the United States, Brazil, Argentina, Canada, and India, which together account for more than 90% of the global area planted with GM crops and generate the majority of world output. The dominance of these countries is driven by favorable regulatory frameworks, strong agricultural sectors, advanced biotechnology adoption, and significant investments in agricultural research and development. At the same time, the market structure demonstrates increasing participation of developing economies, particularly in Latin America and Asia, where GM technologies are being widely adopted to enhance productivity, improve resilience to climate change, and strengthen export competitiveness. As a result, while the market remains highly concentrated, the geographical distribution of production is gradually expanding, reflecting the emergence of new regional centers of GM crop cultivation (*Tbl. 2*).

In general, genetically modified crops are officially allowed for cultivation in more than 30 countries worldwide [16]. It is worth noting that genetically modified crops occupy about 36% of the world's sown areas, and the dynamics of development are quite active – from 1.7 million hectares in 1996 to over 200 million hectares at the current stage of development. This confirms the growing role of biotechnology as a strategic tool for ensuring sustainable development,

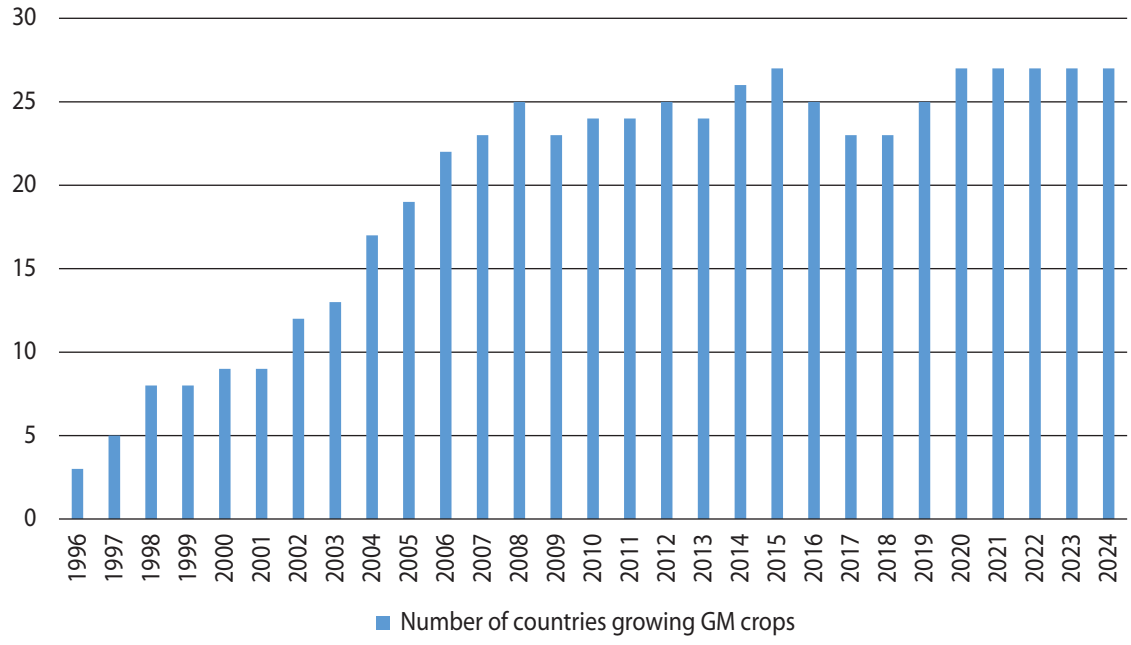

Fig. 1. Number of countries growing genetically modified crops, 1996–2024

Source: [13; 16].

in particular in addressing global challenges related to food security and climate change.

Table 2

Leading countries by the number of sown areas for GM crops, 2024

No.	Country	Area under GM crops, million hectares	Change, %	Share, %
1	USA	75.4	1.3	35.9
2	Brazil	67.9	1.4	32.4
3	Argentina	23.8	8.3	11.4
4	Canada	11.7	–0.4	5.6
5	India	11.2	–7.1	5.3
6	Paraguay	4.4	2.1	2.1
7	China	3.5	17.9	1.7
8	South Africa	3.5	–0.5	1.7
9	Pakistan	1.9	–16.7	0.9
10	Bolivia	1.8	1.4	0.9
–	Others	4.8	22.5	2.3
Total		**209.8**	**1.9**	**100.0**

Source: [13].

It is worth noting that this market is dominated by developing countries, with only the countries of Central and South America providing about 50% of the sown areas of genetically modified crops (*Tbl. 3*).

Table 3

Area sown with genetically modified crops in Central and South American countries, 2024

Country	Sown areas, million hectares	Change, %	Share, %
Brazil	67.9	1.3	68.1
Argentina	23.8	8.3	23.9
Paraguay	4.4	2.1	4.4
Bolivia	1.8	1.4	1.8
Uruguay	1.5	49.8	1.5
Colombia	0.2	1.8	0.2
Honduras	0.1	21.8	0.1
Chile	0.0	–16.2	0.0
Mexico	0.0	–7.6	0.0
Total	99.7	3.5	100.0

Source: [13].

An analysis of the structure of GM crop areas in Latin American countries indicates a high concentration of production in several key agricultural countries. Brazil remains the absolute leader, accounting for 67.9 million hectares or 68.1% of all GM crop areas in the region. This confirms the country's dominant role in the global soybean, corn and cotton market, as well as the high level of integration of biotechnology into the national agricultural sector. Argentina is in second place with 23.8 million hectares and a share of 23.9%.

At the same time, this country has demonstrated one of the highest growth rates among large producers: 8.3%, which indicates a further expansion of the use of GM crops in export-oriented agricultural production. Significantly smaller production scales are characteristic of Paraguay, Bolivia and Uruguay, but their role in the regional market is gradually increasing. Uruguay is particularly noteworthy, where the highest growth rate was recorded – almost 50%, which may indicate increased agricultural investment and expansion of biotechnological production.

In Colombia and Honduras, the areas remain small, but positive dynamics indicate a gradual spread of GM technologies in Central and South American countries. On the other hand, Chile and Mexico show a decrease in areas, which may be due to regulatory restrictions, changes in the State agricultural policy or public discussions on the use of GMOs. In general, the region is characterized by a high level of introduction of genetically modified crops and the preservation of the status of one of the key global centers of GM production.

Considering that the total sown area is slightly more than 200 million hectares, almost 98 of them fall on Central and South American countries, however, it is worth noting that the vast majority of companies involved in development and research are located in the United States (*Fig. 2*).

The USA is the absolute world leader, dominated by Monsanto, DuPont, Dow AgroSciences, Corteva, university research and USDA State programs. The USA forms the global market for GM seeds and technologies, the key players in the market are TNCs, universities, seed and biotechnology companies [17]. The USA is the center of development, patenting and commercialization of most GM technologies. The second place in the number of companies is occupied by China, where the key players are the Academies of Sciences, universities, biotechnology companies, China is one of the main centers of the State-based biotechnology research. The high role of State institutes and national companies in the development of their own GM technologies.

China is actively forming its own biotechnological base, reducing dependence on Western corporations and investing in the State research. Similar approaches are taking shape in Brazil, where State agricultural centers and biotechnology companies are en-

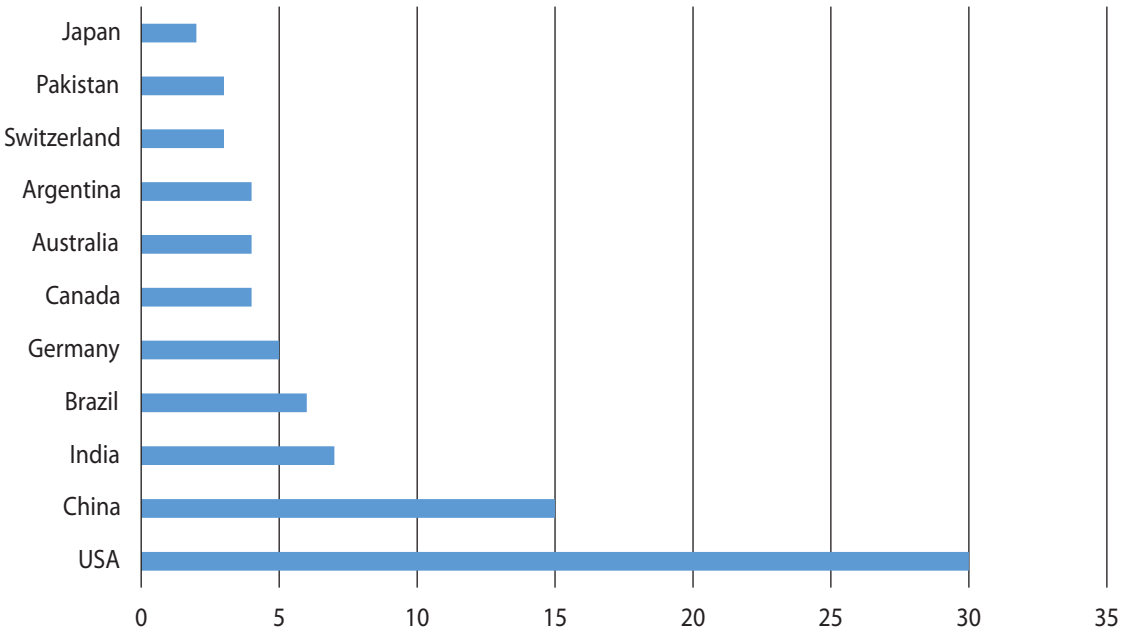

Fig. 2. Key countries involved in the development of genetically modified organisms, 2025

Source: [17].

gaged in developments mainly in the market of genetically modified soybeans and corn. Another strategy is being implemented in India, where the private sector is quite actively cooperating with international corporations and companies. Seed companies, agrogenetic enterprises, and research centers are actively developing GM cotton.

The global market for genetically modified crops is characterized by a high level of technology concentration within several transnational corporations, among which Monsanto, Bayer, BASF, Syngenta and Corteva occupy leading positions. It is these companies that control a significant part of the patents, the seed market and biotechnological developments in the field of agricultural production. At the same time, the largest number of market participants is concentrated in the countries with a powerful agricultural sector and a high level of agricultural exports, in particular in the USA, Brazil, Argentina, China and India. The modern model of development of GM technologies is also characterized by a combination of the public and private sectors: in the countries of Asia and Latin America, State research institutes and academic institutions play an important role, while in the USA and European countries, large private agrobiotechnological corporations have a dominant influence.

There is a geographical transformation of production, the shift of centers of production of genetically modified crops from developed countries to developing countries, the role of Brazil, Argentina and India is increasing. The current development of the genetically modified products market is characterized by the active integration of biotechnology with digital technologies, in particular elements of precision agriculture, artificial intelligence, Big Data and agricultural production monitoring systems. The use of digital solutions allows to optimize the processes of selection, yield control and adaptation of crops to climate change. At the same time, there is a transition to a new generation of biotechnology products based on genome editing technologies, in particular CRISPR/Cas, which expands the possibilities of creating crops with specified characteristics.

The dynamism of the global GM market is confirmed by the constant growth of the world's area of genetically modified crops and the expansion of the geography of their use. A significant share of the market remains concentrated within a few transnational corporations, such as Monsanto (now Bayer), Syngenta, Corteva and BASF, which control a significant part of the global seed market and biotechnology patents. At the same time, the institutional environment has an important impact on the functioning of the market, since State policy, certification systems, labeling requirements and regulatory restrictions differ significantly between countries and regions of the world.

The further development of the genetically modified market will largely depend on the ability to ensure a balance between the economic efficiency of agricultural production, environmental safety and the level of public trust in biotechnology. It is the combination of innovative development with efficient regulation that will determine the prospects for the global spread of GM products in the future.

The use of genetically modified crops has a certain positive effect, leading to a reduction in the need for agricultural land (approximately 180 million hectares) [18].

An analysis of the dynamics and scale of areas sown with genetically modified crops allows us to determine not only the level of spread of biotechnology in agriculture, but also to identify crops that occupy leading positions in the structure of global agricultural production. That is why it is advisable to move on to the characteristics of key GM crops that form the basis of the modern market of genetically modified products, including, in particular, soybeans, corn, etc. (*Tbl. 4*).

Table 4

Key GM crops, 2024

Crop	Sown area, million ha	Change, %	Share of sown area, %
Soybean	105.1	4.7	50.0
Corn	68.4	–2.5	32.5
Cotton	24.2	2.2	11.8
Canola	10.4	1.0	5.0
Alfalfa	1.1	–5.5	0.5
Sugar Beet	0.5	–1.6	0.22
Sugar Cane	0.1	8.3	0.03
Wheat	0.0	10.8	0.02
Brinjal	0.0	2.7	0.00
Rice	–	–100.0	0.00
Total	209.8	1.9	100.0

Source: [13].

The structure of the sown areas demonstrates a high concentration of agricultural production within several key crops, primarily soybeans and corn, which together form more than 80% of the total area (50.0% and 32.5%, respectively). This configuration indicates the dominance of the export-oriented raw material model of the agricultural sector and increased specialization of production. The dynamics of changes confirms a further shift towards soybeans (+4.7%), while corn demonstrates a reduction (–2.5%), which may indicate a structural redistribution of resources between crops. Other crops (cotton, canola, alfalfa, sugar crops) occupy much smaller shares and are characterized by either moderate growth or stagnation, which further strengthens the tendency towards agricultural concentration. In general, there is a decrease in the diversification of the crop structure and an increase in dependence on the two dominant crops, which has both economic advantages (scaling exports) and risks (sensitivity to price fluctuations on world markets).

GMOs are most widely used in cotton production, with over three-quarters of the world's cotton acreage planted with genetically modified varieties. High levels are also seen in soybeans, where GM varieties dominate in many exporting countries.

For corn and rapeseed, the share is lower, although these crops also belong to the main segments of the GM market. The phrase "after this level of global adoption, it falls rapidly" means that other crops have significantly lower levels of GMO use or are almost not grown in genetically modified form at all. This is explained by regulatory restrictions, lower commercial demand, technological difficulties and ambiguous public perception of certain types of GM products. Cotton has the highest level of GMO use – 76.0% of the total cotton area in the world, followed by soybeans – 72.4%, corn – 34.0% and rapeseed – 24.0%. After this level, global adoption falls rapidly (*Fig. 3*).

The global market for genetically modified products is being shaped by the systemic interaction of technological innovations, economic incentives and institutional regulation, which ensures its relatively stable and progressive growth. The analysis confirms that the implementation of genetic engineering achievements contributes to increasing the productivity of the agricultural sector, increasing farm incomes and optimizing resource use, in particular by reducing the need to expand agricultural land.

The dynamics of sown areas indicate the transition of the market from a phase of rapid expansion to a stage of mature development, characterized by moderate growth rates and high geographical concentration of production in leading countries. At the same time, the increasing role of the countries of the Global South indicates a gradual transformation of the spatial structure of the market.

At the same time, the further development of the market for genetically modified products will be determined not only by economic feasibility, but also by the efficiency of regulatory mechanisms, the level of public trust and the ability to ensure a balance between innovation, environmental safety and food stability. In this context, the integration of biotechnology with digital solutions opens up new prospects for increasing the efficiency of agricultural production, but at the same time actualizes the need to improve global governance and harmonize standards at the international level.

CONCLUSIONS

The global market for genetically modified crops is characterized by a gradual shift in production centers from traditional leaders (United States, Brazil and Argentina) to new regions, in particular, countries in Asia, Africa and Latin America, where there is an ac-

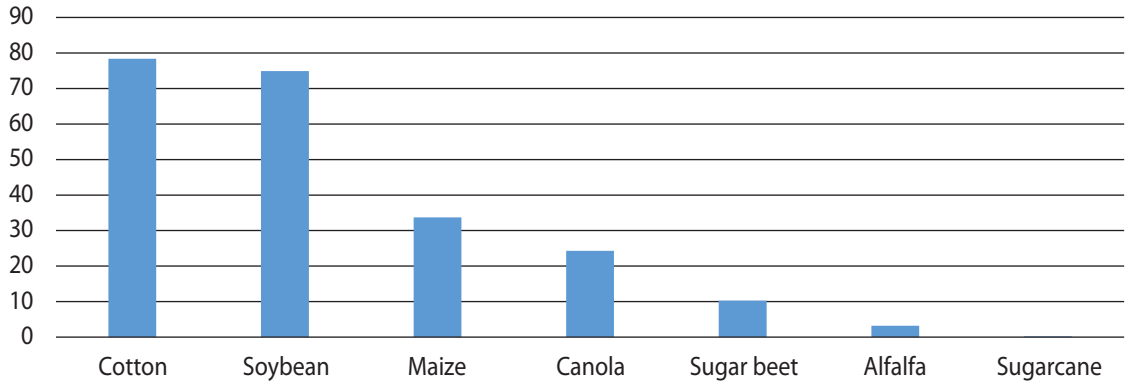

Fig. 3. Global adoption of GM crops, 2024

Source: [13].

tive introduction of biotechnology into agriculture. Regional differentiation in the development of the GM crop market has been identified: commercial mass production dominates in the countries of the Americas, while countries in Asia and Africa demonstrate a gradual expansion of crop areas and increased investment in agrobiotechnology. The strengthening of the role of new production centers is changing the structure of global agri-food competition and shaping new directions of international trade in genetically modified products. Further development of the global GM crop market will depend on the harmonization of international regulation, the level of public acceptance of biotechnology, the innovative activity of transnational agri-biotech companies and the integration of digital technologies into agricultural production. ■

BIBLIOGRAPHY

1. Kuzmenko O., Chyzhevska M. Agricultural entere prise economic security systems modelling. *Scientific Horizons*. 2024. Vol. 27. No. 3. P. 143–153. DOI: https://doi.org/10.48077/scihor3.2024.143
2. Science and Innovations for Food Systems Transformation / Von Braun J., Afsana K., Fresco L. O., Hassan M. H. A. (eds.). Cham: Springer International Publishing; 2023. DOI: https://doi.org/10.1007/978-3-031-15703-5
3. Smyth S. J., Kerr W. A., Phillips P. W. B. Biotechnology Regulation and Trade. Cham: Springer International Publishing; 2017. DOI: https://doi.org/10.1007/978-3-319-53295-0
4. Lubieniechi S., Gleim S., Smyth S. J. Reducing the regulatory burden of plant biotechnology regulations in Canada. *Genome*. 2025. Vol. 68. P. 1–9. DOI: https://doi.org/10.1139/gen-2024-0164
5. Klümper W., Qaim M. A Meta-Analysis of the Impacts of Genetically Modified Crops. *PLoS ONE*. 2014. Vol. 9. Art. e111629. DOI: https://doi.org/10.1371/journal.pone.0111629
6. Brookes G. Genetically Modified (GM) Crop Use 1996–2020: Environmental Impacts Associated with Pesticide Use Change. *GM Crops & Food*. 2022. Vol. 13. Iss. 1. P. 262–289. DOI: https://doi.org/10.1080/21645698.2022.2118497
7. Lusk J. L. Chapter 10. Consumer Preferences for Genetically Modified Food. In: Carter C. A., Moschini G., Sheldon I. (eds.). In: *Frontiers of Economics and Globalization*. Emerald Group Publishing Limited, 2011. P. 243–262. DOI: https://doi.org/10.1108/S1574-8715(2011)0000010015
8. Paarlberg R. Starved for Science: How Biotechnology Is Being Kept Out of Africa. *Harvard University Press*. 2008. URL: https://www.wcfia.harvard.edu/publications/starved-science-how-biotechnology-being-kept-out-africa
9. Amanullah M., Nahid M., Hosen S. Z. Global Overview of Genetically Modified Foods and Its Benefits: A Review. *Health Dynamics*. 2024. Vol. 1. No. 7. P. 236–243. DOI: https://doi.org/10.33846/hd10703
10. Global Food Security Index. 2022. URL: https://impact.economist.com/sustainability/project/food-security-index#rankings-and-trends
11. Brookes G. Farm income and production impacts from the use of genetically modified (GM) crop technology 1996–2020. *GM Crops & Food*. 2022. Vol. 13. Iss. 1. P. 171–195. DOI: https://doi.org/10.1080/21645698.2022.2105626
12. Safety Assessment of Transgenic Organisms. *Organisation for Economic Co-operation and Development*. 2023. URL: https://www.oecd.org/en/publications/safety-assessment-of-transgenic-organisms-in-the-environment-volume-10_62ed0e04-en.html
13. Global GM Crop Area Review. April 2025. URL: https://croplifevietnam.org/wp-content/uploads/2025/05/ENG_Global-GM-Crop-Area-2024-Review.pdf

14. Global GM Crop Area Review. 2024. URL: https://thehealthsciencesacademy.org/wp-content/uploads/2024/04/Global-GM-Crop-Area-Review_Feb2024.pdf
15. AgbioInvestor GM Monitor. 2025. URL: https://gm.agbioinvestor.com/
16. Tome K. G., Dionglay C., Escasura J. C. Countries Approving GM Crop Cultivation. 2024. URL; https://www.isaaa.org/blog/entry/default.asp?BlogDate=10%2F31%2F2024
17. Developers. 2025. URL: https://www.isaaa.org/gmapprovaldatabase/
18. Brookes G., Barfoot P. Environmental impacts of genetically modified (GM) crop use 1996–2018: impacts on pesticide use and carbon emissions. *GM Crops & Food*. 2020. Vol. 11. Iss. 4. P. 215–241. DOI: https://doi.org/10.1080/21645698.2020.1773198

REFERENCES

Amanullah M., Nahid M. & Hosen S. Z. (2024). Global Overview of Genetically Modified Foods and Its Benefits: A Review. *Health Dynamics, 7*(1), 236–243. https://doi.org/10.33846/hd10703

Brookes G. (2022). Farm income and production impacts from the use of genetically modified (GM) crop technology 1996–2020. *GM Crops & Food, 1*(13), 171–195. https://doi.org/10.1080/21645698.2022.2105626

Brookes G. & Barfoot P. (2020). Environmental impacts of genetically modified (GM) crop use 1996–2018: impacts on pesticide use and carbon emissions. *GM Crops & Food, 4*(11), 215–241. https://doi.org/10.1080/21645698.2020.1773198

Brookes G. (2022). Genetically Modified (GM) Crop Use 1996–2020: Environmental Impacts Associated with Pesticide Use Change. *GM Crops & Food, 1*(13), 262–289. https://doi.org/10.1080/21645698.2022.2118497

croplifevietnam.org. *Global GM Crop Area Review*. https://croplifevietnam.org/wp-content/uploads/2025/05/ENG_Global-GM-Crop-Area-2024-Review.pdf

gm.agbioinvestor.com. (2025). *AgbioInvestor GM Monitor*. https://gm.agbioinvestor.com/

impact.economist.com. (2022). *Global Food Security Index*. https://impact.economist.com/sustainability/project/food-security-index#rankings-and-trends

isaaa.org. (2025). *Developers*. https://www.isaaa.org/gmapprovaldatabase/

Klümper W. & Qaim M. (2014). A Meta-Analysis of the Impacts of Genetically Modified Crops. *PLoS ONE, 9*. https://doi.org/10.1371/journal.pone.0111629

Kuzmenko O. & Chyzhevska M. (2024). Agricultural enterprise economic security systems modelling. *Scientific Horizons, 3*(27), 143–153. https://doi.org/10.48077/scihor3.2024.143

Lubieniechi S., Gleim S. & Smyth S. J. (2025). Reducing the regulatory burden of plant biotechnology regulations in Canada. *Genome, 68*, 1–9. https://doi.org/10.1139/gen-2024-0164

Lusk J. L. (2011). Chapter 10. Consumer Preferences for Genetically Modified Food. *Frontiers of Economics and Globalization* (p. 243–262). Emerald Group Publishing Limited. https://doi.org/10.1108/S1574-8715(2011)0000010015

Organisation for Economic Co-operation and Development. (2023). *Safety Assessment of Transgenic Organisms*. https://www.oecd.org/en/publications/safety-assessment-of-transgenic-organisms-in-the-environment-volume-10_62ed0e04-en.html

Paarlberg R. (2008). Starved for Science: How Biotechnology Is Being Kept Out of Africa. *Harvard University Press*. https://www.wcfia.harvard.edu/publications/starved-science-how-biotechnology-being-kept-out-africa

Smyth S. J., Kerr W. A. & Phillips P. W. B. (2017). Biotechnology Regulation and Trade. *Springer International Publishing*. https://doi.org/10.1007/978-3-319-53295-0

thehealthsciencesacademy.org. (2024). *Global GM Crop Area Review*. https://thehealthsciencesacademy.org/wp-content/uploads/2024/04/Global-GM-Crop-Area-Review_Feb2024.pdf

Tome K. G., Dionglay C. & Escasura J. C. (2024). *Countries Approving GM Crop Cultivation*. https://www.isaaa.org/blog/entry/default.asp?BlogDate=10%2F31%2F2024

Von Braun J., Afsana K., Fresco L. O. & Hassan M. H. A. (2023). *Science and Innovations for Food Systems Transformation*. Springer International Publishing. https://doi.org/10.1007/978-3-031-15703-5

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